histological material. The abundant young connective tissue—its invasion of the process breaking it into fragments, sometimes disposing of it altogether—seems to be the principal agent of cure.

Why does this tissue receive so powerful a stimulus? Is it because the tubercle bacillus itself is damaged through some indirect effect of the remedy, thereby allowing such an intense defence reaction to take place? Some by-product of the disturbance of calcium and phosphorus metabolism to which the drug gives rise might be supposed to have such an effect, and the Herxheimer-like action sometimes observed faintly suggests some such possibility. Or, on the other hand, may the reticular tissue itself be made to function with extreme intensity and efficiency by calciferol or by some product of its activity? It has been noted in more than one case at Alton that, while biopsy wounds in lupus generally heal with difficulty, healing under calciferol takes place almost by first intention. In the patient who had 30 biopsies the wounds gaped at first but healed quickly while treatment was in full swing. This patient developed toxic symptoms, and treatment was stopped after 3½ months. From that time his biopsy wounds again healed with difficulty, although improvement had been well maintained.

Much work which lies outside the scope of clinical and clinical-laboratory observation will have to be done on this subject, probably in the field of biochemical research. It is a fascinating problem which, if solved, might throw light on the character of the natural defence mechanism of the organism against tuberculosis. For it would appear that calciferol is not a chemotherapeutic agent in the ordinary sense, but that it may be a catalyst or an accelerator of a normal process.

In the meanwhile those of us who are satisfied that the advantages of the drug outweigh its dangers ought to use it with all the care which observers in the clinical, pathological, and biochemical fields have shown to be necessary.

Finally, it should not be forgotten that the local manifestations of tuberculosis are part of a general disease, and that the patient as a whole requires good food, fresh air, and adequate rest. Lupus requires, in addition, local measures which demand considerable experience and skill. All these can best be given in an institution specially equipped for the purpose.

We acknowledge with gratitude our indebtedness to Dr. E. M. Martland, of the Pathological Department of the Salisbury General Infirmary, who has undertaken all the pathological investigations on the Alton cases, and to Mr. L. E. Davey for pathological work in connexion with cases at St. Thomas's Hospital.

The microphotographs reproduced on the photogravure plate were taken by Mr. A. E. Clark, technician to the Department of Pathology at St. Thomas's Hospital. The other photographs were taken by Dr. Macrae.

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HYPERTENSION—AETIOLOGY AND SURGICAL TREATMENT

BY

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[WITH PHOTOGRAVURE PLATE]

A large number of patients suffering from hypertension have now been treated surgically in various clinics. A good review of the results up to date is given by James L. Poppen and Charles Lemon (1947) on the surgical side, and by Robert Sterling Palmer (1947) on the medical side. The present communication is founded upon a small number of cases, but certain of the observations made in it, when considered in relation to the recent work of Trueta and his co-workers at Oxford, provided a stimulus for regarding the subject anew from the point of view of aetiology.

Hitherto the cause of hypertension has remained obscure, and the approach to the problem of treatment has been largely empirical. There has indeed been an absence of any comprehensive explanation of why the blood pressure is raised in these cases throughout their whole course, although the work of Goldblatt (1937-8, 1938, 1946, 1947) has added greatly to our knowledge of the subject, particularly when definite renal disease is demonstrable. Renal ischaemia has been shown to produce a pressor substance—renin—which by its action on the plain muscle of the middle arterial coat produces general vasoconstriction in the arterial system, thus raising the blood pressure. There have also been a small number of human cases with renal disease present in only one kidney, the removal of which lowered a previously persistently raised blood pressure. But this sequence—organic renal disease, renin, and hypertension—cannot be adduced to explain why the majority of cases should show a raised blood pressure throughout the earlier and greater part of their course. Biopsy of a large number of kidneys in such cases does not reveal any renal abnormality (Castleman and Smithwick, 1943).

