On atheroma and some of its consequences, with their treatment : an address delivered before the Cardiff Medical Society on February 21, 1895 / by T. Lauder Brunton.

32.

ON ATHEROMA AND SOME OF ITS CONSEQUENCES, WITH THEIR TREATMENT.*

AN ADDRESS DELIVERED BEFORE THE CARDIFF MEDICAL SOCIETY ON FEBRUARY 21, 1895.

By T. LAUDER BRUNTON, M.D., F.R.S.

MR. PRESIDENT AND GENTLEMEN,—When I was asked to address this society I was told that a subject of practical interest would be best appreciated, and I have accordingly chosen one which is not only of interest to us as medical men, but either is now, or will be by-and-by, of interest to us personally, for if we live long enough few of us are likely to escape atheroma and its consequences. It is a trite proverb that "the strength of a chain is that of its weakest link," and the same idea has been applied to man in the saying that "a man is as old as his vessels." In this phrase we have, in the first place, an acknowledgment that the different parts of a man do not all age at the same rate, but that some grow feeble and old before the rest; and, secondly, that the vessels are especially apt to grow old early, and upon their strength or feebleness the fate of the whole organism hangs. Nor is it only in the relative ageing of the vessels as compared with other tissues that a difference is to be remarked, for it occurs also in different parts of the vascular system. Sometimes it is the aorta which becomes affected, while the smaller arteries remain comparatively free. At other times it is the small arteries which become affected, while the aorta remains healthy. Consequently, the symptoms which result from atheromatous disease of the vascular system may differ much, but there are two great groups which come prominently forward—namely, those in which the symptoms are cardiac and those in which

* Reprinted from *The Lancet*, October 12, 1895.

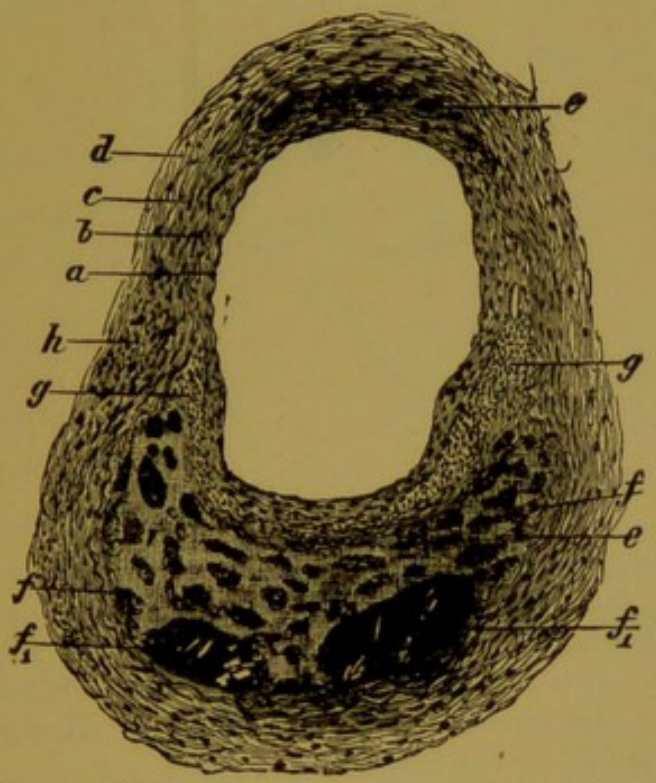
they are cerebral. The cardiac affections are chiefly connected with atheroma of the aorta. The cerebral symptoms, although usually associated with atheroma of the vessels in the brain, may also be due to alterations in the aorta and in the heart itself. The atheromatous process is so common in old age that it is usually regarded as a necessary concomitant of advancing years. It has been compared by Virchow to chronic arthritis of the joints, and has been called by him "arteritis deformans," while he calls the joint affection "arthritis deformans." But while a certain amount of atheroma is almost invariably associated with advancing years, the arteries may become atheromatous at an earlier age in consequence of disordered nervous supply or disordered tissue change and elimination. Thus it has been found experimentally by Lewaschew* that irritation of nerves leads to changes in the vessels which they supply, the vasa vasorum being at first dilated, and afterwards the middle coat becoming displaced by connective tissue, so that the internal coat and adventitia become blended. Clinical observation also shows very strikingly how mental worry affects the vessels, and how frequently in elderly people it is followed by vascular changes. Altered nutrition also affects the vessels enormously, and, although atheroma may occur to a very great extent apart from syphilis, yet this disease certainly leads very frequently to endarteritis and vascular degeneration, with weakening of the large vessels or occlusion of the smaller. Endarteritis has also been produced experimentally by lesion of the kidneys, leading to their contraction, and the atheroma which is so frequently found along with contracted kidney may, as I hope to show, be actually dependent to a certain extent on that condition. The process of atheroma is thus described by Ziegler:† "The intima is generally the most affected, while the media is often unaltered and the adventitia only slightly infiltrated. In other cases the adventitia may be somewhat thickened, and the media atrophied. The change in the intima consists of more or less extensive but generally unilateral thickening. At the points where the altered passes into the unaltered tissue the thickening is made up of fibrous tissue more or less notably infiltrated with leucocytes. The

* *Virchow's Archiv*, vol. xcii, p. 152.

