# BLOOD PRESSURE CHANGES IN ESSENTIAL HYPERTENSION AFTER EXCISION OF THE CELIAC GANGLION AND DENERVATION OF THE AORTIC PLEXUS

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One of the first operations designed to control elevation of blood pressure in essential hypertension was a unilateral adrenalectomy which was performed by Dr. George Crile in 1915. Since that time, 120 operations designed to control essential hypertension have been performed at the Cleveland Clinic.

A series of eleven unilateral adrenalectomies resulted in only transitory falls of blood pressure levels. Bilateral denervation of the adrenal glands was next attempted, and this procedure resulted in definite symptomatic relief.

In the majority of cases the hypertension was temporarily lessened, and in early cases in young patients lasting relief was obtained. In advanced cases, however, no striking changes in blood pressure were noted. This operation alone is, therefore, not a specific treatment for essential hypertension.

This experience with operations on the adrenal glands led us to abandon the hypothesis that essential hypertension was a disorder resulting from an excessive secretion of adrenalin and forced us to look for other explanations. Working on the hypothesis that the increased peripheral resistance necessary to maintain the hypertension was the result of a spasm of the vascular bed and was mediated by the sympathetic nervous system, Dr. George Crile on May 4, 1934 in addition to the denervation of the adrenal sectioned the left major splanchnic nerve beneath the diaphragm. The operation was performed through a modified kidney incision and was followed by an immediate fall in blood pressure. In the next series of cases the major, minor, and least splanchnic nerves were divided through a subdiaphragmatic approach in fifty-one cases. Greater symptomatic relief followed this procedure.

The blood pressure often showed a dramatic initial fall and in the majority of cases was below the preoperative level when the patient was ready to leave the hospital. The later results were more encouraging than after bilateral denervation alone. These results together with those in the early stages of hypertension and in juvenile cases gave us the impression that we were dealing successfully with the disease and this led us to the study of the comparative anatomy of the adrenal sympathetic complex as a whole. From this study we have come to appreciate the importance of the aortic sympathetic plexus. This plexus was denervated in a series of ten cases, the denervation including

