An Address ON ARTERIAL SCLEROSIS.

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GENTLEMEN,—I am half ashamed to ask your attention to such a common disease as arterial sclerosis. But though it is common there is very little known about it, and since it is common the more we know about it the better.

I suppose the picture that will occur to every one's mind is that of a rather stout man of about 50, who has led a fairly hard-working and fairly successful business life, whose exercise has consisted in going to and fro between his office and his house, most of the way, perhaps, by train, and whose interests have lain almost entirely in getting the better of other people. His amusements have been confined to a little social intercourse with friends very like himself, and he has had three hearty meals every day of his life. At about that age he begins to feel certain inconveniences. He gets dizzy when he is lacing his boots; if he has to hurry to catch his train he gets very short of breath; he notices that he gets palpitation now and again without known cause; that sometimes he has a certain amount of discomfort about the heart as if he had not quite room enough in his chest, and perhaps that at the end of the day there is a little swelling about his ankles. As he has never, according to his own ideas, exceeded due limits, he cannot make out why he should be troubled. We find that his heart is a little enlarged, and that after walking backwards and forwards for a few yards quickly it beats rather forcibly. His pulse is perhaps occasionally intermittent, but the most striking thing about it is that if, while feeling it with the left forefinger, we try and stop it with the right, it takes a very considerable pressure to obliterate it. In a stout man it is not easy to be sure of the thickness of the arterial wall, but this can sometimes be felt to be abnormal. Under such conditions we naturally examine the urine. As such patients are not in bed it is not easy to obtain a proper sample of the twenty-four hours' urine. We cannot then know the total quantity, and if we do not, the specific gravity of a single sample is often misleading. The urine is usually acid, clear, and contains no albumen. We do not feel quite justified in diagnosing chronic interstitial nephritis, yet the rest of the conditions are such as usually coincide with that complaint.

Or the picture may be a little different. The patient may be thin and spare, may have led a highly-intellectual strenuous life, may have been temperate and self-controlled, and may have played golf regularly and done a good deal of walking in his holidays. Yet he complains of much the same symptoms; we find his heart the same, and, in addition to an incompressible pulse, we find an artery like a vas deferens and highly tortuous.

In both these cases we may soothe our minds by saying that there is chronic interstitial nephritis, but the evidence for this is nothing more than inference, and even if the inference were true, it would not help us much, for the patient's complaints refer entirely to faults in his circulation. To say that he has interstitial nephritis is no direct explanation of his symptoms, and the present tendency of pathologists is to consider interstitial nephritis to be a consequence of arterial disease rather than a cause of it. I have purposely chosen slight degrees of the condition; every one is familiar with cerebral hæmorrhage, and fatal cardiac failure as the end of these cases.

The faults of circulation of which this man complains are of two kinds. From what we can feel in his radial we may guess that his dizziness when stooping depends on a similar stiffness in his cerebral vessels, which prevents them from following closely the variations of pressure produced by position, and thus at times deprives his brain of blood. All the rest of his symptoms can be explained if we suppose that his heart, though manifestly hypertrophied, has become not quite competent for its task.

But how have these changes come about? Why, without any evident cause, should the arteries have become inelastic? And why should the heart, which was strong enough to stand the muscular life of youth, fail to support the much quieter life of middle age? The answer to these questions may be found by examining the condition of the arteries after death and the blood pressure during life.

1. THE CHANGES IN THE ARTERIES.

There is probably no point of pathology better established than that, as a broad rule, the inner coat of arteries becomes with advancing age increasingly subject to certain morbid changes. In the larger arteries these changes are usually styled "atheroma," sometimes "endarteritis deformans"; in the microscopic arteries we find hyaline swelling and hyperplasia of the elastic layer and of the subendothelial cells. These changes are capricious; the abdominal vessels, forming what is called "the splanchnic area," may be free when the skeletal vessels are affected or the reverse, and the cerebral vessels may be free when the rest are diseased. The carotid and the external iliac—two arteries which are nearly of the same size and bear almost the same relation to the trunk of the aorta—are attacked by atheroma quite differently; in the first it is extremely common, in the second extremely rare. The pulmonary arteries, except in special circumstances, nearly always escape.