The recent work of Trueta and his fellow workers (1947) has thrown some light on this gap in our knowledge of hypertension. By experimental work on animals they have proved that an extreme degree of cortical renal ischaemia can be temporarily produced by vascular spasm. Furthermore, during this stage of cortical spasm the blood is bypassed through the juxta-medullary glomeruli back into the vasa recta and so into the renal vein. The cortical ischaemia is fairly persistent and is produced by various nervous stimuli, but it also can be brought about by a humoral agency such as a posterior pituitary extract. A short quotation from their conclusions runs as follows: "If when the pressor substance is formed in cells situated in the renal cortex, and if anoxia is an essential condition for its production, it follows that the pressor substance will be formed when the cortex becomes ischaemic. It seems possible, therefore, that excessive diversion of the intrarenal blood-flow from the cortex through the medullary by-pass may be an initiating factor in the production of the pressor substance, and thus in the development of human essential hypertension." A further point which provides a parallel with cases of human hypertension is the fact that these workers found considerable individual variation in their animals.

The remarks concerning aetiology which follow constitute an attempt to apply to the problem of hypertension these recent additions to our knowledge of renal function, and must be regarded in that light and not as a proved and accepted series of facts.

One further number of *Soil and Health*, which was edited by the late Sir Albert Howard, will be issued as a memorial number. Those interested should write to Miss E. B. Kirkham, The Rise, Milnthorpe, Westmorland.

Fig. A is an attempt to show the clinical course of an average severe case of hypertension from start to finish. During adolescence the blood pressure is normal, but is subject to considerable transitory increase, chiefly from emotional causes. There is some evidence that hypertension is commoner in later years in these apparently normal young people, who on examination for the Services or for some routine purpose are found to have temporarily an unexpectedly high blood pressure. During rest, and in the absence of emotion, their blood pressure remains normal.

After the age of 20 or 30, the blood pressure starts to increase slightly, but the effect of rest or of sedation is still to bring it down to the normal figure. Emotion during this period will of course also produce a further considerable transitory increase. As years go by the blood pressure increases, the first stage of true disease lasting for a varying period of time into the late thirties and the forties, and, rarely, possibly up to 50 years of age. This first stage of hypertension is not associated with any discoverable change

FIG. A.—S.I indicates sympathectomy done before the onset of permanent renal damage. S.II indicates sympathectomy after renal damage has occurred.

in the kidneys, but at the end of this phase arterial degeneration begins. The arterial degeneration is a hyaline medial change, and would seem to be a natural result of senescence, accentuated and rendered premature possibly by the persistently raised blood pressure. Individuals whose arterial structure is of poor quality suffer the degeneration early, whereas those with high-quality arterial tissue suffer the change late, if at all. Moreover, it would seem that nephritis produces a similar softening or degeneration of the arterial middle coat analogous to that produced by advancing years, but of far more rapid development and at almost any age. The arterial change affects the kidneys more than any other part of the body, but also attacks the vessels in the retina, pancreas, small intestine, testis, and suprarenal bodies.

Two Stages

The success of sympathectomy for hypertension (S.I and S.II, Fig. A) is likely to vary greatly according to the stage of the disease and the underlying pathological state, which must therefore be considered separately. During the first stage the increasing blood pressure may well be caused solely by spasm of the renal cortex, at first transitory, but later continuously involving varying areas of the renal cortex for most of the 24 hours. During the second stage permanent organic renal disease will result from arterial

degeneration, and will constitute a permanent source of renal cortical anoxaemia. Thus in each of these two stages the hypertension can be explained on the renin theory; in both stages the renin comes presumably from transitory cortical spasm, and during the second stage it also comes from permanent cortical ischaemia from arteriosclerosis. It is worthy of note that the hyaline degeneration of the media is scattered in a patchy manner throughout the body, for it is not seen in the muscles or in the skin vessels. This freedom from arterial degeneration over such a big area is a sufficient proof that the raised blood pressure must at all times and in both stages be due to vascular spasm and not to organic vascular obstruction resulting from permanent arterial narrowing.

Stage I.—An example of this stage is provided by the case of a man who at the ages of 15 and 17 was found to have a high blood pressure. At 22 the figures were 240/160, at 32 they were 180/140, and at 37 they were 194/124. During the whole of this period he has lived a normal life, playing rugby football as a young man and being busily engaged in business during his later years. In addition he was an active fire-watcher during the war. For the whole period of time, 22 years in all, he has been free from symptoms. This type of case is commonly met with, and the symptoms in such cases often seem to be due more to the anxiety aroused by medical advice, or by apprehension, than by the disease itself. Certain definite deductions would appear to be legitimate from these cases. The long-sustained increase of the arterial pressure as such would seem to have no deleterious effect either on the arteries or on the heart. It is true that hypertrophy of the arterial media occurs, but the lumen of the vessels remains normal. It is also true that hypertrophy of the left ventricle occurs, but there is no evidence of any cardiac disability or failure. During these earlier years of life no degenerative effect intervenes.