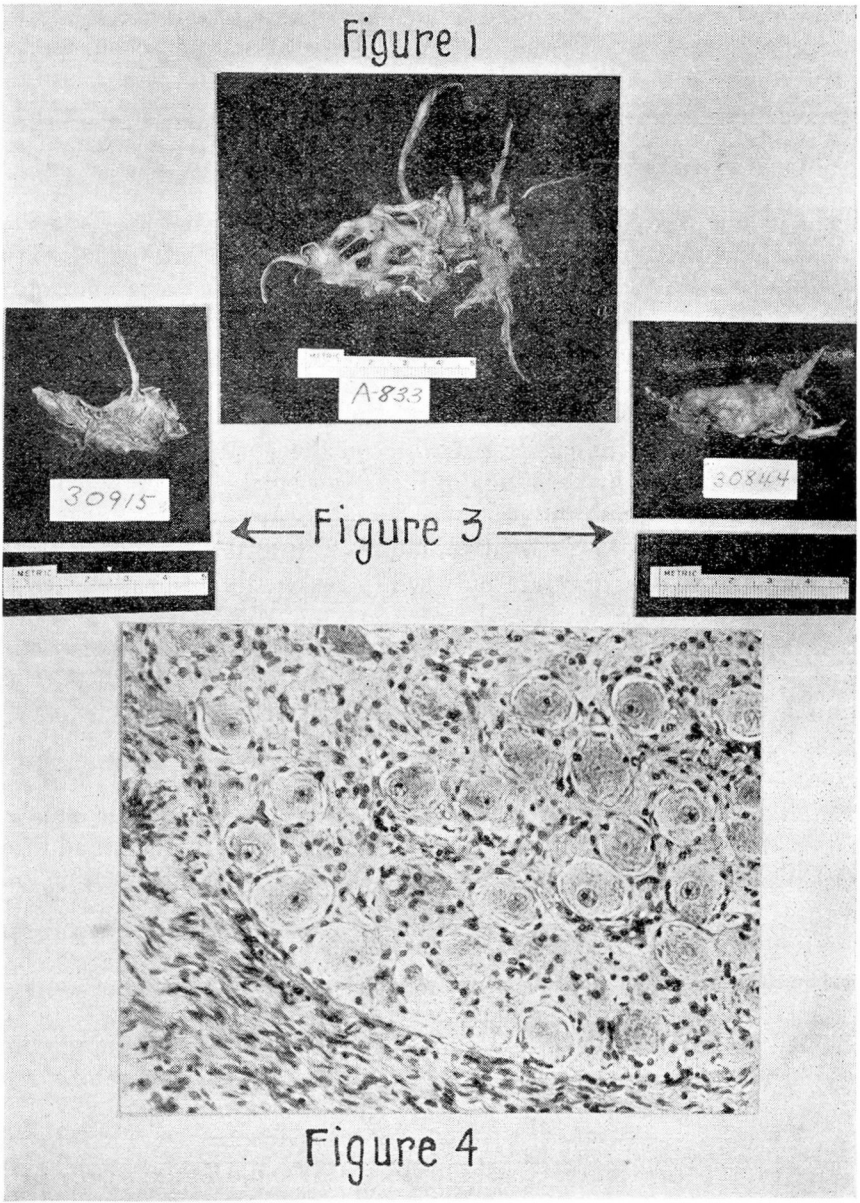


FIGURE 1: Photograph of celiac ganglion and plexus (autopsy specimen).

FIGURE 3: Left and right celiac ganglia removed surgically in cases of essential hypertension.

FIGURE 4: Photomicrograph of celiac ganglion removed from a patient with severe essential hypertension. Note the large ganglion cells interspersed in dense nerve tissue.

section of the branches to this plexus from the ganglionated cords from the adrenal glands and from the splanchnic nerves. A still greater fall in blood pressure resulted from this type of operation and encouraged us to add to it resection of the celiac ganglion. The first of these operations was performed on May 6, 1936.

## The Celiac Ganglion and the Aortic Plexus

The celiac plexus is composed of a left and right ganglion connected with a dense maze of nerve fibers. (Fig. 1.) The left ganglion invariably lies directly on the corresponding side of the aorta and into it pass the major and minor splanchnic nerves on that side (Fig. 2). On the right the ganglion lies just to the right of the aorta and into it pass the right major and minor splanchnic nerves. The ganglionic tissue on each side composes a firm mass of about the diameter and thickness of a nickel. This mass is easily palpable on the aortic wall and can be identified definitely by palpation of the major splanchnic nerve entering at its upper outer quadrant.

On the left the ganglion is densely adherent to the aorta and can be mobilized from this structure only with considerable difficulty. On the right it is less closely attached and more movable. The medial sides of the two portions are connected with many tough nerve fibers which intermesh around the celiac artery. On the lateral aspects of the ganglion are numerous branches to the adrenal glands.

The aortic plexus lies below the celiac ganglia, receives branches from the ganglia, and branches from the lumbar ganglionated cords and from the least splanchnic nerves. The renal vein which is delicate and easily injured crosses just beneath the celiac ganglion. In addition the suprarenal vein and artery are in close proximity to the ganglion and, when stretched, are easily confused with nerve trunks. On the right the ganglion is in close relation to the vena cava (Fig. 3).

Histologically, the celiac ganglion is composed of dense nerve tissue in which are interspersed numerous large ganglion cells (Fig. 4). Excision of the ganglion removes the ganglion cells and renders impossible regeneration of postganglionic fibers. Theoretically, therefore, any change resulting from ganglionectomy should be permanent.

## Technique of Celiac Ganglionectomy and Denervation of the Aortic Plexus

The operation of celiac ganglionectomy is performed in two stages, the left ganglion being removed at the first operation and the right, one week later. The incision starts at the angle formed by the twelfth rib with the sacrospinalis muscle, extends the entire length of the twelfth rib and is curved downward to a point just anterior to the crest of the

