AN EVALUATION OF THE SURGICAL TREATMENT OF HYPERTENSION*

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IN a discussion of the surgical treatment of hypertension, three procedures should be mentioned, unilateral nephrectomy, the removal of adrenal tumors, and sympathectomy.

Unilateral Nephrectomy: The percentage of hypertensive patients who have a unilateral renal lesion which would justify nephrectomy is very small, probably a fraction of one per cent. The statistical chance that removing such a kidney will favorably influence the course of the disorder is in the vicinity of 20 per cent according to Smith[1]. It would seem reasonable to use the same indications for nephrectomy in hypertensive patients as in non-hypertensive patients.

Adrenal Tumors: It is difficult to estimate the incidence of adrenal tumors among hypertensive patients. In those cases I have treated surgically in whom the adrenal glands were carefully inspected and palpated, the incidence was approximately 5 per cent. One tumor in ten proved to be a pheochromocytoma, an incidence of 0.5 per cent. The vast majority of the remaining tumors were cortical adenomas and with one exception did not appear to influence the hypertension materially. It is therefore apparent that adrenal tumors together with the even rarer paragangliomas are factors of importance in less than 1 per cent of hypertensive patients. Because the result of removing these tumors is almost always worthwhile, it is important that the diagnosis be made. In this connection it should be reëmphasized that although many pheochromocytomas cause paroxysmal attacks of hypertension, others produce a continued non-paroxysmal form of the disorder. To differentiate the latter group from patients having so-called essential or

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malignant hypertension may be difficult. Most of our patients have fallen into the latter category, and the tumors were discovered only because the adrenal glands were explored. Certain signs and symptoms which in retrospect would appear to be of diagnostic value have been noted. Among these are excessive sweating, postural hypotension with tachycardia, normal cold pressor response, hypermetabolism, altered peripheral blood flow, hyperthermia, and hyperglycemia. This small but interesting group of patients will be discussed in greater detail in the near future.

Operations Upon the Sympathetic Nervous System

In by far the largest number of hypertensive patients who have been treated surgically, a sympathectomy of one sort or another has been performed. The first attempt to modify the course of hypertensive cardiovascular disease by sympathectomy was made in 1924. Numerous reports have appeared in the literature since that time.[2-10] The first operation was a periarterial sympathectomy upon the left femoral artery of a young male suffering from the most severe form of the disorder, so-called malignant hypertension, in its terminal stage. This operation was performed by Adson. In the following year he operated upon a second patient, this time performing a bilateral lumbar sympathectomy. Their experiences with these two patients were discussed by Rowntree and Adson in 1925.[11]

As time has gone on, operations upon the sympathetic nervous system have become more and more extensive. Every conceivable variation has now been tried, including total sympathectomy in a few cases. I would estimate that at least 5,000 and possibly 10,000 hypertensive patients have been treated by one form of sympathectomy or another in this country during the past twenty years. At the same time, probably hundreds of thousands of patients have been treated in other ways. One might therefore think that it would be possible to evaluate one form of therapy or another with finality at this time. This, however, is not the case.

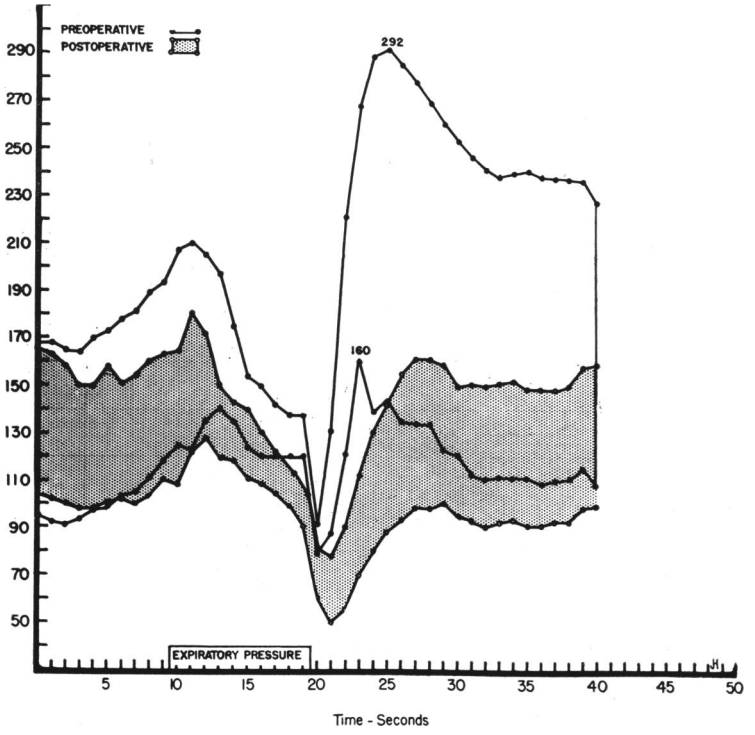
Evaluation of Splanchnicectomy—Physiologic Effects