Stage II.—The first essential cause of the medial degeneration seems to be a change in the vessel wall produced either by the natural degenerative tendency of advancing years or, in a few young individuals, by nephritis. The second is the trauma produced by the continued high arterial pressure. It would seem, arguing from the type of case described above, that this second factor of trauma is alone not enough to produce the degeneration. It is noteworthy, particularly from the clinical point of view, that the changes produced in the arteries are identical in the retina and in the kidney, but pathological and post-mortem investigations prove that the renal arterial changes are more advanced than are those of the retinal vessels. Although pressure seems to rank second to degeneration it is very important, for the results of sympathectomy show that release of the pressure allows a rapid regression of the retinal changes. And it is therefore legitimate to assume that a similar regression can occur to some extent in the renal arteries.

Hypertension in Nephritis

Two cases are described at this point because, although not cases of primary hypertension, they shed some light upon the effect of sympathectomy on the lesions found in essential hypertension.

These patients were both young men, aged 23 and 21, and in each case the speed of onset of the hypertension was rapid and the renal function poor. They had previously been accepted as fit for the R.A.F. and Army respectively, in which they had served as healthy men. In each at the time of medical investigation retinitis was present of the grade-IV degree—that is, with haemorrhages and exudate and papilloedema. In the first case the length of history of symptoms was 12 months and in the second case three months. They were both treated by sympathectomy: bilateral removal of the sympathetic chain D6 to L1, and excision of the greater and lesser splanchnic nerves. Sympathectomy was done in the first case because it was difficult to decide whether it was one of malignant hypertension or of chronic nephritis, and it was felt that since the outlook was hopeless it was right to give him the benefit of the doubt by operation. Subsequent review makes it probable

that the case was in fact one of chronic nephritis and not of primary malignant hypertension. The second case was definitely one of chronic nephritis with a similar clinical picture.

Fig. B shows the effect of sympathectomy in the first case. The blood pressure has been lowered and remains lower six months from the date of the second operation. The renal

FIG. B.—S.I indicates the first and S.II the second stage of operation.

function has not been diminished, proving that there was no quantitative relationship between the height of the blood pressure and the renal function. The retinitis disappeared to a great extent in three weeks as a result of the lowered blood pressure. This retinal change is most significant, for, as already mentioned, the vascular changes in the kidneys are analogous to those in the retina. Moreover, the clinical improvement after operation suggests that a corresponding improvement has also occurred in the renal arterial system. It is noteworthy that Trueta and his colleagues found that splanchnic sympathectomy caused cortical flushing in their experimental animals and prevented to a great extent the cortical spasm induced by their various experimental measures. Fig. C shows the effect of

FIG. C.—S.I indicates the first and S.II the second stage of operation.

operation in the second case, the blood urea being lower after operation than it was before. Here too there has been a great improvement in the state of the retinae.

The Heart

The term "hypertensive heart disease" has come into general use, but it would seem as though the label is not quite correct, however useful it is. In the first stage of hypertension the raised blood pressure as such seems to

have no effect upon an otherwise normal heart except by producing hypertrophy. Medial coronary hypertrophy is the only abnormality, the lumen of the coronary vessels remaining normal. Patients with hypertension in this stage who have died from some other cause have been carefully examined, and there is an absence of any hyaline degeneration in the coronary system (personal communication of Prof. W. G. Barnard). The amazing persistent health of the heart after working for years against a much-raised peripheral resistance may perhaps be explained to some extent by the following considerations. First, the coronary flow is diastolic, so that the trauma from the full impact of the hypertensive pulse wave does not directly affect the coronary vessels. Secondly, the effect of adrenaline on the peripheral arteries is to constrict, and on the coronary arteries is to produce dilatation; it is a reasonable hypothesis that this paradoxical mechanism may also occur with other biochemical pressor substances, such as the renin in

FIG. D.—Electrocardiogram in man with hypertension before and after lumbar sympathectomy, showing disappearance of signs of left ventricular stress. First operation, Jan. 31, 1947; second operation, Feb. 21. Electrocardiograms taken on Jan. 14 and March 3.

hypertension. The electrocardiogram at a later stage of the disease begins to show the typical picture of left ventricular stress (Fig. D).