Again, the microscopic changes above mentioned, which are very common in the vessels of the kidney and of the spleen, are not generally distributed. They are, for instance, hardly ever seen in those of the liver or of the muscles (Jorés).

We should naturally turn to experiment for the explanation. But it happens that the animals which pathologists can use for experiment are not subject to this disease. Very severe lesions can indeed be produced by the injection of adrenalin and of nicotin, but they differ widely from what we may call the natural disease in man. We are thus driven to observation of man as our only method of understanding these conditions, which, though probably comprising more than one disease, are commonly grouped together under the name of arterial sclerosis.

It is common knowledge that arterial sclerosis as seen in man may be due to certain poisons such as that of syphilis and lead, and alcohol is generally supposed to have a similar influence. It is quite certain, too, that chronic diffuse nephritis can produce endarteritis in young people. But the great majority of cases do not fall under any of these heads, and in them the cause of arterial sclerosis is still undecided. It has been found by Virchow and other observers that the changes in the intima are usually greatest where blood pressure is highest, and it is well known that though the pulmonary arteries are seldom affected, the cases in which they suffer are cases in which from some cause or other the blood pressure in this system is raised. Just so it is in experiment. Those poisons, adrenalin and nicotin, which produce severe lesions of the intima, are poisons which greatly raise the blood pressure.

Thus, while atheroma and endarteritis tend in their turn to raise the blood pressure by offering increased resistance, they seem to be often, and perhaps usually, the result of a high pressure antecedent to themselves.

But however this may be, we know from experiment that, unless calcareous plates are present, these changes in the intima are not the cause of stiffness in the vessel. A highly atheromatous aorta may stretch as readily as one that is not atheromatous, and if an artery is stiff you may peel off its inner coat and yet leave it as stiff as before. The loss of elasticity in arteries cannot, therefore, be explained by any of the conditions which we have yet considered.

If, now, we pass from these visible changes to examine the mechanical properties of arteries, a rather remarkable result appears. Wills and I, amplifying some work done by Roy, found that from the age of 20, the earliest we could examine, to the latest period of life, there was a continuous loss of elasticity in the aorta, which could not be ascribed to any cause other than age. No disease appeared to interfere with, or sensibly to increase, the gradual stiffening which age produces.

What, then, can there be in age which has this effect? We were quite unable to find in the middle coat, which is

the seat of this stiffening, any anatomical change by which we could explain it. But we found a second fact which is very significant. In successive decades the arteries not only lose elasticity, but also become progressively wider. The stiffer the artery the wider it is.

Put in that way the statement is not very illuminating, but if you turn it the other way round and say the wider the artery the less it will stretch, then at once the explanation suggests itself that arteries are inelastic because they have already been dilated, and, therefore, that the whole thing—both the changes in the intima and the loss of elasticity in the media—may, perhaps, be resolved into increase of blood pressure.

2. INCREASE OF BLOOD PRESSURE.

Ever since von Basch and Potain, thirty years ago, began the study of blood pressure in the living man an immense amount of work and of invention has been devoted to it. Many instruments have been devised for its measurement, one of the best of which is a sphygmomanometer, due to Riva-Rocci, with an arm-band 12 cm. broad added by Martin.

You will easily understand that, even with the best instrument, we cannot reach the same precision on the living body as from experiments with a strip of artery taken from the dead. But it is quite firmly established that, just as we should expect from the results of the latter, the blood pressure rises as age advances. There is a marked difference between the average pressure of apparently normal persons at 20, 40, and 60 years of age, and this is increased if we include the diseased, since most chronic diseases tend to raise pressure.