In evaluating a therapeutic measure, consideration must be given to the nature of its effect upon the disorder in question. Any therapeutic value which sympathectomy may have is undoubtedly due

to the physiologic effects of this procedure upon the cardiovascular system. These fall into two categories,—known and presumed. Of the known effects there are two,—modification of blood pressure levels and modification of the reflex regulation of blood pressure resulting from the inactivation of important components of the vasoconstrictor mechanism. Of the presumed effects, abolition of reflex secretion of adrenin and stabilization of blood flow through the denervated vascular bed might be mentioned.

Effect of Splanchnicectomy Upon Blood Pressure Levels: Reduction in blood pressure levels varying from slight to marked, lasting from one to ten years, have followed the denervation of large vascular areas. The percentage of patients in whom significant changes in blood pressure levels have been noted varies in the different series from about 20 per cent to as high as 75 per cent. The percentage will vary because the criteria used for judging changes in blood pressure differ and because there are wide variations in the patient material and operative techniques in the different series. It has been difficult to predict just what the effect of operation upon blood pressure levels will be in unselected cases and how long it will last. Judging from my own experiences, 66 per cent of unselected patients with persistently elevated blood pressure with associated cardiovascular changes have had a slight to marked reduction in blood pressure lasting from one to five years.[12] In the five to ten-year follow-up period, 47 per cent of these same patients have had a blood pressure reduction comparable to that noted during the first five-year period.[13] This indicates a definite tendency for blood pressure to return to or towards preoperative levels with the passage of time. The great majority of patients who have had prolonged and persistent reductions in blood pressure levels have done well as judged by mortality rates and improvement in or lack of progression of cardiovascular disease. In occasional instances, cardiovascular disease has progressed in spite of marked and persistent reduction in blood pressure levels. In other cases, improvement in the status of the cardiovascular system has been noted in the absence of any demonstrable change in blood pressure levels. The favorable effect of sympathectomy does not appear to be solely dependent upon the lowering of blood pressure levels.

Effect of Splanchnicectomy Upon Reflex Control of Blood Pressure: The second known physiologic effect of splanchnicectomy is a marked alteration in the reflex control of blood pressure. This has been recently



* Fig. 1—Response to Valsalva test before and after lumbodorsal splanchnicectomy. Variations in blood pressure caused by reflex vasoconstriction are abolished when a large vascular area such as the splanchnic bed is denervated. These variations may be very marked, as in this case. This physiological effect of sympathectomy occurs regardless of whether the basal levels are altered or not and is well demonstrated by the Valsalva maneuver as in this figure. Intra-arterial blood-pressure levels are optically recorded with a Hamilton manometer before, during, and after a ten-second period of forced expiration. Before operation there was a sharp overshoot of blood pressure to very high levels within a few seconds after the expiratory period. After operation (shaded graph) the overshoot was abolished. It seems probable that the elimination of such reflex variations in blood pressure is partly responsible for the favorable changes in the cardiovascular system which may be noted after operation.

demonstrated by Wilkins et al.[14] In response to various stimuli, blood pressure levels may rise abruptly to high levels in normally innervated patients. This may be a factor of considerable importance in connection with the rate of progress of cardiovascular disease. These sudden elevations of blood pressure occur within a few seconds following stimulation. These are readily demonstrated by the Valsalva maneuver, during

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which intraarterial blood pressure levels are optically recorded by means of the Hamilton manometer. These reflex variations in blood pressure are almost always completely abolished following the denervation of a large vascular area. This effect occurs irrespective of changes in basal blood pressure levels and is well demonstrated by Figure 1. The effect has been shown to persist for years after operation, even in patients in whom the blood pressure has returned to or near preoperative levels. It is reasonable to believe that the prolonged abolition of marked overshoots in blood pressure due to reflex vasoconstriction would reduce the stress and strain upon the cardiovascular system.