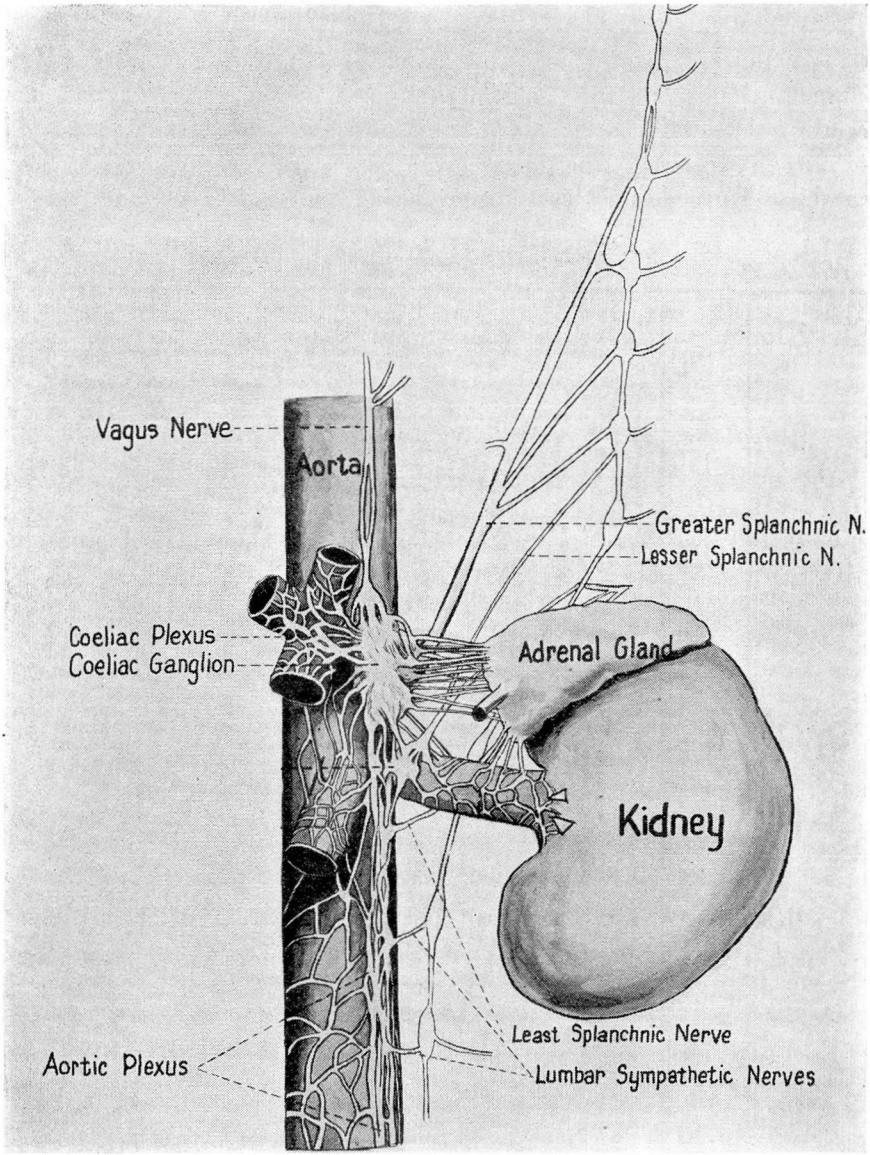


FIGURE 2: Drawing to show relationships of celiac ganglion, splanchnic nerves, and the aortic plexus.

ilium. The quadratus lumborum muscle is divided close to the twelfth rib and the muscles are separated downward to the iliac crest. The lumbodorsal fascia is then incised and the retroperitoneal space widely exposed. The hand is swept along the quadratus lumborum and psoas muscles until the aorta is palpated. The celiac ganglion is easily located by the sense of touch and can be partially mobilized by blunt dissection.

When the ganglion is mobilized sufficiently to enable the operator to identify the splanchnic nerves, a hook is slipped beneath the major splanchnic nerve, and the ganglion is exposed and carefully examined to ascertain its relation to the renal vein, the vena cava (on the right) and the adrenal vessels. The ganglion is then carefully excised with long scissors. No bleeding results from cutting the nerve tissue and there is