In those cases investigated at St. Bartholomew's Hospital which showed this change there was a return to the normal picture very quickly after sympathectomy. The time taken for this change back to normal was from ten to fourteen days after sympathectomy. The picture of left ventricular stress would appear to be due to some general functional change of the muscle as a whole rather than to local structural coronary abnormality, for the abnormal cardiogram is often present in the absence of dyspnoea or of undue enlargement, and the pattern of the change is very constant, in contradistinction to the varying appearance produced as a result of local coronary infarction. One case of cardiac disease in a hypertensive patient is worthy of particular mention.

A woman aged 44 had been suffering from increasing shortness of breath and headache for one year. The blood pressure was 198/114, and the electrocardiogram showed a left bundle-branch lesion (Fig. E). The retinae and renal function were both normal. Five months after sympathectomy the blood

pressure was 138/90, the dyspnoea had subsided, and in her own words "she could now do anything." The electrocardiogram was relatively unchanged. The bundle-branch lesion was not a result of coronary infarction, for there was no history of any such illness or any complaint of anginal pain. The latter two coronary conditions seem, in the experience of other observers, to contraindicate sympathectomy in hypertensive cases.

A second case of particular interest, kindly referred to me by Dr. Graham Hayward, was that of a man aged 24. He was

FIG. E.—Tracings from a case with a left bundle-branch lesion. The first two curves are before sympathectomy and the last three after sympathectomy. The T-waves in leads I and II have become upright or diphasic after sympathectomy. The bundle-branch defect itself remains unaffected.

FIG. F.—Radiographs of a man aged 24 with hypertension, previous and subsequent to sympathectomy. First operation, Dec. 5, 1946; second operation, Dec. 27. Radiographs taken on Nov. 5, 1946, and April 15, 1947.

unduly adipose, weighing 235 lb. (105.6 kg.). His chief complaints were shortness of breath and headaches. He was fully investigated, but no other evidence of pituitary disease was found. There was no sign of myxoedema. His blood pressure was 180/120, and it fell to normal after sympathectomy, and remained so, the latest figures after seven months being 134/74. Fig. F shows his cardiac outline before and after sympathectomy. The reduction in heart size is striking. This at first sight would seem to be a case in which the heart had been enlarged in stage I by the hypertension alone, returning to normal after the lowering of the blood pressure. But his

adiposity was certainly pathological, and probably some additional undiscovered factor or factors were involved in the considerable hypertensive cardiac enlargement.

Sympathectomy

The effect of sympathectomy upon hypertension appears to vary considerably from case to case. The general experience hitherto seems to be that the operation is most successful in younger patients, particularly those below 40 and those in whom the diastolic blood-pressure figure is considerably raised, so that there is a comparatively small pulse pressure. On the whole patients over 50 respond to the operation only for a short period and not to a great degree, as judged by the lowering of the blood pressure. The operation is usually unhelpful in patients with advanced cardiovascular or renal disease, but even here exceptions occur, especially in the younger age groups. Previous to operation various tests have been applied with a view to trying to determine the extent of lowering of blood pressure likely to be achieved by sympathectomy. The sodium-amyltal test, 3 gr. (0.2 g.) for three doses at intervals of an hour, often causes the blood pressure to fall considerably to a level which seems to be to some extent comparable with that likely to be achieved by sympathectomy.

In addition to these tests the following investigations are always done. Retinoscopy by a skilled ophthalmologist, complete examination of the urine, the urea-clearance test,

FIG. G.—Blood-pressure chart of a woman aged 44, showing successful result after sympathectomy.

FIG. H.—Blood-pressure chart of a man aged 52 whose response to sympathectomy was only temporary.

the urine-concentration test, an electrocardiogram, radio-scans of the heart, and sometimes an intravenous pyelography. The family history is of the greatest importance, and the patient's age is a valuable general guide. The clinical picture must be correlated and carefully considered as a whole. A further indication for sympathectomy is a definite change for the worse in a closely observed case in which the blood-pressure condition has previously remained stationary. The cardiac indication is a deterioration in the cardiac function in an otherwise suitable case, as measured by increasing dyspnoea, a changing electrocardiographic picture, and an increase in the size of the heart by careful measurement. But coronary disease is a contraindication to sympathectomy for hypertension.

