hence the local origin of the disease. We can also understand why agencies so different as tar, x rays, and animal parasites are capable of inducing cancer. Under exceptional conditions the parenchyma of a carcinoma may have such an effect on the cells of its stroma that the virus is able to infect the connective tissue cells and a sarcoma arises from a carcinoma. The cells of some very rapidly growing and highly malignant tumours produce in abundance a substance which will act as an accessory biological factor, but only for the same type of cell as the one of which the tumour is composed. Such a tumour can therefore be transmitted by a cell-free filtrate containing both virus and the specific factor. Other tumours contain less of this specific factor or it is more labile; they can therefore only be transmitted by living cells. There is therefore no fundamental distinction between these two types of neoplasms, as was hitherto supposed; they differ only in degree.

These differences in the amount of specific factor present in different tumours affords an explanation of the variations in the clinical behaviour of different neoplasms as regards rate of growth and malignancy. A tumour forming an abundance of the specific factor will grow rapidly and metastasize rapidly, because in such an extreme case the tumour will grow, not only by cell division, but also by a transformation of the normal cell of the same type. This would explain the fulminating growth of some types of cancer in the human subject. Tumours containing less of this specific factor or forming a less stable specific factor will grow more slowly and metastasize less rapidly. The striking fact that the growth of a neoplasm is independent of the nutrition of the animal in which it grows calls, as we have seen, for an explanation which places the impulse to grow within the cancer cell. This is obviously in accord with the conception that the growth of a cancer cell is due to an intracellular virus assisted by a chemical factor elaborated by the tumour cells.

Gye's work raises many new problems into which I cannot now enter, but it has solved our old and fundamental difficulties. Its particular merit is that it is not in conflict with any of the previously established facts, but, on the contrary, it confirms them. Taking them as his starting point, he has just gone one step further, and in doing so he has hit upon a conception which links together all our knowledge concerning cancer, which removes all the apparent contradictions, and which, so far as I am able to judge, explains all the essential features of the disease. It is the first adequate explanation of the causation and growth of cancer, and it points the way to further progress.

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THE SURGICAL TREATMENT OF ANGINA PECTORIS.

BY

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IN a previous article (*BRITISH MEDICAL JOURNAL*, 1924, ii, p. 553) I described my conception of the pathogenesis of angina pectoris, and of the mode of action of the sensory cardio-aortic nerve fibres in producing the attacks. I concluded that the best surgical operation applicable to this disease was the intercepting of the maximum number of the sensory cardio-aortic fibres without interference with the important groups of the cardiac accelerators. Jonnesco's operation, in which the stellate ganglion is removed, does

FIG. 1.—Course of the sensory cardio-aortic and of the cardiac accelerator fibres. The sensory cardio-aortic fibres originate in the heart and aorta and form two groups. The first group passes through the stellate ganglion and divides into: (1) a dorsal bundle, for the second, third, and fourth dorsal pairs; (2) a cervico-dorsal bundle, for the sixth, seventh, and eighth cervical, and first dorsal pairs; (3) a vertebral bundle, entering the fifth, sixth, and seventh cervical pairs through the vertebral nerve; (4) the cervical sympathetic bundle, which follows the cervical trunk and joins fibres reaching the trunk through the superior and middle cardiac nerves and the anastomoses which unite the cervical trunk, the vagus, and its branches. The cervical sympathetic bundle is divided between the first five cervical pairs, the medulla, and cranial nerves, and the Gasserian ganglion, reached through the carotid and cavernous plexuses. The second group follows the cardiac branches of the cervical sympathetic and cervical portion of the vagus without reaching the stellate ganglion. It divides into: (1) a bundle entering the cervical trunk through the superior and middle cardiac nerves, and joining fibres in this bundle which originated from the first group; (2) a bundle following the superior cardiac fibres, the depressor nerve being included here, middle cardiac fibres from the recurrent nerve, and inferior fibres from the thoracic supply of the vagus. This bundle enters the vagus trunk and travels towards the medulla, a part of it traversing the anastomoses in the cervical bundle.

not fulfil these conditions, and should be abandoned for the following reasons.

