

THE SURGICAL APPROACH TO ESSENTIAL HYPERTENSION

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HYPERTENSION is the most serious malady known to persons in temperate zones throughout the world. It occurs in over half of people over 50 years of age. It directly or indirectly is the cause of twenty-five per cent of all deaths. Whenever at any age a blood pressure above 140 mms. of mercury systolic, or 90 diastolic is found, either frequently or constantly, especially but not necessarily in the absence of a rapid pulse, then the diagnosis of a pathological elevation of blood pressure must be made.

### INTRODUCTION:

Surgery has achieved an accepted place in the armamentarium of modern hypertensive therapy. It has arrived at this position only as a result of extensive research and painstaking efforts by men in various countries. Anatomists, Physiologists, Internists and Surgeons have made important contributions. Out of this vast endeavor is slowly emerging a working hypothesis upon which we may base our decision in a particular case.

Stimulus has been provided both by the failure of medical treatment as well as by the success which has greeted surgical intervention on the sympathetic nervous system in the treatment of peripheral vascular disease. Great, as have been the strides in surgical therapy, many controversial points still remain. Among these are:

- (a) Upon which patients should Surgery be advised?
- (b) What are the best criteria for prognostication?
- (c) In what way does Sympathectomy and Splanchnicectomy exert its beneficial effect?
- (d) What operative technique yields the best results?

My interest in this subject was stimulated during the past two years by association with A.C. Abbott of Winnipeg. In 1936 he performed his first operation for hypertension using the technique described by George Crile Sr., in the same year. This consisted of a denervation with partial resection of the adrenal gland. This was a bilateral operation carried out in two stages and was done in conjunction with John Gunn, M.D., who operated upon a second case simultaneously.

Subsequently Abbott adopted the technique of Adson. This consisted of a subdiaphragmatic resection of the greater lesser and least splanchnic nerves together with lumbar ganglia one and two and the caeliac ganglion.

For a period of six years from 1940 he used Smithwick's transdiaphragmatic approach on a considerable number of cases. In 1946, following our first transthoracic vagotomy the accessibility of the splanchnic nerves and sympathetic chain was appreciated. From that time we have used almost exclusively a transthoracic, transpleural approach much similar to the technique of Hinton and Lord and a similar technique described by Linton.

In our technique the approach is made between the 8th and 9th, or 9th and 10th ribs, depending on the physical conformation of the thoracic cage or through the subperiosteal bed of the 9th rib.

In contradistinction to the above mentioned authors technique who cut the fibres of the diaphragm transverseley along the ribs, we divide the diaphragm by an atraumatic muscle splitting incision in line with its fibres. This incision is found much easier to close.

This transthoracic approach enables one to remove the sympathetic chain intact from Dorsal 5 to Lumbar 2, together with the Greater Lesser and Least splanchnics along with the Celiac Ganglion. This is a bilateral operation carried out in two stages.

This paper is presented as a resume of current thoughts by various authorities on the subject as well as a summary of my own experiences gained in the Surgical treatment of Hypertension during the past two years.

ETIOLOGY:

There are many causes of and diseases associated with Hypertension in man. Page (1) has classified these into groups - Renal, Cerebral, Cardiovascular, Endocrine and Unknown.

The first four groups contain many generally recognized disease entities such as chronic nephritis, chronic pyelonephritis, intracranial tumors, coarctation of the aorta and tumors of the pituitary and adrenal glands. The fifth group, comprising over 95% of all cases is the essential or primary type, so called because after ruling out all the above less common causes of an elevated blood pressure, one is left with no organic abnormality adequate to explain it.

Boyd (2) states that Essential Hypertension seems to be a definite entity due to a single cause but so far no cause has been suggested which satisfied all the requirements of the case. Pathologically, the hypertension seems to be due to spasm of the arterioles in the first instance followed later by hypertrophy of the arteriolar muscle and finally by degeneration of that muscle from exhaustion with fibrous tissue replacement. The explanation of the original spasm is the difficulty.

It is generally considered that under ordinary circumstances the maintenance of blood pressure depends upon the adjustment of the cardiac output and the peripheral vascular bed which are variable, to the volume of circulating blood which is constant. This is accomplished by three chief mechanisms:

- (1) The influences which the aortic and carotid sinus nerves exert on the cardiac and vasomotor centres.
- (2) The secretion of adrenalin.
- (3) The intrinsic tone of the peripheral arterioles.

At this moment, the etiology of essential hypertension appears to be unknown. In its development age, sex, race, environment and heredity seem to be important factors. Its mechanism is probably humoral in origin. It can arise from kidney disease but this does not seem to be the general rule. A consideration of the known facts indicates that it is a deep seated constitutional disorder woven into the very structure and personality of the individual and that it probably represents a composite of multiple factors.