Many observers seem to agree that the presence of malignant hypertension with rapidly advancing retinal changes constitutes a definite emergency indication for the operation, not only with the idea of saving vision but because, especially in young people, good results have been recorded. The effect of sympathectomy is shown in a satisfactory case (Figs. G and H), and in a patient in whom the blood pressure rose again nearly to its pre-operative level within three months (Fig. H). In the first patient sympathectomy presumably released the cortical spasm and thus prevented a further excessive production of renin. There was here no permanent renal lesion from which such a production of renin could subsequently occur. But it is noteworthy that

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FIG. 1.—Right eye before sympathectomy.

FIG. 3.—Renal retinopathy pre-sympathectomy.

FIG. 2.—Same eye after sympathectomy.

FIG. 4.—Same eye after sympathectomy.

ROLE OF SYMPATHETIC NERVE IN CANCEROUS PAIN : MARCEL DARGENT

FIG. 1.—Cluster of lymphocytes around sympathetic ganglion cells.

FIG. 2.—Alterations of protoplasm in ganglion cells. Pyknosis of nuclei.

FIG. 3.—Carcinoma tongue. Metastatic node in sympathetic ganglion.

FIG. 4.—Relation between the metastatic node and arteriolar wall.

even in such a case emotion can send up the blood pressure for the time being, possibly through that part of the sympathetic nervous system which still remains untouched. In this patient a low blood pressure after operation was not merely a result of vascular laking of blood in the splanchnic area, for at the end of three months there was no residual orthostatic hypotension.

Temporary Lowering of Blood Pressure

Fig. H shows a lowering of the blood pressure immediately after operation, partially due to the release of cortical renal spasm, but also to the laking of blood in the abdominal area. The reappearance of hypertension in this case was no doubt due to a resumption of renin formation by the permanently diseased renal tissue. Trueta and his colleagues have found in such patients histological evidence of the permanently established by-pass mechanism already described by which some blood is permanently diverted from the renal cortex; thus a chronic cortical ischaemia may persist to some extent as a purely mechanical effect whether spasm be released or not.

In this second class of case it is still not easy to explain why there should be even a temporary improvement, for at first sight there should be no diminution of renin formation in the permanently damaged kidney. Fig. J is an

FIG. J.

attempt to offer an explanation for this. The first two rectangles suggest what happens in the satisfactory class of case as a result of sympathectomy (stage I of hypertension). The cortical spasm which has produced the renin is removed by the renal sympathectomy. Splanchnic laking of blood also occurs. The blood pressure is therefore lowered permanently. The other two rectangles diagrammatically show the state of affairs when chronic renal disease is present (stage II of hypertension). Neither the dead nor the normal renal tissues are concerned in the hypertensive process. In this case as well as in the previous one glomerular spasm is present and is beneficially affected by sympathectomy. It is the presence of diseased renal tissue, shown by the oblique lines, that distinguishes this type of case from that in which sympathectomy produces a satisfactory result. Sympathectomy will in both cases lower the blood pressure temporarily and greatly by producing a laking of blood in the splanchnic area, an effect which is additional to the effect on the renal cortex. Such lowering of the blood pressure can cause regression and temporary healing of the diseased blood vessels as shown in the retina.

This improvement may also to some extent benefit the renal arteries, and thus may temporarily reduce the area of active advancing renal disease to a degree sufficient to reduce the output of renin to an inconsiderable amount. But within a period of weeks or months the permanently diseased but not dead cortical tissue is enough to produce once more an increasing output of renin, which will cause a return of the hypertension with renewed renal spasm. This renewed renal spasm will in its turn manufacture more renin, with a return of the blood pressure to its former high level. The permanent by-pass mechanism of Trueta

is also likely to be a factor in the resumption of cortical ischaemia in chronic renal arterial disease.