Untoward Physiologic Effects: Among the physiologic effects of operation which are troublesome to the patients are postural hypotension with tachycardia, increased perspiration and coldness in the undenervated areas. The magnitude and duration of postural hypotension varies with the extent of the operation into the lumbar areas. Unless postural hypertension without unusual tachycardia is present before operation, it is our routine to remove the sympathetic trunks bilaterally from the eighth thoracic to the first lumbar segments inclusive. The postural hypotension after such a procedure is generally not particularly troublesome and is readily counteracted by bandages and girdles. These are usually discarded in about three months. More extensive denervations result in more prolonged postural effects. It has not been demonstrated as yet that they are indicated as a routine measure. It is most important to avoid lumbodorsal splanchnicectomy in hypertensive patients with unusually rapid heart rates. In these, postural hypotension and tachycardia may be very troublesome and disabling. A thoracic sympathectomy including the cardiac innervation but preserving the lumbar outflow is indicated in such cases. If care is taken to adjust the operative procedure to the patient, prolonged disability can be avoided without sacrificing therapeutic effectiveness. If loss of ejaculation is important, the lumbar ganglia should be preserved on one side. Increased perspiration in undenervated areas in hot weather and vasoconstriction in cold weather are unpleasant but not serious sequelae. The symptoms which are acquired as a result of the operation are usually more than counterbalanced by the improvement in symptoms present prior to operation. Of the patients who have been reëxamined 5 to 10 years after operation, 83 per cent state that the favorable effects of operation definitely outweigh the unfavorable effects. Improvement in or relief

of headaches was obtained by 92 per cent of cases. Headaches of consequence were not present in 27 per cent of cases prior to operation. Most patients return to work in the course of three to six months. This, together with the hospital stay and its associated expense, introduces an economic factor which must be considered. If on the other hand, the patient's useful life expectancy is materially increased, this factor is more than counterbalanced. It seems proper to caution against too extensive operative procedures and to emphasize the need for selecting the proper type of denervation for the individual patient. If the operation is either too extensive or inappropriate, the untoward effects will frequently outweigh the beneficial effects.

Operative Mortality and Morbidity: The operative mortality has been low considering the advanced cardiovascular changes which have been present in many patients. The operative mortality and morbidity vary with the surgical technique employed. The transthoracic approach carries the highest mortality and morbidity. In experienced hands and with careful attention to preoperative preparation, anesthesia, and postoperative care, the operative mortality should be in the vicinity of 1 per cent. Of utmost importance is the replacement of operative and postoperative blood loss. In virtually every patient it should be presumed that slow, insidious oozing will take place into the operative field during the early postoperative period. This frequently will amount to 500 cc. or more and exceeds operative blood loss in importance. This can be detected by hematocrit determinations on the third and sixth postoperative days. In all cases, particularly in those with more advanced cardiovascular disease, it is essential that blood loss be replaced and hematocrit levels be maintained.[15] This will significantly reduce operative mortality and morbidity.

As a rule, the operative procedures are carried out in two stages about ten days apart. For the lumbodorsal technique, the average hospital stay is thirty days. Transthoracic procedures are utilized by us in cases in which we wish to include the heart in the denervated area. This technique is employed in hypertensive patients having coronary heart disease with angina pectoris or in patients with tachycardia. The operations are performed two weeks apart and the total hospital stay is usually lengthened by a week or so. This technique is employed in about 20 per cent of patients and the lumbodorsal extrapleural technique in about 80 per cent. The principal source of postoperative discomfort

TABLE I

Vascular Area	*No. of Cases*	*Status 5-10 Years After Lumbodorsal Splanchnicectomy*		
		Improved	*No Change*	*Worse*
Retinal	120	41%	39%	20%
Cardiac	125	42%	49%	9%
Renal	114	29%	61%	10%
All (including cerebral)	100	51%	12%	37%

is intercostal neuritis. This can be greatly minimized by reducing operative trauma.