HEREDITY FACTORS:

That there is a large hereditary factor in essential hypertension was pointed out by Ayman (1934). He found that in families in which both parents had absolutely normal blood pressure, the incidence of elevated blood pressure among the children was only 3%. In families in which one parent had hypertension the incidence increased to 28% and in families in which both parents had hypertension the incidence was 45%.

EXPERIMENTAL WORK:

It may be worth while, at this point, to review some of the more important experiments which have lead to our modern concept of the mechanism involved in the production of essential hypertension.

THE ROLE OF THE KIDNEY:

Goldblatt (3) and his co-workers experimenting on dogs demonstrated that persistent hypertension could be induced in the dog by constriction of both main renal arteries or by the constriction of one main renal artery and extirpation of the contralateral kidney. Goldblatt's work has been fully confirmed by others.

Release or removal of one or both clamps results in a slow or rapid return of blood pressure to normal. After several years of such artificially produced hypertension in animals, there was no significant disturbance of renal excretory function and autopsy revealed no lesion of the arterial tree except in the arterioles of the eye. If both main renal arteries are severely constricted severe hypertension results -- (Goldblatt 1940). Pathological changes in the extra renal arterioles and small arteries are found which are identical with those of the malignant phase of human essential hypertension. The significant difference between this type of experimental hypertension and the human malignant variety is that in the former no characteristic changes are found in the glomeruli and arterioles of the ischemic kidneys. These changes are thought to be the result of hypertension and the action of some chemical substance. The clamp, by rendering the kidney of the experimental animal ischemic protects the kidney from the hypertension. This is not the case in man.

Goldblatt and others in further experimental observations in which they denervated the clamped kidney and produced exactly the same degree of hypertension, proved that a nervous reflex from the kidney plays no part in the increased peripheral resistance which results in hypertension. They further showed that in dogs, denervated vessels are no less susceptible to the constricting agent (humoral) than those which are normally innervated. It suggested that if human essential hypertension is caused by a similar humoral substance sympathectomy will not be effective unless it in some way alters the mechanism responsible for the change in renal blood flow, which in turn results in the elaboration of the "pressor substance". Goldblatt states that these experiments do not exclude the possibility that in human essential hypertension stimuli from the central nervous system may play an accessory or, in some cases, even a primary part in elevating blood pressure.

These experiments have shown that an alteration in blood flow to the kidney will result in persistent hypertension presumably due to the elaboration by the kidney of a pressor substance. The inference that this may also be true in man is clear. However, the cause of altered renal blood flow in man is not clear, and nothing in these experiments seem to case the slightest bit of light upon this matter.

Views on the above problems have changed somewhat in the past six or seven years and it is the general consensus of opinion now that the role played primarily by the kidney is much less important than was formerly held. It is generally accepted that the ischemic renal lesions are the result not the cause of hypertension. The small arterioles in the kidney may well be more sensitive to heightened pressure than the vessels in other organs, and if this is true it could explain the presence of severe arteriolar lesions in the kidneys compared with those in other arteries.

Castleman and Smithwick (4) report biopsies on the kidneys of 100 hypertensive patients in the course of lumbar sympathectomies. In more than half the cases there was no significant degree of arteriosclerosis in the renal vessels. They conclude that in 50% of the cases the hypertension was not preceded or caused by the vascular lesions. Boyd says that at the present time post mortem examination does not appear to warrant the conclusion that the ordinary type of essential hypertension is renal in origin.

The experimental work of Corrigan and Pines (5) suggests that the relation of venous to arterial pressure in the kidney may be a factor of importance. These workers demonstrated that hypertension produced by the Goldblatt method could be relieved by increasing the venous outflow from the kidney. Compression of the renal artery results in venous and capillary stasis - and Corrigan and Pines suggest that the blood may be led off through the arteriovenous shunts which are known to be present in the kidney, so that the capillary bed is short circuited. As

tissue metabolism depends on the circulation of blood in the capillaries it may well be that the effect of the shunt is deficient oxygenation of metabolic production with production of the hypertensive - i.e. humoral factor.

HUMORAL FACTOR:

Much evidence has now accumulated which both directly and indirectly shows that the elevation of blood pressure which follows constriction of the main renal arteries in animals is due to a humoral mechanism of renal origin. Fasciolo and Page demonstrated that the blood from a kidney with its main artery constricted is actually vasoconstrictor and pressor.

In 1898 Tigerstedt and Bergmann demonstrated that a substance having a powerful and prolonged pressor action could be extracted from the normal kidney. This substance they name renin. Page and his associates showed that Renin exerts the pressor effect by interacting with a protein substance in the blood which they termed pre-angiotonin to form the pressor substance angiotonin. It has been shown that the intravenous injection of Renin in a normal animal produces the same physiological effect as those observed in experimental renal hypertension and in human essential hypertension.