Figs 1 and 2 on the Photogravure Plate show water-colour drawings, by Mr. A. Seymour Philips, of the right eye of a man aged 50 before and after sympathectomy. Mr. Philips reports as follows: "There are very great changes, and the improvement after operation is considerable. Fig. 1 shows marked haemorrhages and oedema of the whole retina, especially evident at the macula, which is pushed forward by fluid from behind. In Fig. 2 all signs of haemorrhage and oedema have disappeared. Changes at the macula in this picture are those normally following inflammation or swelling, and are due to pigment disturbance. Venous network above is caused by dilatation of collateral circulation following venous thrombosis. The optic atrophy has developed as a result of the oedema, and so the patient's vision is below 6/60 and will remain so. I could not make out that the retinal arteries had changed at all in calibre between the two examinations, and it will be noted how fine they are, especially near the disk."

In another case Mr. Philips was again responsible for the water-colours (Plate, Figs. 3 and 4), and Mr. Rupert S. Scott reported on Jan. 7, 1947: "In spite of the fact that the retinal changes are present in hypertensive cases I prefer to label this condition renal retinopathy. There is a slight degree of oedema of the disks, and much change in the macular area of the retinae in the form of soft patches of exudate and superficial haemorrhages. At the right macula there is seen a well-marked macular fan. The retinal arteries show attenuation." (Fig. 3.)

Mr. Scott saw this patient again on March 13, 1947, after sympathectomy, and wrote: "Apart from some oedema of the lower margin of the left, the optic disks appear physiological. The haemorrhages and patches of soft exudate previously seen in the retinae have now disappeared; the macular fan persists in the right eye, and a less-marked one is present in the left eye. The retinal arteries exhibit a slight increase in brightness of the light reflex but otherwise appear in good condition." (Fig. 4.)

Indications for Sympathectomy

It is interesting and useful to consider the probable indications for sympathectomy in the light of what we know, or with what we seem to have learnt, from recent work concerning the factors producing hypertension. During the early years of the disease the blood pressure increases and remains high, often without symptoms and certainly without organic renal disease. If sympathectomy were performed in such a case as the one previously described belonging to this group it is clear that operation would not be effecting any useful purpose so far as symptoms were concerned. Since the condition at this stage may remain symptomless for a number of years it is equally probable that sympathectomy would not be a justifiable measure from the point of view of the underlying pathological process. If a sympathectomy were done too soon regeneration of the sympathetic paths might occur, and a second sympathectomy would be rendered much more difficult later in the disease, when the effect of the operation would be more beneficial. Hypertension may remain symptomless for over 20 years, and so far the experience of the operation extends only to 10 years at the outside. There would thus seem to be no indication for sympathectomy during most of the earlier part of stage I of hypertension. On the other hand if operative treatment is delayed until the time when permanent arterial degeneration has occurred in the kidneys, producing in them a permanent source of renin, it would equally seem to be true that the measure has been delayed too long. It would logically follow that careful investigation and observation of a patient with hypertension should have as their chief aim the determination of the following two points: the previous duration of the disease, and an estimation whether it is in a stationary phase or whether there is the slightest indication of recrudescence or exacerbation.

There is at present no clinical test available which will enable us to judge the position exactly, but it is probable that a periodic thorough and careful investigation of the retinal arteries by a skilled ophthalmologist is likely to provide the best guide to whether the onset of arterial degeneration is beginning to threaten. A periodic careful investigation of the renal function is also desirable in such cases. Finally, every case must be considered on its individual merits—general, cardiological, renal, familial, and psychological.

The author would like to express his great indebtedness to Mr. E. G. Tuckwell for his very helpful and stimulating surgical co-operation.

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ROLE OF SYMPATHETIC NERVE IN CANCEROUS PAIN

AN INQUIRY ON 300 CASES

BY

MARCEL DARGENT

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[WITH PHOTOGRAPHIC PLATE]

The question of pain-relieving operations on the sympathetic nerve in patients with evolutive carcinoma has been widely discussed. Although by experiment we have acquired much information concerning some of the functions of the sympathetic nervous system, a yet clearer view of its sensory functions may be obtained by a study of operative results and the anatomico-pathological findings in relation to this particular cancerous pain. Indeed, some of these operations have been performed in France as an empirical attempt to relieve pain in desperate cases: they have been only partly successful.