Effect of Sympathectomy Upon Cardiovascular Disease: Following sympathectomy, attention has been called to favorable changes which have been noted in the cardiovascular system. Most reports are concerned with patients followed for a few months to a few years. To date only two publications have dealt with more than small numbers of surgically treated patients followed for five years or more. The first was by Peet and Isberg,[16] and the second, a recent report by this author.[13] A follow-up period of at least five years seems necessary in order to begin to evaluate the effect of operation upon the cardiovascular system and to study the rate of progress of cardiovascular disease. It may be necessary to follow patients for ten or more years to evaluate this aspect of the problem accurately. Peet and Isberg reported improvement in the eyegrounds of 62 per cent of 146 patients followed for five to eleven years. Unfavorable changes were noted in 3 per cent of the cases. The remaining 35 per cent showed no change. They noted that during a similar follow-up period, 91 per cent of 80 hearts which were normal in size before operation did not change significantly, while 9 per cent became larger. Of 48 enlarged hearts, 52 per cent decreased in size, 44 per cent remained the same, and 4 per cent enlarged. Of 84 cases with normal electrocardiograms, 93 per cent showed no change and 7 per cent became worse. Of 57 abnormal electrocardiograms, 53 per cent improved, 42 per cent were unchanged, and 5 per cent were worse. Of 62 patients having normal renal function prior to operation, there was no change in 82 per cent and a reduction in 18 per cent. Of 55

TABLE II—ELECTROCARDIOGRAMS OF NON-SURGICALLY AND SURGICALLY TREATED HYPERTENSIVE PATIENTS FOLLOWED FOR 5 YEARS OR MORE

Author	*Treatment*	*No. Cases*	*Improved*	*No Change*	*Worse*
Canabal, Thomson, and White, P.D. (1945)	Non-Surgical	50	10%	40%	50%
Rasmussen and Boe (1945)	Non-Surgical	39	8%	56%	36%
Isberg and Peet (1948)	Surgical	184	19%	76%	5%
Smithwick (1948)	Surgical	125	42%	49%	9%

cases with impaired function, 36 per cent were improved, 53 per cent unchanged and 11 per cent were worse. The status of the various vascular areas of the first 100 or more cases to be followed for 5 to 10 years after lumbodorsal splanchnicectomy are summarized in Table I.

The significance of these data depends upon a comparison with similar data concerning non-surgically treated hypertensive patients followed for comparable periods of time. Unfortunately very little comparable data are available at this time. I have been able to find some information concerning the status of the electrocardiograms of hypertensive patients who were not treated surgically and who were followed for five years or more in the reports of Canabal, Thomson, and White[17] and of Rasmussen and Boe.[18] These are summarized in Table II and are compared with the most recent findings of Isberg and Peet[19] and with those which I have reported. The comparison is very much in favor of the surgical series, is very significant statistically, and suggests that the course of hypertensive heart disease as judged by the electrocardiograms has been favorably modified by surgical treatment. In Table II the statistics of four authors are compared without regard to the original status of the electrocardiograms, since these data were not available for the patients who were not treated surgically. Of the 184 cases in the Isberg and Peet series, the electrocardiograms were normal in 101 and abnormal in 83 cases before operation. There was no change in 94 per cent and an unfavorable change in 6 per cent of the normal group during the five to twelve-year period following operation. Improvement was noted in 41 per cent of the abnormal group, with no

change in 55.4 per cent and an unfavorable change in 3.6 per cent. Of the 125 cases in my series, 55 had normal and 70 abnormal electrocardiograms before operation. In the normal group, there was improvement in 14.5 per cent, no change in 80 per cent and an unfavorable change in 5.5 per cent. In the abnormal group there was improvement in 64.3 per cent, no change in 24.3 per cent and an unfavorable change in 11.4 per cent. The time of follow-up was five to ten years for the 125 cases. We have used the criteria of Canabal, Thomson and White in evaluating changes in the electrocardiograms. Because there is considerable variation in the normal range, it is possible for an electrocardiogram, originally normal, to improve.

Much more data concerning the progress of cardiovascular disease in our surgically treated patients will become available as the follow-up progresses. It is important that the data which are available concerning patients who have not been treated surgically be supplemented as soon as possible. In this conection, the following quotation from the article of Canabal, Thomson and White is pertinent. "Having become interested in these electrocardiographic changes following splanchnic sympathectomy, we sought in vain for published reports of comparable and adequate control studies, that is, studies of the evolution of the hypertensive electrocardiogram in patients without such operation. Hence, we have collected as many such data as we have as yet been able to find which were based on adequate criteria. This search has been difficult and has yielded only fifty cases."