And another fact appears almost equally important. I stated that we could not find that any disease sensibly affected the elasticity of the aorta at death. Individuals in each decade certainly varied one from another, but in the 100 male cases we examined no disease seemed to have any consistent effect at all comparable with that of time. On the other hand, there is no question about the effect of some diseases, for instance, diffuse nephritis, upon blood pressure. They may increase it very greatly.

From this side also, therefore, it seems probable that a rise in blood pressure is antecedent to change in the vessels, and even requires considerable time before it deprives them of their natural elasticity.

But what is antecedent to the rise in blood pressure? What conditions have brought that about?

Here we enter upon a region of dispute in which there are many theories and few facts. The pressure must be the result of increased resistance. The heart responds to this by increasing the size of its fibres.¹ As the resistance becomes greater, the heart hypertrophies again and so the process goes on till at last the heart's power of reaction is worn out and the resistance becomes too great for it to overcome.

Where is the resistance? It might be due to some disease in the blood vessels. If so it must be in the minute vessels, for the radial, and probably all arteries visible to the naked eye, are not themselves the seat of resistance. They lie in the area of dilatation between the heart and the resistance. It is conceivable that in these minute vessels some anatomical change takes place which blocks the passage through them. Gull and Sutton talked of arterio-capillary fibrosis, Johnson described muscular hypertrophy, and nowadays, though both these ideas have lost their hold, we recognize the hyaline swelling and the hyperplastic thickening of the intima of which I have already spoken. But lately, as I said before, the tendency has been to regard these rather as the consequence than as the cause of high pressure.

Again, it has been suggested that the blood becomes more viscous in old age, and that the increased friction accounts for the resistance. Direct attempts to verify this have, however, failed to show that increase in viscosity is the rule even in cases of nephritis.²

Thirdly, it has been supposed that the blood contains toxins or undigested products, or extracts of animal tissues, or even excretory substances which have failed of excretion, and that these, or some of these, may by their effect upon the fluid, or upon the vessels which contain it, render the blood flow more difficult.

We can find examples that might easily fit this hypothesis of an impurity in the blood.

1. Thayer found that old typhoid fever patients had a much higher blood pressure than was natural, and it is conceivable that this is the after-effect of some toxin or antitoxin formed in the blood.

2. It is very tempting to believe that the high pressure of plethoric men is due to the imperfect performance of the final or muscular stage of digestion. Their stomachs and intestines act well, their livers work up the portal products, but they do not take sufficient exercise, and in consequence do not disintegrate by muscular chemistry the intermediate forms of metabolism.

3. Contamination with excretory substances has often been suggested to explain the symptoms of nephritis. This idea has derived some support from the fact that in nephritis the freezing point of the blood is generally lowered, which implies that the blood contains a greater number of molecules than the normal.

4. In the last year or two experimenters (Tigerstedt and Bergmann, Ascoli, Batty Shaw) have shown that extracts of renal tissue when injected into the system have an extraordinary power of raising blood pressure. It is therefore a plausible theory that in chronic nephritis much renal tissue dies and is removed by the absorbents, and that this substance, returned into the blood, produces at any rate a large number of the cases of high pressure.

You see, therefore, that the elderly gentlemen with high blood pressure, of whom I spoke at first, may be accounted for in more than one way. If they have not had typhoid fever they may have had some other complaint with a possible toxin. If they have not greatly over-eaten themselves they are very exceptional specimens. If they happen to pass water rather frequently we can at once suppose that they have a latent nephritis, and can then choose between two different explanations of their high pressure.

But these hypotheses cannot in any individual case be established upon a firm basis. Even with the most careful examination we cannot reach certainty. As far as we can tell, any one of them may be true of a given patient.

TREATMENT.

In this necessary state of doubt it seems to me that our business is to act upon that one of them which gives the most hope for treatment. We cannot expect to remove disease already fixed permanently in the arteries. We can with some hopefulness attack a floating impurity in the blood. It is on this side that the chances of treatment are best.

Of course, if symptoms are severe, the first necessity is rest in bed, and under it alone a good many cases improve. Muscular effort produces for the time great rise of pressure, and complete muscular rest removes these moments of strain and gives the heart a chance to recover its tone.