Many studies notably by Corcoran and Page, have now been reported on the physiological effects of angiotonin on the blood pressure, heart rate and output, coronary and visceral blood flow, venous pressure, renal blood flow and urea clearances. In general these correspond to the effects of the intravenous injection of Renin on intact animals. As a result, angiotonin is now pretty well accepted as the final effective pressor and vasoconstrictor substance of the humoral mechanism of experimental hypertension. However, it has not yet been isolated from the blood of human beings with hypertension and so the final proof that it is the responsible agent is lacking.

Nevertheless, despite extensive investigation of essential hypertension, the etiology and pathogenesis of this condition remains obscure. From the standpoint of clinical practice, however, it may not be amiss to attempt a hypotheses by which an intelligent therapeutic program may be promulgated. With this apology, it is suggested that the series of events leading to hypertension may be somewhat in the nature of the following, -

- (1) As a result of stress and strain, of modern civilization an autonomic imbalance is established whereby the balance of power is tilted in favor of the adrenergic system.
- (2) Adrenergia produces vasoconstriction with narrowing of the arteriolar bed most particularly in the kidneys.

- (3) Renal ischemia is followed by or associated with the production of Renin and Angiotomin or the inactivation of anti-renin.
- (4) Diminution in or absence of the Renin neutralizing substance results in transformation of Renin to Angiotomin without augmentation of the previously established adrenergic hyperpiesis.

It may be that the transition from adrenergic hypertension to angiotomin hypertension determines the clinical mutation from benign to malignant hypertension. The above hypothesis suggests a three way approach to the problem of therapeutics.

1. PROPHYLACTICALLY - by psychotherapy sedation rest, way of life, etc.
2. PHARMOCODYNAMIC - approach by as yet not understood anti-Renin substance.
3. SURGICAL APPROACH- to isolate the kidney from the autonomic system.

DEVELOPMENT OF PRESENT DAY OPERATIVE PROCEDURES:

Although Bruning, Pende and Dairielopolu were the first to propose neurosurgical treatment of Hypertension in 1922, one of the early articles on the subject was written by Adson and Rowntree in 1925. (7).

Adson, at Rowntree's suggestion, carried out a bilateral lumbar sympathetic neurectomy with removal of the ganglia with rami and all the branches and trunks of the 2nd, 3rd and 4th lumbar segments of the sympathetic chain through a median abdominal incision. It occurred to them that relative freedom from vascular spasm might be attained through the removal of the vasoconstrictor influence of the sympathetic nerves to the vessels of the leg.

It was their concept that lumbar sympathectomy might decrease the peripheral resistance to blood flow and thus result in a lowering of the blood pressure levels. It was thought that this might not only lower the systemic blood pressure but also provide simultaneously an area of diminished resistance that would give way under strain and thereby serve somewhat in the capacity of a safety valve for the protection of the cerebral and renal vessels. Adson found that the results of the above operation were purely transitory and not sufficient to warrant the procedure.

In 1930 Pieri actually performed the first unilateral trans-thoracic splanchnic resection. Adson, in the same year, approached the problem by laminectomy and anterior root resection extending from the 6th thoracic to the 2nd lumbar. This operation was more effective but had to be abandoned because of the high mortality and untoward side effects. However, before this procedure was abandoned it was modified to include only the 9th thoracic nerve to the 2nd lumbar nerve. Some gratifying results were obtained without the risk of the former radical procedure.

The above types of Rhizotomy having proved that interruption of the sympathetic impulses to the splanchnic area was followed by a lowering of the blood pressure and a relief of symptoms, the interest of neurosurgeons was aroused in approaching the problem from an extra spinal route and from this interest two procedures developed.

In 1934 Craig developed his sub-diaphragmatic splanchnic resection technique, consisting of removal of the 1st and 2nd lumbar sympathetic ganglia with the intervening trunk plus a subdiaphragmatic resection of the splanchnic nerves, which was followed in 1935 by the supra-diaphragmatic technique of Peet. This operation is a one stage procedure in which thoracic ganglia 9 to 12 and the intervening trunk together with as long a segment of the great splanchnic nerve as can be obtained through an 11th rib exposure are removed bilaterally at the one operation.

Under the impression - that both the supradiaphragmatic and subdiaphragmatic types of resection of the splanchnic nerves and the sympathetic ganglia had their advantages, and that more extensive denervation probably would be followed by a greater response - the two procedures were combined into the transdiaphragmatic type of surgical procedure by Smithwick.

Smithwick's is a two stage operation. The approach is made by resection of the 12th rib, the division of the diaphragm and removal of the splanchnic nerves from the mid-thoracic region to the caeliac ganglion and the sympathetic trunk from the 9th thoracic to the 2nd lumbar ganglion.