1. The Jonnesco method intercepts important groups of the cardiac accelerator fibres, and the coronary and pulmonary vasomotor nerves. Physiologists have shown experimentally that animals deprived of their extracardiac nerves lose the power of resistance, and it has also been proved that removal of the stellate ganglion weakens the heart beat. By repeating such tests in dogs I have found that excision of the first thoracic ganglia seriously affects the fundamental physiology of the myocardium. The alterations are rendered still more grave if this operation is preceded by ligation of certain branches of the left coronary artery.

2. Removal of the stellate ganglion by the Jonnesco method has produced high mortality in Basedow's disease and in epilepsy (about 20 per cent. in each). In his text-book published in 1923 Jonnesco states that only one of 130 cases of epilepsy treated by his operation proved fatal. Brunning, however, has remarked that the statement is not consistent with one made in 1899, when Jonnesco stated, in Braun's thesis, that 8 out of 33 cases had been fatal. In epilepsy death occurred immediately after the operation or followed it within one, fifteen, or seventy days. Many of the rather numerous fatal cases occurring in Basedow's disease after removal of the stellate ganglion were preceded

FIG. 2.—Cardio-vascular reflexes in angina pectoris. Sensory pressor and depressor fibres emerge from the heart and aorta. The depressor fibres pass to the medulla: (1) to the moderating vagal centre—slowing of the heart by the depressor reflex is thus explained; (2) to the vaso-dilator centre, which is in turn in relation with vaso-dilator centres in the lower part of the dorsal cord; these facts explain the abdominal vaso-dilatation and fall in blood pressure produced in the depressor reflex. The indirect connexions between the sensory depressor fibres and the vaso-dilator centres of the peripheral circulation are not shown; these are also concerned in reducing the blood pressure (François Franck). The pressor fibres are connected with centres in the medulla and cord: (1) with the medulla accelerator centre in relation, through descending fibres, with accelerator centres in the lateral horns of the cervico-dorsal cord. These connexions explain the cardiac acceleration accompanying the pressor reflex; (2) with the medullary vaso-constrictor centre, connected by descending fibres with the centres in the lower part of the dorsal cord. The pressor reflex thus causes abdominal vaso-constriction and increases blood pressure. But other pressor fibres exist, not traversing the medulla and directly influencing the medullary vasomotor centres through sensory fibres which reach the cervico-dorsal cord through the inferior cardiac nerves and stellate ganglion. These fibres affect: (1) vaso-constrictor and vaso-dilator centres of the upper limbs, which explains the modifications in the brachial plethysmogram described by me in angina; (2) vaso-constrictor centres in the lower part of the dorsal cord, reached by descending fibres; thus is explained the rise in blood pressure produced in dogs by stimulating the central end of the Vieussens loop; (3) accelerator centres in the medulla. Different sensory cardio-aortic fibres reaching the medulla and cord may possibly affect the motility of the coronary vessels, as well as that of the pulmonary vessels. These connexions show that all stimuli starting from the heart and aorta travel centrifugally by way of the sympathetic as well as the parasympathetic. Normally the parasympathetic group is the more affected, explaining the depressor reflex produced by stimulation of the heart and aorta. In angina pectoris the sympathetic fibres are more affected, the depressor reflex being thus absent, and the pressor present. Reflexes starting from the heart and affecting the vessels are more marked on the left side, for the following reasons: (1) The cardiac nerves are more developed on this side. (2) The myocardial pressure producing the anginal attacks, or which in other abdominal states give rise to different vascular reflexes, occurs most intensely in the left ventricle, which is more related with these states and possesses the largest amount of cardiac muscle. This mechanism explains why anginal sensations and disturbances which occur in various abnormalities of the heart are situated on and radiate especially toward the left side. (3) Coronary lesions are more marked on the left side. Myocardial sclerosis so produced renders the left sensory terminations hypersensitive, a factor predisposing to anginal attacks.

by signs of myocardial insufficiency. The mortality would prove to be much higher if the cases were followed up for longer periods, and if all the fatal cases were published.