But I have chosen a slight case for my example, and chiefly on this account—that in such a case the last stage has not been reached, and that we can not only remove the symptoms for the time, but to a great extent prevent their increase and recurrence.

Such a patient will not be in bed, and will not be greatly benefited by going there. We can, however, do him a great deal of good by drugs, by diet, and by regulation of his habits.

1. Habits.

It is highly important that such a man should take a certain amount of regulated exercise daily; for, though exercise, if severe, strains the heart, it is, when moderate, the best possible means of ensuring a healthy metabolism. I have suggested that this may be through the chemical activity of the muscles themselves. That is only a suggestion—nothing more. The effect may be due to other causes; but of its reality I think there cannot be any doubt at all.

A second point is early rising. I cannot give you any other reason why this should do good than that perhaps it promotes metabolism by giving opportunity for a little exercise before any large meal has been taken.

And a third is the renunciation of tobacco. The power of a pipe of tobacco in raising the pressure in man is as certain as is the result of its injection in animals. And though we cannot suppose that smoking produces such extreme changes in the arteries as do the strong injections used in animal experiments, the results of these must weigh greatly with us in treatment.

2. Drugs.

In some cases severe symptoms are for the time greatly relieved by nitrites. But their effect is usually transient. Still, I have known men made much more comfortable by small doses of nitroglycerine given for a week or two. For a more permanent effect small doses of potassium iodide have been highly recommended.

But I do not think that any drug approaches calomel. Given in small doses of 1 gr. or $\frac{1}{2}$ gr. every night for a short time and repeated at intervals, it sometimes is of very great use. It is not its purgative effect that is needed; it is really what is called an alternative. Every one appreciates its effect on the spirits, and I believe this to be chiefly an effect on the blood pressure, for it is known that melancholy is a state in which the pressure is high.

Alkalies act chiefly by increasing the flow of urine, and this, especially in cases complicated—for this is my view of the position—by nephritis, is often of great importance.

3. Diet.

I think that diet is perhaps even more important than either habits or drugs. I have not any doubt that in some cases a very light diet acts like a charm. Let me give an example:

A man of over 50, very thin and spare, was admitted under me. He was complaining of severe dyspnoea and oppression, and had been in bed for some time at home without benefit. He could not lie down. There was no disease of his lungs, no oedema, no dilatation of the right side of his heart, and no albuminuria. I am not prepared to say his kidneys were healthy; probably they were fibrous. But the main thing about him was extreme degeneration of his radial artery and a very high blood pressure. He was put on our hospital milk diet, and from that moment improved rapidly. He went out, resumed his usual food, and in three weeks his symptoms returned. This time I made him go on milk diet at his own home and the result was as good as before.

This effect, however, does not always follow. Almost at the same time I tried this diet on a rather older man with the same symptoms without producing any effect on his blood pressure. He improved slowly, just as such cases usually improve when they lie up.

Whereas in the first case it seemed that the alteration in diet really removed to a great extent the cause of high pressure, which was, therefore, probably a floating impurity, in the second case it is reasonable to suppose that the pressure was due to some permanent changes in the vessels. Under such circumstances the high pressure is necessary for the blood flow, and all we can do is by rest and small doses of digitalis to strengthen the heart for its task.

I do not quite know how, when this treatment succeeds, the effect is produced. It is not the necessary result of milk, for if milk alone is given, which involves drinking 5 pints daily, it is said to increase the blood pressure rather than diminish it. Our milk diet, however, contains milk (2 pints), bread and butter, rice or custard pudding, and tea (1 pint). There are about 70 grams of proteid in it. The reduction of blood pressure, therefore, might be due either to the reduction of proteid or to the alteration of the kind of proteid taken.

In some cases I think the first is certainly the most important. In chronic nephritis, which always means diffuse nephritis—for interstitial nephritis is a latent disease—it used to be the custom to prohibit meat. Hale White and von Noorden have written against this treatment, and I fully agree with them. Such patients do much better with meat than without it, but the total of their food must be kept at a very moderate level, because their means of disposal of refuse are crippled.