Smithwick's approach has been extended to include resection of other ribs by Grimson who carries out a total or sub-total paravertebral sympathectomy, in which he resects, in addition to the splanchnic nerves, the stellate ganglion, both thoracic chains, the caeliac ganglion and the first and second lumbar ganglia.

Other transthoracic procedures involving radical sympathectomies have been carried out by Hinton, Poppen, Lord, Linton and others.

#### ADRENAL GLAND RESECTIONS:

Mention should be made at this point of such operations as unilateral or partial bilateral resections of the adrenal glands for essential Hypertension. Crile was the greatest exponent of such therapy. Resections of the Adrenal gland in combination with sympathectomy or section of the anterior roots, have not enhanced the effect produced by means of the latter operation alone. The hypothesis that hyperadrenalinemia and increased sensitivity to adrenoline are genetic factors in essential hypertension has not been verified by later investigations. Resection of the Adrenal glands in patients with hypertension does not appear to be justified except in cases of pheochromocytoma. Smithwick emphasized the importance of examining the Adrenal gland during sympathectomy and by so doing he has discovered and resected Adrenal Adenoma not otherwise detected.



UNILATERAL NEPHRECTOMY:

Unilateral renal lesions are occasionally the cause of hypertension. Unilateral nephrectomy in rare cases has resulted in a favorable result in hypertension. When this lesion is suspected at the Mayo Clinic it is customary to have a combined operation performed by the urologic and neurologic surgeons, the operation consisting of nephrectomy and sympathectomy. If definite and persistent lowering of the blood pressure occurs after removal of the kidney, further surgical treatment (sympathectomy on the opposite side) is not necessary. In such circumstances removal of the kidney is given credit for the lowering of the blood pressure, for it is known that unilateral sympathectomy does not materially lower the blood pressure for more than a few days. If, after a week or ten days after removal of an atrophic kidney plus unilateral sympathectomy, there is no decrease in blood pressure it is assumed that the kidney is not the sole etiologic factor and a second sympathectomy (other side) is then considered necessary. The patient is then regarded as having primary or essential hypertension.

RESULTS OF THE VARIOUS SURGICAL PROCEDURES:

It is assumed that in any attempt to assess the value of an operative procedure for hypertension, the results of surgical treatment must show a decided improvement over those of medical therapy.

KEITH and WAGENER'S CLASSIFICATION:

Keith and Wagener classify hypertensives into four groups, with the respective mortality rates of each. This is generally considered to be the best chart for comparison.

GROUP I : those with slight to moderate increase in the blood pressure which ordinarily becomes normal as a result of rest, and mild sclerosis of the retinal arteries usually without symptoms.

GROUP II : those with moderate to severe hypertension, moderate sclerosis of the retinal arteries, and occasionally venous thrombosis; clinical symptoms are present or absent.

GROUP III : those with moderately severe hypertension and angiospastic retinitis with an exudative retinopathy, almost always associated with clinical symptoms of hypertension.

GROUP IV : **these** with severe hypertension, angiospastic retinitis, edema of the optic discs, and always clinical manifestations of hypertension.

These authors found that the fatality rate among patients who have hypertension of Group I or II is 30 to 42 percent respectively, within four years. The fatality rate among patients who have hypertension of Group III is 78% within four years, and in Group IV the rate is 98%.

PEET AND SMITHWICK'S RESULTS:

That surgical therapy in selected cases has a much better record is amply illustrated by a study of the reports of various neurosurgeons of repute.

The published articles of Peet, and those of Smithwick, constitute by far the largest series of cases subjected to neurosurgery for essential hypertension. In their most recent paper, Peet and Isberg (8) review some 1500 cases and analyze the results in 437 treated and carefully followed for five to twelve years after operation.

They classified these 437 cases into six groups in accordance with their general clinical profile with the constitutional course of the disease forming the primary basis for classification:

- Group 1. Early, mild asymptomatic hypertension normal or grade I fundi and no evidence of cardiac, cerebral or renal involvement.- (5 cases).
- Group 2. Symptoms predominate - abnormal fundi, but no evidence of cardiac, cerebral or renal impairment.- (72 cases).
- Group 3. Organic heart disease is predominant - abnormal E.K.G. and cardiac enlargement.- (154 cases).
- Group 4. Cerebrovascular disease is prominent.- (53 cases).
- Group 5. Impaired Renal function is predominant. Each patient showed diminishing concentrating ability and urea clearance values.- (41 cases).
- Group 6. Malignant hypertension. These patients had severe neuroretinitis with definite papilledema and displayed a rapidly progressive downhill course.- (112 cases).

Peet's results are as follows:

57.5% are living 5 to 11 years after operation. The operation mortality was 3.6%. All of Group 1, and 95% of Group 2, are alive 5 to 11 years after operation. Two thirds of patients in Groups 3, 4 and 5 are alive. 45% of the males and only 30% of the females had died.