3. The mortality of the Jonnesco operation in angina pectoris is also high. In one case death occurred four days after the operation, with signs of acute asystole of the left heart, and with pulmonary oedema; in a second case death followed similarly in four days. In another case the patient was found dead in his bed the day after the operation. In a case in which Hofer applied the Jonnesco operation the patient died within twenty-four hours, with pulmonary oedema and asystole of the left side of the heart. A case treated by Diez ended fatally in a month, one by Radici

in twenty-one days, and one by Reid and Friedländer in fifteen days. Arrilaga reported recently a case of death with syncopal phenomena after this operation. Most of these patients presented signs of acute myocardial insufficiency, which shows the danger of dividing cardiac accelerators in a disease in which the myocardium is so often much degenerated. Again, Arrilaga has shown that the Q.R.S. phase, as indicated by the electro-cardiogram, becomes prolonged in anginal cases after excision of the stellate ganglion by the Jonnesco method; a fact which indicates aggravation of the myocardial condition. Diez confirms the findings of Arrilaga, who also, with Clerc and Basconnet, insists on the gravity of this change. In cases where it occurred, 60 per cent. of the patients died during the year. When an anginal subject, who has never presented

FIG. 3.—Path through which pain radiates in angina.

the signs of asystole of the left side of the heart, shows this syndrome and dies on the day of operation or soon after, and when we remember that the positive inotropic function of the accelerator fibres is intercepted by the Jonnesco treatment, these untoward results must inevitably be attributed to the removal of the stellate ganglion.

4. Cases of survival after the Jonnesco operation may be explained on the assumption that the myocardium has not degenerated to the same extent in all anginal cases. It is also true that most of the cases so far reported have not been followed up for a sufficient length of time. We do not know how long we must wait to be sure that interception of the accelerators has not injured the myocardium. Such reports are incomplete, the only really complete cases being the fatal ones. Surviving patients should not figure in the statistics unless operating surgeons report the clinical conditions existing some years after operation. I may also remark that excision of the stellate ganglion is a rather difficult technical procedure. In the hands of a surgeon so experienced as Jonnesco complete excision may be counted upon, but I seriously doubt whether it has been complete in all the cases operated upon for angina by those operating thus for the first time. Such incomplete excision may also explain the survival of some cases, as compared with the particularly high mortality reported by Jonnesco.

Most reports on the Jonnesco operation are made by surgeons; no cardiologists have yet accepted it, and the question is one for cardiologists. I was the first to point out the danger of removing the stellate ganglion; but Wenckebach is of the same opinion and suggests section of the depressors, while Hofer also has condemned the Jonnesco operation. Diez, who at first approved the operation, has now written to me supporting my view of it, since in one of his cases sudden death occurred one month after the operation. In his important work on the heart Vaquez is inclined to approve my treatment, which leaves the stellate ganglion untouched, and Richon concurs, maintaining that extensive mutilation of the ganglia endangers the centrifugal fibres. Leriche categorically opposes the Jonnesco operation, as it was followed in four cases by death from acute asystole of the left side of the heart.

PERSONAL METHODS.

In 1922 I remarked that removal of the stellate ganglion should be abandoned, but that I hoped that angina pectoris

might be improved by cutting other nerve fibres, and I suggested section of the cervical sympathetic. Clinical and experimental studies made then have enabled me to add during the last three years the division of other nerves without danger and probably with benefit. The procedure which has gradually evolved is as follows:

1. Section of the cervical sympathetic (Fig. 5). We thought at first that section of the cervical sympathetic was necessary; we also contemplated altering the connexion of the visceral sensory neuron with the cerebro-spinal sensory neuron situated in the cord or spinal ganglion by dividing, or blocking with alcohol, the second, third, and fourth spinal nerves. Since fresh experiments were necessary, and are now progressing, discussion of this point must be postponed. Section of the cervical sympathetic was successfully accomplished by C. F. and A. F. Jennings in 1924. In the previous year Coffey and Brown had combined section of the cervical bundle with division of the first cardiac nerve. The five cases thus treated were clearly improved.

2. Section of the cervical sympathetic and vertebral nerve, or section of the anastomoses connecting the superior cervical ganglion with the cranial nerves (Fig. 6). The vertebral nerve may contain sensory fibres; its section is therefore desirable. Gino Pieri de Belluno tried my method of dividing the cervical bundle and the vertebral nerve; improvement followed. In my previous article in this JOURNAL I advocated that in addition to cutting the cervical

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 4.—Cervico-thoracic sympathectomy: the Jonnesco method. Removal of the entire cervical chain and of the first thoracic ganglion. The operation leaves intact the sensory cardio-aortic fibres contained in the vagal branches, and interrupts highly important accelerator fibres and coronary and pulmonary vasomotor fibres, causing fatal results.