But we must not expect to reduce pressure in them; in later stages, at any rate, it does not fall, even when, owing to uraemic vomiting, scarcely any food is taken. This obstinacy may perhaps be due to disease of the abdominal arteries. It is known that these vessels have a preponderant influence on blood pressure, and also that they are nearly always diseased in chronic nephritis of middle life. But it seems to me more probable that, as experiment suggests, the degenerating renal tissue pours a toxin into the blood which no change of diet could remove. In such cases the one important thing is to drain the poison off by increasing the flow of urine.

In other cases, however, I think it impossible to deny that the kind of proteid taken is of importance. I am not

at all a faddist about food. I do not share the belief that meat invariably floods our tissues with uric acid, and I think that many people are the better for a little wine. But my observation leads me to think that there is a great variety in the metabolism of different persons, and that the diet which is good for one is, quite apart from gastric indigestion, poison for another. There is exaggeration in this as in all things, and it is not often that a patient's observation of his own symptoms can be accepted without reserve. Still, it is my belief that chemical analysis has much further to go than the mere estimation of calories, or of the nitrogenous contents of the ingesta and excreta, and that our own observations if carefully made will often tell us more than chemistry can yet explain. Chronic rheumatism, of which you see plenty here, some forms of headache, and high blood pressure, appear to me to be clues of special importance in examining the effects of different forms of proteid, and I think there is a great deal to be done by following them up.

I do not ascribe the same importance to carbohydrates. They have great influence on digestion. Some people cannot eat bread or potatoes, some can eat raw sugar but not cooked sugar, and so on; but I have not observed that they affect blood pressure.

I should say the same of minerals. Salt has a certain connexion with oedema, but this is not through blood pressure. Calcium I never saw have any effect at all.

This, however, may be from want of observation on my own part, for I see that others think differently.

Meanwhile there is one lesson that middle age has always to learn, and that is that it must be moderate, and that moderation means for it something very different from the ordinary meals of healthy and active youth.

REFERENCES.

¹Gutch, *Journ. of Pathol.*, 1901. ²Hirsch and Beck, *D. Arch. f. klin. Med.*, 1902, vol. lxxii, p. 560.

Remarks

ON

SOME POINTS IN THE PATHOLOGY AND TREATMENT OF ADHERENT PERICARDIUM.

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THE subject of this study is a boy, son of healthy parents. His brothers and sisters are also healthy. There are no cases of tuberculosis in the family. He is living in the country, under exceptionally favourable hygienic conditions. His father is a doctor.

There seemed to be nothing wrong with him until the summer of 1903; he then got an exudative pleurisy on the left side. There were pain and fever during some weeks, and a certain amount of fluid. The fluid was absorbed, but dullness remained, with marked retraction of the lung. He did not, however, regain his appetite, and there was some shortness of breath.

A year afterwards, in the summer of 1904, a pericarditis followed. There was again a considerable amount of fluid, there was fever, and the boy was very weak. Again the fluid and the fever disappeared, but at the moment the exudate seemed to be locally reabsorbed, alarming symptoms made their appearance. The pulse became very quick and weak; an extreme shortness of breath and a very painful and enormously swollen liver were developed.

I was asked to see the patient, and found the symptoms characteristic of adherent pericardium. The pulse was small, weak, and frequent, diminishing during inspiration (*pulsus paradoxus*); the veins were considerably over-filled, and during inspiration there was marked swelling of the veins in the neck. In the regio cordis there was a visible and palpable systolic retraction of the ribs and the intercostal spaces. The heart sounds were faint but pure. The liver was huge and hard, reaching nearly to the umbilicus, and very sensitive to touch. Its size seemed out of proportion to the stasis of blood in the venous system (see Fig. 8 a).

The history of this disease, or rather of its symptomatology, is connected with many a great name. Kussmaul, Friedrich, and many French and English clinicians, have