Significant reductions in blood pressure, complete and definite symptomatic relief improvement of eyegrounds and improvement of abnormal electrocardiograms were noted. Cardiac enlargement and kidney concentrating ability have been maintained for five to eleven post-operative years, in a remarkable percentage of 112 patients, with pre-operative malignant hypertension.

Smithwick (9) reported on a large group of some 600 patients who underwent his type of splanchnic resection. He divided them arbitrarily into four groups - based largely upon eyeground changes.

- Group 1. Minimal changes in fundi, no cardiac or renal change.
- Group 2. More marked retinal changes but no haemorrhage or exudate. Slight cardiac enlargement and minimal evidence of altered renal function.
- Group 3. Haemorrhage and exudate in the eyegrounds - enlarged hearts - some evidence of impaired renal function - and some have had cerebral accidents.
- Group 4. Malignant phase of the disease with edema and elevation of the disc. Smithwick's operative mortality was 2.2%.

The majority of a series of 179 unselected cases observed for one to five years were improved. Favorable changes in eyegrounds, electrocardiograms and cardiac and renal function as well as improvement in the patients general well being were noted. In Smithwick's cases, the post-operative blood pressure was significantly lowered in 65.8% of cases; was unchanged in 12.8% and higher in 6.8%.

COMPARISON OF MORTALITY RATES - OPERATIVE CASE VERSUS NON-OPERATIVE:

A comparison with Keith and Wagener's material, shows that sympathectomy (Peet) has increased the chance that a patient with malignant hypertension may live for more than five years from less than 1 to 19 per cent.

With regard to Group III. The prognosis is decidedly better in Peet's material. In Groups I and II, no significant difference in mortality rate is obtained between Keith and Wagener's and Peet's materials.

SYMPATHECTOMY AS A PROTECTION AGAINST CEREBRAL ACCIDENTS:

Rasmussen and Boe (10) carried out follow-up examinations on 196 non-operated hypertensive patients for a period of five to nine years. Fifty-two of the patients died in the follow up period; 50% of the men and 28% of the women died within two years. The death rate from cerebral haemorrhage definitely increased with increasing blood pressure levels found at the first examination. About one-third of the patients with systolic pressure above 200 MM Hg. and more than a third of those with diastolic pressure above 125 Hg. died from apoplexy within a few years.

The above mentioned authors suggest that operative treatment capable of reducing the blood pressure may be a prophylactic measure against death from apoplexy. A comparison between the mortality rates from cerebral accidents in their series and in operated series supports this suggestion.

In Peet and Isberg's operated series of 437 patients followed up for five to eleven years after sympathectomy, 61 patients died from cerebrovascular accidents - 73% of the patients in their series had a diastolic pressure above 125 mm Hg. before operation. Even if all the deaths from cerebral accidents occurred among the patients with a diastolic pressure of that height, the death rate from cerebral accidents in this group is only 19 per cent as against 33 per cent in the non-operated series of Rasmussen and Boe.

CHOICE OF OPERATIVE PROCEDURE:

The multiplicity of operations which have been tried, and the controversy which has been aroused in respect to the application and results are testimony in themselves that one procedure has not proved to be infallible.

AT THE PRESENT TIME THE MOST COMMONLY USED OPERATIONS ARE:

1. The subdiaphragmatic approach of Adson and Craig. This procedure, however, is being done less and less recently and appears to be losing favor.
2. The supradiaphragmatic splanchnicectomy of Peet.
3. The transdiaphragmatic approach of Smithwick with modifications by various surgeons.
4. The combined thoracic and abdominal approach of Grimson.

It is difficult to prove that the results of transdiaphragmatic sympathectomy are more favorable than those of the less extensive Peet procedure. The results being essentially the same. All the same, it is possible that Smithwick's transdiaphragmatic procedure may lower the blood pressure in patients in whom the supradiaphragmatic operation fails. Other observers who perform the operation with great dexterity have not had the success reported by Peet.

X Grimson (11) states that the lowering of blood pressure observed to follow sympathectomy has been directly proportional to the extent of the sympathectomy, and inversely proportional to the severity of the disease.

Linton (12) states that a sympathectomy to be effective must be complete. Since it can be demonstrated anatomically that vasoconstrictor fibres may reach the abdominal viscera over connections which often leave the major splanchnic trunks as high as the sixth rib and descend along the aorta and oesophagus, a sympathectomy should extend as high as the 6th dorsal ganglion. The delicate rami which leave the major splanchnic nerves and descend along the aorta and oesophagus can be interrupted in no other way than by high Resection of the splanchnic trunks.

If a maximal postural hypotension is desired, the lumbar chain should be removed below the 3rd lumbar ganglion, since a few cases have been seen where slight degrees of sweating persist in the legs after resections stopping at the 2nd lumbar ganglion. That the tendency of these nerves to regenerate is great is well known.