Mortality Among Hypertensive Patients

An evaluation of the surgical treatment of hypertension should take into consideration the effect of the procedure upon the mortality rate. In the final evaluation of any therapeutic measure, its effect upon life expectancy will be the most important consideration. The mortality rates for hypertensive patients followed for four to eleven years who were not treated surgically may be judged from representative reports in the literature. Those of Janeway,[20] Blackford, Bowers, and Baker,[21] Keith, Wagener and Barker,[22] Rasmussen and Boe,[18] and Bechgaard[23] are summarized in Table III. The mortality rates vary widely in the different series, from 28 per cent to 91 per cent. Obviously, there must have been a considerable difference in the patient material comprising the various series. In the majority, the mortality was high. It becomes

TABLE III—MORTALITY AMONG HYPERTENSIVE PATIENTS NOT TREATED SURGICALLY

Author	*No. Cases*	*Time Followed*	*Mortality*
Janeway (1913)	458	1-10 years	50%— 5 years 75%—10 years
Blackford, Bowers, and Baker (1930)	202	5-11 years	50%
Keith, Wagener, and Barker (1939)	219	5-9 years	91%
Rasmussen and Boe (1945)	100	6 years	52%
Bechgaard (1946)	1,038	4-11 years	28%

TABLE IV—MORTALITY AMONG HYPERTENSIVE PATIENTS NOT TREATED SURGICALLY

Author	*Males*	*Females*
Janeway (1913)	53%	33%
Blackford, Bowers and Baker (1930)	70%	39%
Keith, Wagener, and Barker (1939)	93%	88%
Rasmussen and Boe (1945)	71%	43%
Bechgaard (1946)	41%	22%
Average	66%	45%

apparent that it is impossible to compare mortality rates for different groups of hypertensive patients unless they are divided into subgroups in which some of the important variable factors present in this disorder are held constant. Before mortality rates can be used as a measure of the value of any particular form of therapy, this must also be done. The more variables that can be controlled, the more accurate will be the conclusions. Among the many important variables are the sex of the patient, the severity of the hypertension as judged by the resting diastolic blood pressure level and the grade of eyeground change. The age factor should also be taken into consideration. About 90 per cent of the patients in my series are below 50 years of age. The majority of patients in non-surgically treated series are over 50 years of age.

TABLE V—MORTALITY AMONG HYPERTENSIVE PATIENTS TREATED SURGICALLY

Author	*Technique*	*No. Cases*	*Time Followed*	*Mortality*		
				Total	*Males*	*Females*
Peet and Isberg (1946)	Supradiaphragmatic Splanchnicectomy	437	5-12 years	42.5%	62%	30%
Smithwick (1948)	Lumbodorsal (thoracolumbar) Splanchnicectomy	317	5-10 years	29%	35%	25%

Influence of Sex Upon Mortality: The importance of the sex factor is clearly brought out by Table IV, in which the mortality rates for the male and female patients of the same authors quoted in Table III are given. It is very apparent that the mortality among males is much higher than among females, the average rate for the former being 66 per cent and for the latter 45 per cent during a comparable period of observation. It is therefore clear that in evaluating therapy, the sex factor must be taken into consideration.

The mortality rates for surgically treated patients followed from five to ten years or more are summarized in TableV. With regard to my statistics, it should be stated that during the first 5 years of the study, from October, 1938 through September, 1943, a total of 330 patients with continued hypertension and cardiovascular changes varying from slight to marked were operated upon. A bilateral lumbodorsal splanchnicectomy was performed in all of these cases. As of September 1, 1948, thirteen of the patients are untraced. This represents 4 per cent of the total material. The remaining 317 cases were operated upon at least five and at most ten years ago. Of these, 225 are living and 92 are dead, a mortality of 29 per cent. The mortality for males was 35 per cent and for females 25 per cent, again emphasizing the higher death rate among males. The difference in the mortality rate for the two sexes, however, was not nearly as great as in those cases who were not treated by lumbodorsal splanchnicectomy. These statistics are included in Table V, which also contains comparable data from the Peet and Isberg series. The over-all mortality differs in the two series, that for male patients being much lower in the lumbodorsal series. The

TABLE VI—MORTALITY AMONG HYPERTENSIVE PATIENTS
Six Years after First Examination or 5 to 10 Years after Operation

Resting Diastolic Level	*Rasmussen and Boe*			*Smithwick*		
	No. Cases	*No. Deaths*	*Mortality*	*No. Cases*	*No. Deaths*	*Mortality*
90-109	46	20	43%	80	5	6%
110-124	31	18	58%	98	24	25%
125+	19	14	74%	139	63	45%

mortality rates for both males and females are considerably lower in the lumbodorsal series than the average for the cases not treated surgically.