FIG. 5.—Section of the cervical sympathetic. (Daniełopolu and Hristide: Soc. roumaine de biol., November 2nd, 1922.)

FIG. 6.—Section of the vertebral and cervical sympathetic, or section of the anastomoses connecting the superior cervical ganglion to the cranial nerves. (Daniełopolu, January, 1924.)

sympathetic and the vertebral nerve, those fibres should also be divided which were widely distributed within the thorax from the cervical sympathetic and cervical portion of the vagus.

3. Resection of the cervical sympathetic chain (leaving the inferior cervical ganglion intact) with section of the vertebral nerve and of all vagal fibres descending into the thorax (Figs. 7 and 8). If some of these nerves are absent or are too difficult to divide, only those sections which are feasible should be made, but in all cases the cervical sympathetic should be excised. After suggesting the operation described in the previous paragraph (2), my researches proved the existence of numerous anastomoses between the cervical sympathetic and the vagus and its branches, which probably contain sensory cardio-aortic fibres. Apart from the inferior ganglion, which is left intact in this operation, the cervical sympathetic contains no important groups of cardiac accelerator fibres, and may therefore be removed, in accordance with the principle of dividing as many as possible of the cardio-aortic sensory fibres, with the least possible interference with the important accelerator fibres. Lilienthal, in 1925, and therefore after the publication of my recommendation to remove the stellate ganglion intact, published results obtained in three cases of angina pectoris in which he had removed the cervical sympathetic without interfering with the inferior ganglion—the operation advocated by me in 1924. His results were excellent.

4. Resection of the cervical sympathetic (leaving the inferior cervical ganglion intact) with section of fibres of the cervical vagus and its intrathoracic branches; section of the vertebral nerve; and section of communicating branches uniting the inferior cervical ganglion and first thoracic nerve with the sixth, seventh, and eighth cervical and first dorsal nerves (Fig. 9). If a nerve is present which connects the superior laryngeal and the vagus, it must also be cut; the operation must be as complete as possible, and any inaccessible nerves must be left. Jacobovici reports a case of angina in which my method proved highly successful; Leriche had similarly favourable results in one case. I have made this last method as perfect as possible because my experiments had shown the value of dividing various nerves the section of which was harmless. In all my experiments I have observed the principle of cutting as many of the sensory cardio-aortic fibres as possible, without touching the important cardiac accelerator fibres which pass through the stellate ganglion.

My method is wholly different from that of Jonnesco, who claims that sympathectomy is ineffective unless the stellate ganglion is included, as practised by him in epilepsy and Basedow's disease. My method is based on the following data:

1. My clinical and experimental studies have shown that all the nerves selected for section contained sensory cardio-aortic fibres. Radiation of pain to the lower jaw and the palatine vault showed that the cervical sympathetic is partly sensory. Radiation of pain to the pathway of the cervical pairs of nerves indicates that section of the rami communicantes, which unite the cervical bundle or the vertebral nerve with the cervical cord, intercepts many sensory fibres. Radiation of pain to the path of the eighth cervical and first dorsal nerves proves that sensory fibres exist in the communicating branches which I propose to divide. Results obtained in dogs show that the vertebral nerve sometimes contains sensory fibres, and may be cut with advantage. Hofer's operation, which proved that cases improved after division of some branches of the vagus, indicates that this nerve contains sensory fibres. I believe that all intrathoracic branches of the cervical vagus should

FIG. 7.

FIG. 8.

FIG. 9.

FIGS. 7 AND 8.—Resection of the cervical sympathetic chain, leaving intact the inferior cervical and first thoracic ganglia, with or without section of the vertebral nerve and branches entering the thorax from the vagus (October, 1924). Fig. 7 represents the more complete, Fig. 8 the less complete, operation.