X The most complete and lasting denervation of the adrenal glands is particularly important, as the experiments of White, Okelberry and Whitelaw have suggested that any return of adrenal secretion causes extensive recurrent vaso-constriction of the sensitized smooth muscle of the arterioles in the denervated areas.

Heinbecker (13) has ably presented evidence that a humoral mechanism not overactivity of the sympathetic nervous system, is the primary cause of essential hypertension.

In the treatment of hypertension, the only two organs capable of releasing Hormones concerned with the pathogenesis and symptomatology of hypertension and whose function can be modified by sympathectomy, are the kidney and adrenals. It follows that any beneficial effect to be obtained by removal of portions of the sympathetic nervous system in the treatment of essential hypertension is to be obtained when such removal results in a denervation of the adrenals and the kidneys.

The removal of portions of the sympathetic nervous system more extensive than is required for denervation of the adrenals and kidney is unnecessary. It can have no influence on the causal mechanism of essential hypertension. The temporarily greater enlargement of the vascular bed effected thereby, may cause a shunting of blood from the kidneys sufficient to impair their function and thereby through the release of Renin accelerate the degenerative changes in the extra renal blood vessels.

However, the nature of the operation is physiologic rather than pathologic and the results depend on the physiologic response of the vascular system. All types of sympathectomy and splanchnicectomy have been followed by arrest of the progress of the disease and alleviation of symptoms. Although it is true that the more extensive operations have resulted in a greater denervation of the vascular system, they also result in a more extensive cutaneous area of non-sweating which produces discomfort to the patient in adjusting to climatic changes, and further discomfort is experienced because of excessive sweating in the unaffected areas.

VARIABILITY OF BLOOD PRESSURE:

It would be well at this point to summarize current thinking on this all important aspect of the subject.

Considerable investigation has shown that normal as well as patients with essential hypertension exhibit a wide spontaneous variability in blood pressure in a 24 hour period. Mueller and Brown (14) have compared the 24 hour variation in blood pressure during stay in hospital in patients with normal or raised blood pressure. In 26 patients with normal pressure the difference between highest and lowest systolic values within one 24 hour reading, amounted to an average of 40 mm. Hg., and in 61 patients with hypertension to 55 mm. Hg. The daily variations in the two groups were of the same type, and the authors, therefore, draw the conclusion that the autonomic vascular regulation in hypertension "is not abnormal in type but only in degree".

Several investigators who have studied the variation in blood pressure in essential hypertension maintain that early forms of this disease are characterized more by the variability than by the height of the blood pressure.

Mosenthal (15) states that such hypertensives whose blood pressure during rest and sleep or under the influence of sedatives shows a marked fall, have been considered to have a better prognosis than hypertensives with the same maximum blood pressure whose level does not show the same range of variation.

In normal subjects the blood pressure falls during rest. However, in hypertensives the fall of blood pressure during a short rest is generally more pronounced. The term "fixed" hypertension has been used to signify a considerable elevation in blood pressure during basal conditions. The term is misleading, as it has been shown by Hammerstrom (18) that even the patients with the highest blood pressure level show a considerable variation, especially in the systolic pressure.

AMYTAL AND NITRITE TESTS:

The variability of blood pressure in hypertensive patients has been studied by means of various tests. Their purpose is either to lower or to raise the blood pressure.

The most commonly used test is the Sodium Amytal Test. Starting at 9:00 a.m., a patient in bed is given three grains of Sodium Amytal at 9:00, 10:00 and 11:00 o'clock. Blood pressure readings are taken every half hour or every hour until 3:00 in the afternoon.

A second test is the Nitrite Test. .032 gms. of Sodium Nitrite (powdered) is given at intervals of half an hour for six doses with the patient resting in bed. Over a period of three hours the blood pressure is measured every half hour.

COLD PRESSOR TEST:

A further test, the cold pressor test, was introduced in 1932 by Hines and Brown (16). They consider a rise of 20 mm. Hg. Systolic and 15 mm. Hg. Diastolic as the upper limit for a normal cold pressor response.

Hypertensive patients show as a rule a greater and more prolonged cold pressor response than normotonics. The cold pressor response is considered to be a neurogenic reflex and its development depends on intact peripheral sensation in the cooled part of the body.

Larsson (17) has demonstrated the importance of peripheral vascular tone in the size of cold pressor response. The pressor response obtained when a patient is placed in a warm environment and has a low peripheral vascular tone before the cooling is less than when the same subject has a high peripheral tone.

Cold pressor response diminishes after administration of alcohol and sedatives and does not appear at all during narcosis.