Mortality According to Resting Blood Pressure Level: The blood pressure level of a particular hypertensive patient is difficult to evaluate. There is no generally accepted method for determining this figure. Many authors utilize ambulatory blood pressure data. Because of the fact that ambulatory pressures may be elevated and resting pressures much lower or within the normal range we have felt that it was preferable to use resting levels. There is no unanimity of opinion as to what constitutes a resting level. Some authors feel that a rest period of many days or even weeks is desirable. Our plan has been to have the patients rest for forty-eight hours in order to detect patients with transient or intermittent hypertension. Patients with diastolic levels below 90 resting and over this figure when active are classified as having transient or intermittent hypertension. We have operated upon a few such cases and they will be reported separately. Patients with resting diastolic levels of 90 m.m. or more are regarded as having persistent hypertension. This report deals with such cases. While it is undoubtedly true that the disastolic levels of some cases would fall to lower levels with a longer rest period, we have felt that rest beyond a certain point becomes a therapeutic measure and for practical purposes is not as satisfactory as a short rest period for differentiating between transient and persistent hypertension. Prolonged bed rest would, however, differentiate between varying degrees of persistence of hypertension.

Rasmussen and Boe[18] hospitalized their patients and divided them into three groups on the basis of resting blood pressure levels. The levels

TABLE VII—MORTALITY AMONG HYPERTENSIVE PATIENTS
5-10 Years After First Examination or Operation

Hypertension Group or Grade Eyegrounds	*Keith, Wagener, Barker*			*Smithwick*		
	No. Cases	*No. Deaths*	*Mortality*	*No. Cases*	*No. Deaths*	*Mortality*
1	10	4	40.0%	86	9	10.5%
2	26	17	65.3%	89	22	24.8%
3	37	34	92.0%	82	37	45.2%
4	146	145	99.3%	42	22	52.4%

selected were 90-109, 110-124, 125 and over. The mortality rates for cases falling into the three groups were determined after a period of six years had elapsed since the original examination. We have divided our 317 cases in the same fashion and the mortality rates are included for comparison in Table VI. In their series, as in ours, the mortality rate increased as the resting diastolic level increased. The rates were considerably lower in the corresponding groups treated surgically.

Mortality According to Eyeground Changes: In 1939, Keith, Wagener and Barker[22] emphasized the importance of the changes in the eyegrounds of hypertensive patients as a guide to prognosis. A series of 219 patients was divided into four groups largely on this basis. The patients who fell into group I had mild narrowing or sclerosis of the retinal arteries. Those in group II had moderate to marked sclerosis of the retinal arteries characterized especially by exaggeration of the arterial reflex and arteriovenous compression. Group III contained patients with angiospastic retinitis characterized especially by edema, cotton-wool exudate and hemorrhages in the retina superimposed upon a combination of sclerotic and spastic lesions in the arterioles. If measurable edema of the optic discs was added to this picture the case was placed in group IV. These patients were followed for a period of five to ten years at which time the mortality rates were determined and survival curves were constructed for each of the four groups. The prognosis was shown to vary for each group. They felt that their series of cases offered a good control for any specific form of therapy since treatment consisted of general measures, especially with regard to diet and rest and the regular use of certain sedatives.