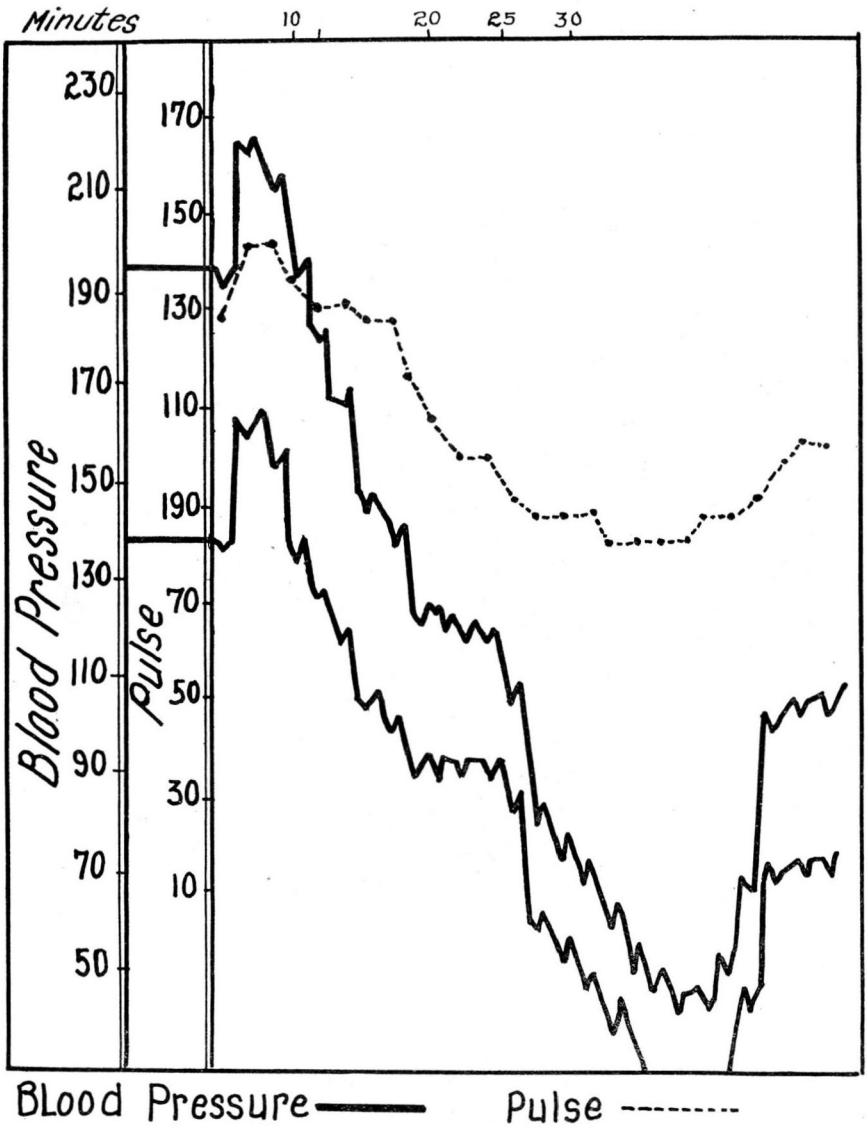


FIGURE 5: Photograph of anesthetist's chart showing pulse and blood pressure changes during operation.

no necessity for cutting the nerve trunks between clamps. The least splanchnic nerve and the branches from the ganglionated chain to the aortic plexus are severed and the component parts of the celiac plexus lying upon the aorta are then divided, thus completing the denervation of the aortic plexus.

## Results of Celiac Ganglionectomy

The blood pressure response is usually immediate and dramatic, the pressure falling from 40 to 150 points at the time the ganglion is removed (Fig. 5). The pulse, however, remains slow and of good volume. much like the pulse of a patient under a spinal anesthetic.

The pressure tends to be low for the first six to twenty-four hours, but the systolic pressure never remains below 100 mm. of mercury for more than a few hours. The initial drop is followed by a secondary rise which reaches its peak about the fifth day postoperatively. The pressure then gradually falls and by the tenth day has stabilized itself at a level much lower than the pressure before operation (Fig. 6).

At this time one or both sides of the celiac ganglion have been excised in twenty-seven cases of severe essential hypertension. Three fatalities have occurred, one from hemorrhage from the renal vein, one from bilateral thrombosis of the renal veins, and one from an unexplained hyperthermia, possibly of central nervous system origin.

Aside from the case in which thrombosis of the renal veins resulted in uremia, there have been no instances of serious renal failure. This is a significant observation inasmuch as several of the patients in this group were over sixty years of age, suffered from advanced malignant hypertension, and had poor kidney function.

Although several patients had suffered from anginal attacks or cardiac asthma before the operation and in spite of the fact that severe myocardial damage as indicated by changes in the electrocardiogram was frequently present, we have seen no instance of postoperative cardiac decompensation. The lowering of the blood pressure apparently relieves the myocardium of the excessive burden it is carrying.

Following the operation there is usually a period of from two to six days in which abdominal distress and distention are troublesome complaints. This results from the derangement in the visceral innervation but compensation is soon made and this results in no permanent ill effects.

In half the cases in this group the hypertension had entered the malignant phase as evidenced by the presence of edema of the optic discs. The oldest patient was 62 and the youngest 26, the average age being 43 years.

In eleven cases only the left ganglion was removed, in six cases denervation of the aortic plexus (older type of operation) was done on one side and the celiac ganglion was removed on the other, and in seven cases bilateral excisions of the celiac ganglion and denervation of the aortic plexus were performed.