It was shown by Hammerström (18) that hypertensive patients with arteriosclerotic retinal changes (Group II fundi) show the greatest average cold pressor response and those with normal eye grounds (Group I) the lowest average response. In this respect there is a parallelism between the magnitude of the 24 hour variation and the drop of blood pressure during Amytal Test on one hand and of the Cold Pressor effect on the other. Both in Hammerstrom's investigations and those of Hines and Brown (16), the patients without signs of organic vascular changes have a lower cold pressor response than the remainder of the hypertensive patients examined.

The cold pressor test has been found most unreliable due to the fact that it is influenced by so many factors. It has been largely abandoned as a routine test in patients with hypertension.

Considerable work has been done to compare the spontaneous variability of blood pressure and the variation according to Amytal, Nitrite and Cold Pressor Tests.

In hypertensive patients with Group I eye grounds, there is practically no difference between the spontaneous variability and the variation obtained by the Amytal and Nitrite Tests. However, in patients with Group II and III eye ground changes, the latter variations are greater than the spontaneous variability.

For practical purposes a satisfactory estimate of the highest and lowest blood pressure under resting conditions is obtained by comparing the reading registered at the first examination after admission to hospital and the lowest pressure during the Amytal Test.

This method is recommended as a simple clinical method of determining the variability of blood pressure in hypertension.

#### COMPARISON OF BLOOD PRESSURE IN MEN AND WOMEN:

According to Hammerstrom's (18) studies, the average systolic pressure and the pulse pressure were higher in women than in men with hypertensive retinopathy. In hypertensive patients without retinopathy there was no significant difference between blood pressure levels in men and women.

Mortality rate in hypertension is higher in men than in women and higher in patients with retinopathy than in other patients. Hypertensive retinopathy occurs three times as often in men as in women. The higher frequency of retinopathy in men in a sample of hypertensive patients where the average blood pressure level and variability were the same in both sexes indicates that vascular changes in hypertensive disease are of greater prognostic importance than the height and variability of the blood pressure.

#### SELECTION OF PATIENTS:

While it has been conclusively proven that Surgery offers many patients with essential hypertension a chance for regression of symptoms as well as an improvement in the progression of cardio-vascular changes, we are as yet still unable to accurately prognosticate in a particular case.



There have been many attempts to find a single test or group of tests which will yield reliable information as to whether or not sympathectomy will favorably influence hypertension.

It is the consensus of opinion that patients over 50 should usually be rejected. Nevertheless, cases have been reported by several authors in which excellent results have been obtained in persons of age 60. Cardiac decompensation, a history of a stroke and diminished renal function usually disqualifies a patient.

The average level of blood pressure is not a good index of the result to be expected from operation. It is an impression, without too much foundation, that the more labile the pressure the better the result. Smithwick's use of pulse pressure as an index may prove more valuable than average arterial pressure. In his index, patients with narrow pulse pressure, which is less than half the diastolic pressure, are placed in Type I. Those with wide pulse pressure equal to or up to 19 mm. more than half the diastolic pressure, constitute Type 2. Finally, those with pulse pressure 20 mm. or more, or greater than one-half the diastolic pressure form Type 3. The results of the operation varied with the type, being in Type 1 the best, and poorest in Type 3.

INDICATIONS FOR SYMPATHECTOMY:

The most important indication for surgery in essential hypertension is progressive deterioration of the cardiovascular system. Unfortunately we are unable to predict with any accuracy which patients are destined to progressive hypertensive disease.

As a result of work done by Peet, Smithwick, Grimson and others we do know that best results are obtained in those patients under 50 with only slight hypertensive changes in their retinae who have good renal and cardiac function who have exhibited a labile blood pressure and who have a small pulse pressure.

The important factors that should be taken into consideration are:

- Age: Best results obtained in those under 50.  
Sex: Women definitely respond better than men.  
Renal Function: If the non-protein Nitrogen is over 40 mgms. per 100 cc's, or the phenolsulphonephthalen test shows the excretion of less than 15% dye in 15 minutes in the absence of congestive heart failures, the patient will not be helped by sympathectomy. This statement can be taken dogmatically.  
Pulse Pressures: Small pulse pressures do better.

The response of the blood pressure to the cold pressor test is a most unreliable factor. It is of no prognostic importance. The Sodium Amytal sedation test is of much more usefulness as an estimate of the variability of blood pressure in a given case, but is also of useless prognostic importance.

It is suggested by Hammarstrom (18) who has published one of the best monographs to date on the surgery of hypertension, that neuro-surgical treatment should be limited to those patients who have severe subjective symptoms, reduced working capacity and who remained unimproved during a considerable period of medical treatment.