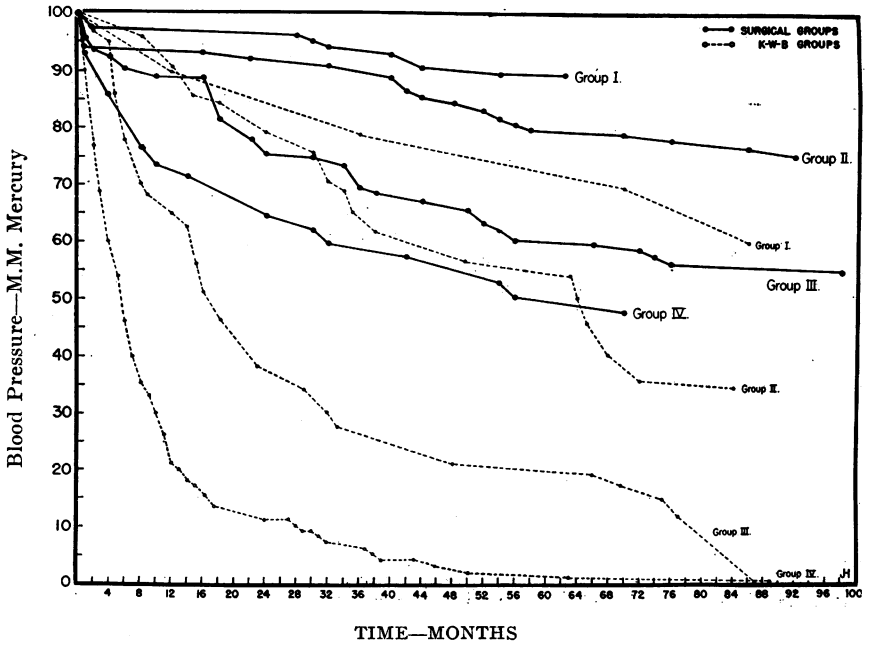

Fig. 2—In this figure the survival curves for 299 hypertensive patients treated surgically are compared with the survival curves for the Keith, Wagener and Barker series of 219 medically treated patients. Both series are divided into four groups according to Keith, Wagener and Barker criteria. The survival curves for the surgical series (heavy lines) may be compared with those of the medical series (dotted lines) group for group. It is apparent that the survival rate is much higher in the surgical series group for group. The number of patients in the medical series group 1 is too small for statistical analysis. The difference in the survival rates for medical and surgical patients in groups 2, 3 and 4 is highly significant statistically. This indicates that the life expectancy for these patients has been materially increased by surgical therapy.

Because of their observations, we have arranged our cases into four groups using their eyeground classification as the primary basis for this subdivision. Of the 317 cases in our series, 18 were considered to have normal eyegrounds. Since there were no cases of this sort in the Keith, Wagener and Barker series, we have eliminated these. The remaining 299 cases have been divided into four groups. The mortality rates for the five to ten-year period after operation are given in Table VII. The findings of Keith, Wagener and Barker are included for comparison. The mortality rates for the different groups vary in our series just as in theirs. There is, however, a marked difference between the cor-

TABLE VIII—METHOD USED FOR DETERMINING THE NUMERICAL GRADE OF HYPERTENSIVE PATIENTS

Factors To Be Considered		*Numerical Value of Each Factor*
C.V.A. without or with minor Residual Abnormal ECG Enlarged Heart Impending Failure	P.S.P. less than 25% in 15 minutes or 60% in 2 hours Age 50 or over Mild Angina	1
C.V.A. with Residual* Frank Congestive Failure Moderate Angina	P.S.P. less than 20% in 15 minutes Unsatisfactory response to sedation	2
P.S.P. less than 15% in 15 minutes		3
Nitrogen Retention		4

* Cerebral deterioration or definite involvement of arm and/or leg.

responding groups in the two series in favor of the patients who were treated surgically. There are too few group I cases in the control series for statistical analysis. The differences observed between group II, III, and IV cases are highly significant statistically. This indicates that the prognosis for many hypertensive patients has been significantly improved by surgical therapy. The same data, presented in the form of survival curves, are shown in Figure 2. This is a figure comparing 299 surgical cases with Keith, Wagener and Barker's 219 medical cases.

SELECTION OF CASES FOR SPLANCHNICECTOMY

Since this paper was presented, further control data for non-surgically treated patients have appeared in the literature. Palmer, Loofbourow and Doering[24] have given mortality rates for 430 cases treated medically and followed for an average period of 8 years. These cases were divided into four groups according to the severity of the cardiovascular changes at the beginning of treatment. Their classification differs from that of Keith, Wagener and Barker in that the degree of damage in the most affected area is the determining factor for grading, rather than the change noted in the eyegrounds. This classification is also helpful in arranging patients into more comparable groups but as

TABLE IX—TWO EXAMPLES OF THE METHOD FOR DETERMINING THE NUMERICAL GRADE OF HYPERTENSIVE PATIENTS

EXAMPLE 1		EXAMPLE 2	
Factors Considered	*Numerical Value*	*Factors Considered*	*Numerical Value*
Abnormal ECG	1	Abnormal ECG	1
C.V.A. without residual	1	Enlarged Heart	1
P.S.P. 20% in 15 minutes	1	P.S.P. 10% in 15 minutes	3
Total	3 = Numerical Grade	*Total*	5 = Numerical Grade

with the Keith, Wagener and Barker classification still permits of wide variations in the patient material in each group because so many other variables of importance are not controlled.