FIG. 9.—Resection of the cervical sympathetic chain, leaving the inferior cervical and first thoracic ganglia intact, with section of the vertebral nerve, of branches of the vagus, and of vagal branches entering into the thorax, and of communicating branches uniting the inferior cervical and first dorsal pairs; and section of the fibres occasionally passing from the superior laryngeal to the vagus. (Daniełopolu, February 4th, 1925.)

be divided. My dissections have brought to light numerous anastomoses between the vagus, the sympathetic, and their branches, the various fibres probably meeting at these anastomoses. Since we must not divide the vagal trunk, we have everything to gain by removing the cervical sympathetic (except the inferior cervical ganglion), and thus intercepting the sensory fibres in the anastomoses and communicating branches.

2. My experiments have also shown that the nerves selected for section contain no important cardiac accelerator fibres, which exist chiefly in the communicating branches from the second, third, and fourth dorsal nerves. I have not found any accelerator fibres in the communicating branches uniting the stellate ganglion with the last cervical pairs of nerves and the first dorsal nerve. In experiments on dogs it was found that the vertebral nerve contained no important accelerator fibres.

3. I have also determined the presence of sensory fibres in the second, third, and fourth communicating branches. These nerves, however, must be preserved, since they contain cardiac accelerator fibres. My investigation has also proved, as previously reported, that angina pectoris may be much relieved, even though all the sensory cardio-aortic fibres are not divided. While leaving intact the sensory fibres in the communicating branches we cut other important nerves, such as the vagal branches, which contain many sensory cardio-aortic fibres. Relapses occurring after the Jonnesco operation are due to the fact that this method leaves the vagal branches intact.

4. Though not a surgeon, my study of the cadaver has shown that these various nerves may be usually divided or resected; moreover, Leriche has stimulated these nerves

during operations on man. My method is also easier than that of Jonnesco, in which the excision of the stellate ganglion requires expert skill.

Such are the arguments in favour of my method. The probability that it will be very effective is indicated by the improvement obtained by Hofer's operation, which divides the depressor nerve, and the results of my earlier methods, including cervical sympathectomy and section of the sympathetic and vertebral nerves. In the report of the Nancy Congress (*Presse Méd.*, August, 1925) occurs this note: "Leriche (Strasbourg reports a case of angina pectoris without cardiac lesions but accompanied by slight aortic dilatation, which has remained cured for five months thus far, by removal, after the principles stated by Daniélopou, of the left cervical sympathetic chain, from the upper cervical to the stellate ganglion, which was left intact. The last three cervical communicating branches and the two roots of the vertebral nerve were also divided. The result is excellent." Jacobovici also obtained a good result in one case by applying my method. The earlier operations in which my method was used were thus very encouraging. As to the question of danger, all the clinical and physiological facts permit me to state that the nerve interferences are harmless. The fatal results after the Jonnesco operation are due to acute myocardial insufficiency produced by removal of the stellate ganglion, which I leave untouched. The question may be raised whether the operation should be performed bilaterally. I have always believed that operations on the sympathetic should be as conservative as possible. The operation should be completed on the left side, and supplementary operation on the right side performed only if the first treatment proves insufficient.

SUMMARY.

In the Jonnesco method the division of certain nerves, such as the cardiac accelerator fibres, involves danger, while nerves which may be divided usefully and without injury are left untouched. By my method it is the former which are left intact, and many nerves—possibly more than in the Jonnesco operation—which contain sensory cardio-aortic fibres, are severed. In order to judge the value of the Jonnesco operation the cases, which are now sufficiently numerous, should be followed up for several years. It is not prudent to continue this operation, which has been followed by fatal results, before trying a method which appears to be wholly harmless and probably very effective. My operation has its contraindications: it should not be employed if signs of myocardial insufficiency are present. Thus, for example, I do not advise it when anginal attacks are complicated by pulmonary oedema, which indicates the presence of extensive myocardial degeneration. Even so Jonnesco's operation would appear to be much more dangerous than mine in these cases. The number of methods which I advise may seem surprising, but the methods are successive, each one perfecting a preceding one. Some proved excellent from the first, but in each new operation division of more sensory cardio-aortic fibres has been attempted in order to make the benefit more complete. The operation should, however, be as complete as possible in each case, resection of the cervical sympathetic being supplemented by section of the vertebral nerve and the communicating branches mentioned, and of certain branches of the vagus, in so far as anatomical peculiarities or technical difficulties allow. Cervical sympathectomy alone is sometimes very effective, but even this may sometimes be impossible because of the general condition of the patient. In such cases treatment should include simple section of the cervical sympathetic bundle, with or without section of the vertebral nerve, intrathoracic branches of the vagus, and the communicating rami. The number of sensory cardio-aortic fibres will be reduced and the pressor reflex, which is the primary cause of the anginal attacks, will be diminished. When clinical improvement has started the operation may be completed at a later date.