The average blood pressure level at entry was 223 mm. of mercury systolic, 140 mm. diastolic. The pressure at the end of from one to five days of preoperative bed rest averaged 208 mm. systolic, 130 mm. diastolic. The immediate response of the blood pressure following ganglionectomy was a dramatic fall to an average of 128 mm. systolic, 87 mm. diastolic, this reading representing the blood pressure some hours after the patient's return from the operating room and after recovery from any surgical shock had taken place. The pressure then rose gradually in the next five days to a level nearly as high as that at entry, the average blood pressure at the height of this secondary rise

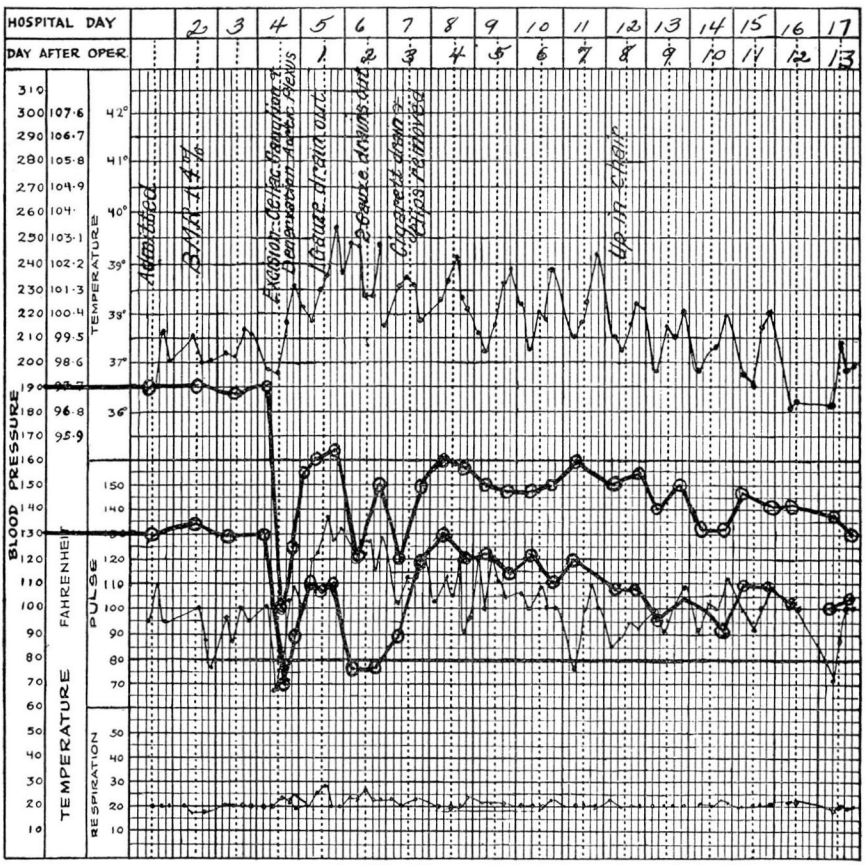


FIGURE 6: Photograph of hospital chart showing typical response of blood pressure to the first stage of the operation.

being 201 mm. systolic, 130 mm. diastolic. Following this rise, the pressures promptly fell again and at discharge on the thirteenth post-operative day the average blood pressure in this group was 166 mm. systolic, 110 mm. diastolic, an average fall of 57 points in the systolic and 30 points in the diastolic pressure.

Eleven patients were followed from two weeks to four months after discharge from the hospital, an average follow-up period of eight weeks. Ten weeks after ganglionectomy and eight weeks after discharge from the hospital, the systolic pressure of this group which averaged 220 mm. at entry was 173 mm. and the diastolic pressure which at entry was 138 mm. averaged 108 mm. (Fig. 7).

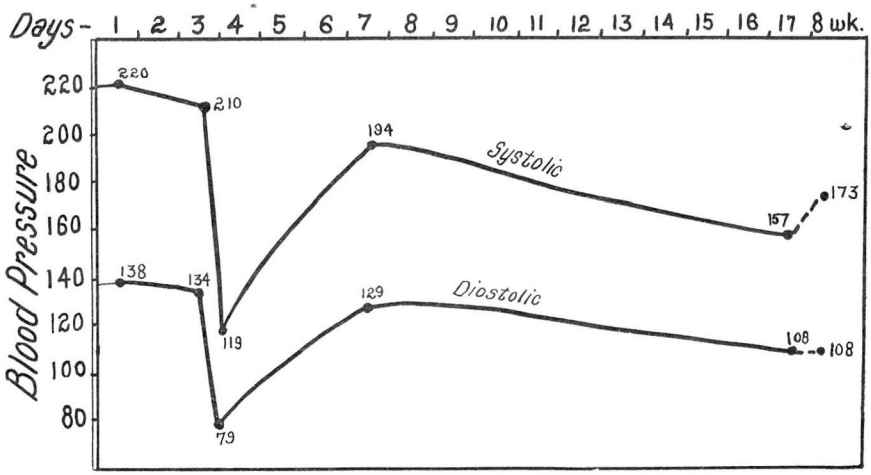


FIGURE 7: Chart of blood pressure changes in 11 cases of celiac ganglionectomy followed for an average of two and one-half months after operation.