Each patient should have a complete work up in Hospital. A program, as follows, is suggested:

1. Estimate of the lowest mean blood pressure reading in a 24 hour rest period.
2. Response to Sodium Amytal estimated.
3. Examination of fundi by ophthalmologist.
4. Electrocardiogram and chest x-ray to determine extent of cardiovascular disease.
5. Tests of Renal Function:
  - Non Protein Nitrogen
  - Clearance Tests
  - Possibly intravenous pyelogram

CASE REPORT:

The case report to follow may serve to illustrate our usual investigation of a patient with hypertension. The operative and post-operative course and follow up may likewise prove of interest.

Miss G., age 30, a School Teacher, consulted first in October 1945. Her entrance complaints were: Headaches and dyspnoea on exertion for several years. She had known of her high blood pressure for six years but had not thought about it until she was reminded of it during a routine health examination. Family history revealed hypertension in her Mother. Past illnesses were irrelevant. Menstruation habit was normal and a review of her systems was essentially negative.

Examination revealed a healthy looking young woman of medium build.

Blood Pressure 208/110; pulse 100.

Heart - apical systolic murmur.

Tests: Urinalysis - acid, specific gravity 1.018, microscopic negative; Haemoglobin 90%; W.R. negative; B.M.R. plus 16.

She was admitted to Hospital for investigation.

On admission, Blood Pressure was 200/120. This had fallen to a sleeping blood pressure of 130/96 some 36 hours later.

Chest Plate suggested beginning enlargement of the heart to the left. Lung fields were negative.

Examination of Fundi by Ophthalmologist, showed ocular media clear except for slight vitreous haze in right eye. There is very marked narrowing and spasm of small arteries especially nasal side of optic discs. The arteries show medial sclerosis throughout, possibly slight macular edema.

Summary - second stage hypertension with retinopathy and beginning compensatory medial sclerosis.

Sodium Amytal Test - with sedation consisting of 3 gns. of Sodium Amytal each hour for three doses, the blood pressure gradually fell to 112/70. Urine tested by the Mosenthal method concentrated to 1.022.

Pyelograms showed no evidence of an ischemic kidney.

A consultation with an Internist was arranged. He suggested: "beginning cardio-vascular changes; heart shows some evidence of enlarged left ventricle". He recommended sympathectomy.

It was concluded in view of her age, labile blood pressure, declining to normal on rest and sedation, with minimal or early cardio-vascular changes and good kidney function, that a splanchnic resection would prove of benefit. Consequently, a Smithwick Splanchnic Resection was carried out in two stages on July 3rd and July 18th, 1946. After removing the 11th and 12th rib, and using an extra pleural approach the sympathetic ganglia were removed from thoracic 7 to lumbar 2, along with the caeliac ganglion and splanchnic nerves. Post-operative course was uneventful and she was discharged home on July 28th, with a blood pressure of 110/88. For several months she was examined at intervals and blood pressure readings by two or more Doctors varied from 112/70 to 128/84.

Symptomatically she was greatly improved and had no headaches or dyspnoea.

On February 19, 1948, some 19 months post-operatively, her blood pressure was 120/80. She is working hard and full time as a School Teacher.

WHAT CAN WE TELL THE PATIENT WITH HYPERTENSION?

It seems reasonable to tell the patient that symptoms such as headache, nervous tension and easy fatigue will be relieved by operation. We can tell a Group II and III patient that he may expect a significant fall in blood pressure in about 60% of cases. In some cases of early malignant hypertension, we can offer in some cases a temporary reprieve from the ravages of disease and their life span may be increased. What life remains often becomes far more bearable with the operation than without it. Thus, if the circumstances are suitable, there can be little doubt that an adequate sympathectomy can be followed by significant therapeutic results. Unfortunately, the suitability of the circumstances is not always easy to determine. Those most experienced and successful in this surgical procedure use a combination of the criteria for operation previously listed, along with a large flavoring of intuition.

SUMMARY:

1. An attempt has been made to present briefly current ideas by leading authorities as to the etiology and pathogenesis of essential Hypertension.
2. The development of the various surgical technique has been described.
3. A plan for the selection of cases for surgical therapy is offered.
4. A method of investigation such as we find feasible is presented.

CONCLUSION:

The surgical treatment of hypertension by means of extensive sympathectomy and splanchnicectomy has been accepted as a sound and logical physiological procedure. At present it is the best weapon we have for attempting to control progressive hypertension or the alleviation of distressing symptoms of an already serious hypertension. As yet we have not been able to predict with accuracy what patients will show a gratifying response to surgery. Furthermore, we cannot predict which patients are liable to progress to more severe degrees of hypertension. Further investigation may help to show which is the operation of choice, but at present the Smithwick type seems to give the best results.

White has aptly summed up the present status of the surgical treatment of hypertension as follows:

"although it is not yet established that the results will be permanent, at least there is good reason to believe that the hands of the clock can be set back a number of years in the majority of younger patients with hypertension who have not been permitted to progress to the stages of advanced degeneration or changes in heart, kidney or brain".

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