Spinal-cord surgery, as advocated by Putnam in the U.S.A. and Leriche and Wertheimer in France, is based on well-defined experimental facts, and consequently holds an important place in "pain surgery," as did radicotomy in the past.

This inquiry, which I started in 1940 under the direction of M. Leriche and have since pursued, has enabled me, first, to gather anatomico-pathological data; secondly, to define the clinical features of sympathetic pain; and, thirdly, to determine the limits of such operations. I do not intend here to describe the anatomical sensory pathways in the sympathetic trunk but simply to record clinical facts derived from experience.

At first, after a successful cocaine infiltration test, I performed surgical sympathetic-nerve resections—12 on the lumbar trunk and 26 on the cervical. As only temporary relief was obtained I gradually gave up this operation, as I found that repeated cocaine infiltrations had produced more lasting results. I have performed over 300 infiltrations of cervical, thoracic, and lumbar parts of the sympathetic trunk, but shall not describe the technique used, as it is well known. I employ 20 to 40 ml. of a 1% solution of "scurocain."

The use of alcohol I have found to be dangerous, as it often produces such intense irritation in the sympathetic

ganglia that the results may be worse than the initial condition. It seems preferable to use repeated cocaine infiltrations.

Anatomico-pathological Data

Macroscopic and microscopical investigations of ganglia removed at operation have disclosed the existence of actual disease of the ganglion in patients undergoing pain. This fact was revealed in two different areas. First, when removing the lumbar trunk in women suffering from carcinoma of the cervix I found it to be tightly encircled by big lymph nodes extending all along the inferior vena cava or the aorta, just in front of the vertebrae and the anterior part of the psoas muscle. Often after radium therapy these patients were apparently healed as regards their pelvis, and the cancerous extension seemed to originate in the lower part of the lumbar column. The sympathetic ganglia were oedematous, with considerable congestive reactions in the surrounding area. Surgical removal was usually very difficult. Once there even occurred a wound of the inferior vena cava. The small veins passing under the psoas arches would often give rise to troublesome haemorrhages. Secondly, in the neck, when removing the upper sympathetic ganglion, I found it to be closely connected with the big lymph nodes, often suppurative, owing to carcinoma of the tongue, tonsils, or cavum, and lying under the sterno-cleido-mastoid muscle, before the splenius capitis.

I have given up removing the cervico-dorsal ganglion in malignant process due to carcinoma of the breast, having witnessed elsewhere an attempt which proved unsuccessful.

All these oedematous ganglia were submitted to microscopical examination. Arteriolitic lesions were found, with hyalinization of the media. But the most striking fact was the presence of thick clusters of lymphocytes around the sympathetic cells even when no drugs had been previously injected (Plate, Fig. 1). On further examination it was seen that the cells had irregular borders, granulous protoplasm, and a pyknotic nucleus (Fig. 2). These lesions were surrounded by normal areas, thus constituting signs of sympathetic-cell agony.

Examination of the upper sympathetic cervical ganglion revealed in one case a very curious fact:

In a 56-year-old man—in perfect condition after treatment four years earlier for carcinoma of the tongue—a big malignant lymphatic tumour was found to progress in the upper portion of the neck. Pain was intolerable. Microscopical examination of the ganglion removed by sympathetomy showed several carcinomatous areas in the centre (Fig. 3). It was not exactly a direct involvement of nervous tissue but a metastatic growth in the lumen of the small vessels of the ganglion (Fig. 4), partially obturated by inflammatory thrombosis.

Further anatomico-pathological data have been supplied by arterial surgery. It is well known that the arterial wall, when irritated, may be the origin of sympathetic pain. Here again we have found evidence of the arterial origin of pain.

Having operated upon a man who three weeks earlier had undergone ligation of the common carotid artery and resection of the upper sympathetic cervical ganglion, which proved ineffective after a three-weeks success, I found a thrombosis of the carotid bifurcation. Arteriectomy of the three carotids was then performed. This patient had cancer of the tonsil, with a large lymphatic node. Microscopical examination showed important lesions of the intima, and an organized clot was adherent to it. The tunica adventitia also was injured. After the operation pain was abolished during the two months that preceded death.

I have since examined arteries of other suffering patients. I have never found any thrombosis (which in the above case could only be explained by the ligature), but I have often