The reports on which this follow-up study is based were obtained either from the patient's referring doctor or were taken from the records of subsequent examinations at the Clinic. We have found that the patient's word is not reliable evidence on which to base the follow-up because the doctor will often attempt to encourage the patient by reporting the blood pressure a little lower than it actually is.

In every instance excellent symptomatic relief of headache, dizziness, palpitation, nervousness, etc., was obtained while the patient was in the hospital. In some instances in which only a unilateral operation was performed, a recurrence of symptoms has taken place, and these patients have been advised to have the second operation. Five of the eleven patients who were followed have obtained complete relief from all symptoms referable to their hypertension. Four have obtained partial

relief, and two have not as yet regained enough strength to return to their work and pass judgment on the degree of symptomatic relief obtained.

There are striking variations in the blood pressure response of different individuals to what is, as nearly as we can tell, the same surgical procedure. For example, it happened that two young men, both in their late thirties, entered the hospital at the same time and were in the same room. Both had severe benign essential hypertension with blood pressures averaging 220 mm. systolic, 140 mm. diastolic. In both cases the major portion of the celiac ganglion on the left side was excised and the aortic plexus was denervated, yet in one instance the blood pressure was 80 points lower at discharge than at entry and in the other it was unchanged.

Likewise, to our surprise, we have found that some of our most brilliant results have been secured in older patients with marked arteriosclerosis and vascular disease. We have, therefore, come to believe that the condition of the blood vessels is not a suitable criterion for the selection of cases and that arteriosclerosis, moderate kidney damage, or moderate myocardial damage do not contraindicate operation. In several instances, moreover, we have operated upon patients who have had one or more cerebral accidents, and these patients have responsed no differently than the others.

## Indications for Operation

Carefully controlled follow-up studies on many cases of essential hypertension will be required before it can be determined whether or not operations on the sympathetic nervous system will be of prophylactic value against the progress of the disease. We, therefore, cannot as yet recommend a major surgical procedure as a prophylactic measure for patients who are symptom-free or who have early essential hypertension. But when headache, dizziness, palpitation, dyspnea, weakness, and nervousness prevent the patient from carrying out his routine duties, we can assure him that the prospects of obtaining relief of these symptoms by celiac ganglionectomy are excellent. We do not as yet know how long this effect will last, but since the ganglion cells are removed and regeneration of postganglionic fibers hence cannot take place, there is no reason to believe that the benefits may not be lasting. Finally we believe that surgical intervention is most strongly indicated when severe essential hypertension has entered the malignant phase as evidenced by edema of the optic discs. As a rule such patients are not only incapacitated for useful work but are doomed as unequivocally as if they suffered from an inoperable malignancy. Fortunately, the initial results in this group have been as satisfactory as those in the less advanced cases.

## Summary

1. The results of 120 operations on the sympathetic adrenal system for the control of essential hypertension are discussed.

2. Operations on the adrenal gland and splanchnic nerves have given relief from the symptoms of hypertension but have not resulted in striking alterations of blood pressure.

3. The celiac ganglia and aortic plexus receive the major, minor, and least splanchnic nerves and send fibers to the adrenals and to the splanchnic vessels. Excision of the ganglia and denervation of the aortic plexus removes the ganglion cells and insures against the regeneration of postganglionic fibers.

4. The initial fall of blood pressure and symptomatic relief following excision of the celiac ganglion have been more promising than in any other procedure that we have hitherto attempted.

5. Moderate degrees of arteriosclerosis, myocardial damage, or kidney damage do not contraindicate operative intervention in essential hypertension.

6. The average blood pressure level of eleven patients with severe essential hypertension at the time of entry to the hospital was 220 mm. systolic and 138 mm. diastolic. Ten weeks after excision of the celiac ganglion the average blood pressure level of this group was 173 mm. systolic and 108 mm. diastolic.