For this reason we have adopted a method for grouping hypertensive patients in which many variable factors are controlled. In order to decide into which of our five groups a particular patient belongs, it is first necessary to determine the numerical grade of the patient. For this purpose, many of the variable factors which have been discussed are assigned a numerical value. This plan is somewhat similar to that utilized by Hinton.[10] The numerical value for each of the factors considered is given in Table VIII. The total of the numerical values determines the numerical grade of a particular patient. Two examples of this plan for estimating the numerical grade are given in Table IX.

It was found that the mortality rate over a five to ten-year period of observation following operation was 12 per cent for patients with a numerical grade of less than 4, and 62 per cent for those with numerical grade of 4 or more. Conseqently the cases were divided into two groups according to whether the numerical grade was less than 4 or 4 or more. Patients with a numerical grade of less than four will fall into our groups 1 or 2. Those with a numerical grade of 4 or more will fall into our groups 3, 4 or 5. The other factors which determine the group for a particular case, in addition to the numerical grade, are the sex, eyegrounds, the severity of the cardiovascular changes in the cerebral, cardiac or renal areas, and the severity of the resting diastolic blood

TABLE X—CLASSIFICATION OF HYPERTENSIVE PATIENTS
Criteria for Grouping

Group	*Numerical Grade*	*Other Factors*
1	Less than 4	Females and males, eyegrounds grade 0 or 1. Females with eyegrounds grade 2 or 4.
2	Less than 4	Females with eyegrounds grade 3. Males with eyegrounds grade 2, 3, or 4.
3	4 or more	Resting diastolic level below 140 m.m. C.V.A. with residual, or frank congestive failure, or a P.S.P. below 15% in 15 minutes combined with a poor response to sedation, not present.
4	4 or more	Same as 3 except one or more of cardiovascular changes referred to are present.
5	4 or more	Resting diastolic level 140 m.m. or more.

pressure level. These are indicated by Table X. It is thus possible to place any hypertensive patient into one of our five groups and since so many variables are controlled, it should make the patient material in each group much more comparable. It should be understood that this discussion applies only to patients who have persistent hypertension as we have defined it, and does not apply to patients with so-called transient hypertension.

In Table XI, the observed mortality rates for the patients in each of our five groups are given. The estimated mortality rates for these same patients as judged by both the Keith, Wagener and Barker, and the Palmer, Loofbourow and Doering control data are also recorded for comparison. It is apparent that there is a very marked difference for group 1, 2 and 3 patients, but no difference for group 4 and 5 patients. This indicates that surgery has failed to modify the mortality rate for patients in groups 4 and 5; and I feel that this constitutes adequate reason for advising against operation in patients who fall into these two groups. On the other hand, it appears that operation has been well worthwhile for patients falling into our groups 1, 2 and 3. A more detailed discussion of this matter is in press.[25]

SUMMARY

The surgical treatment of hypertension is discussed with particular reference to operations upon the sympathetic nervous system.

TABLE XI—MORTALITY RATES FOR SURGICALLY TREATED HYPERTENSIVE PATIENTS FOLLOWED 5-10 YEARS COMPARED WITH MORTALITY RATES ESTIMATED FROM THE KEITH, WAGENER AND BARKER, AND PALMER, LOOFBOUROW AND DOERING CONTROL DATA

	Surgical Series (Smithwick) Observed Mortality			*Medical Series* Mortality Estimated From	
Group	*No. Cases*	*No. Deaths*	*Mortality*	*K.W.B. Data*	*P.L.D. Data*
1	175	13	7%	54%	47%
2	80	18	23%	86%	84%
3	52	14	27%	73%	74%
4	38	31	82%	79%	82%
5	36	33	92%	91%	83%

The favorable as well as the unfavorable effects of surgery of this type are commented upon. If too radical and inappropriate procedures are avoided, the beneficial effects will outweigh the untoward effects in the great majority of cases.

Such comparisons as can be made between surgically and non-surgically treated hypertensive patients followed for five to ten years are distinctly favorable to the surgical series.

The necessity for dividing hypertensive patients into more comparable groups, in which many of the variable factors encountered in this disorder are controlled, is emphasized.

A plan for dividing hypertensive patients into five groups is presented. The actual and estimated mortality rate for each group is given. On this basis, it appears that surgery has been well worthwhile in group 1, 2, and 3 cases. It has not affected the prognosis in group 4 and 5 cases and appears contraindicated in patients falling into these two groups.

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