In addition to the classical angina pectoris, surgical treatment may be considered in abdominal angina. Some of these cases are only angina pectoris with an unusual pain distribution, and may be relieved by the surgical treatment applicable to ordinary angina pectoris; in other

cases, however, a real abdominal syndrome exists, due to arteritis or atheroma in the abdominal aorta, the coeliac trunk, or the gastro-intestinal arteries. Here the syndrome is referable chiefly to sensory fibres supplying the abdominal viscera. To prevent the attacks in such cases the solar plexus must be treated.

The practical conclusion appears that surgical treatment of angina pectoris is of general application. Cases must be well selected, and the completeness of the operation will depend upon the patient's condition. I cannot, therefore, agree with Mackenzie, who has stated that anginal patients should never be treated surgically. The Jonnesco method involving the removal of the stellate ganglion may perhaps be abandoned, but the method I suggest is far more hopeful, and offers much promise in practice.

NOTE.—While this article was in the press there appeared Fontaine's thesis, *Traitement chirurgical de l'angine de poitrine* (édition universitaire de Strasbourg). In this thesis, inspired by Professor Leriche, Fontaine has collected 100 instances of angina pectoris treated surgically, and reaches the following conclusions. He agrees with me in condemning Jonnesco's operation, which leads to acute cardiac failure with death, owing to the removal of the stellate ganglia. Fontaine cites numerous fatal cases, and a note by Leriche on a case in which excision of the stellate ganglia for paroxysmal tachycardia provoked acute asystole. An additional reason for abandoning Jonnesco's operation is, according to Fontaine, that the methods in which the stellate ganglia are not touched have proved so much more effective.

A CASE OF ABDOMINAL TORSION OF THE OMENTUM.

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In the introduction to his paper on abdominal torsion of the omentum Mr. Ernest Cowell¹ writes:

"Abdominal torsion of the great omentum, unaccompanied by complications arising from, or factors associated with, any form of hernia, is a rare condition. A search of the literature from 1882 to the end of 1924 has revealed only eighteen recorded cases, including a new case met with in the surgical practice of the author. In view of the fact that few surgeons publish isolated cases, especially in this country, it is hard to believe the condition is really as rare as one might otherwise suppose. Of the 18 cases, 8 are reported from America, 3 from Germany, 2 from Austria, 2 from France, 1 from Australia, and 2 from England. Torsion of the great omentum associated with hernia is not uncommon. Considerably over a hundred papers have been published on this subject, and approximately 140 cases described."

Since meeting with the case here reported I have heard of no fewer than three apparently similar cases, none of which, so far as I am aware, has as yet been published. The condition, therefore, as Cowell suggests, is probably not as rare as would appear from the scanty literature.

A man, aged 63, was admitted to Dundee Royal Infirmary on November 23rd, 1925, complaining of pain in the right side of the abdomen of four days' duration. Since boyhood he had worked as a colour mixer in linoleum works—lead colours being used. The pain came on gradually, steadily became worse, and was aggravated by coughing or taking a deep breath. There was no vomiting, and the bowels, always regular, had moved daily since the onset. He was of average build, and rather thin. General condition good. He complained of pain in the right iliac fossa. Temperature 97.2°, pulse 72. Abdomen slightly distended; no respiratory movement in lower half. Liver dullness normal; flanks clear. Resistance all over the abdomen with "boarding" on the right side extending from the right iliac fossa almost to the costal margin. There was definite acute tenderness over the area of "boarding." No palpable swelling, and no hernia. Rectal examination negative. Leucocyte count, 15,200 per c.mm. Tongue dry, and slightly furred. Lower teeth carious with advanced pyorrhoëa. A pre-operative diagnosis of appendicitis was made,