† *Pathological Anatomy, &c.* Translated by Donald Macalister, M.D. Part II, sections i to viii, p. 71.

same is true of the innermost layers of the altered intima; but the deeper layers in contact with the elastic bounding membrane consist of pale indistinctly fibrillated tissue, which is devoid of nuclei and almost entirely necrosed; they contain numerous aggregations of granular detritus. The granular masses consist partly of albumin, partly of fat, and older foci of softening nearly always contain tablets of cholesterin. Atheroma thus appears to be essentially a necrosis with granular and fatty

FIG. 1.



After Ziegler. Section of an atheromatous cerebral artery. *a*, Intima considerably thickened. *b*, Bounding elastic lamella of intima. *c*, Media. *d*, Adventitia. *e*, Necrosed denucleated tissue with masses of fatty detritus. *f* and *f*, Detritus with cholesterin tablets. *g*, Infiltrated leucocytes in the intima. *h*, Infiltrated leucocytes in the adventitia.

disintegration of the thickened intima. The atheromatous ulcer is produced by the advance of the disintegrating process towards the lumen of the vessel and rupture of the innermost layers of the intima. We may conceive how readily such a rupture might occur if we note that on the post-mortem table very slight pressure on an atheromatous patch often suffices to break in the surface layer and convert the patch into a cavity." Sometimes the atheromatous patch, either while whole or after undergoing ulceration, may become more or less calcified, and the sharp points of the calcareous plates may not only make

their presence evident to the auscultator's ear by giving rise to a sharp whizzing murmur over the aorta, but may lead to the production of fibrinous clots by a process analogous to that of whipping blood after it has been shed. Along with atheroma it may be advisable to take endarteritis obliterans, which is practically atheroma in the smaller vessels, and consists, like it, in a thickening of the internal coat, though possibly with less

FIG. 2.

Position of murmur.

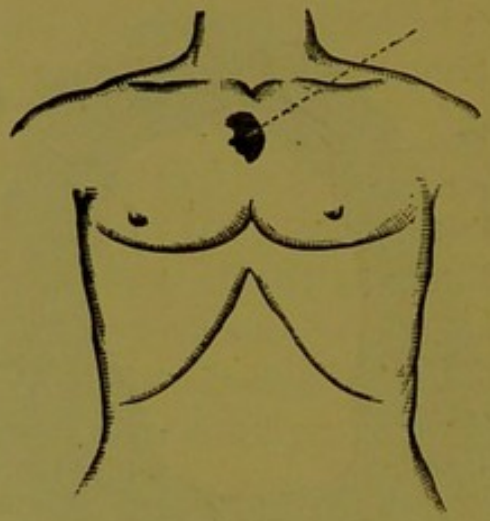


Diagram to show the usual position of the murmur which indicates atheroma of the aorta. It is generally heard best over the right half of the sternum, opposite the second rib or first intercostal space, but it may be lower down or higher up. It is sometimes very limited, but is frequently transmitted upwards along the innominate, while an anæmic murmur is transmitted usually horizontally to the left.

deposit between the internal and middle coats than what we find in atheroma of the larger arteries. I shall therefore class it along with atheroma, and use this term as more convenient when talking both of the affections of the large and of the minute arteries.

The consequences of atheroma will differ according to the size of the artery affected and the extent and nature of the affection. Atheroma of the aorta may not only weaken the coats of the vessel and give rise to the formation of aneurysm, but may affect both the heart and nerve centres in other ways. Atheromatous thickening close to the aortic orifice will tend to lessen the calibre of the coronary arteries, and at the same time render them rigid and unyielding. Should an atheromatous

mass undergo softening, so that an ulcer forms in the interior of the aorta, numerous granules will be discharged into the blood, and will be carried to various organs and there cause embolic infarcts,* arresting more or less completely the circulation in the vessel beyond the part where their course is arrested. Similar consequences may arise from atheroma of medium-sized vessels, and when very small vessels are affected their lumen may be completely obstructed by the gradual thickening of their walls, instead of by sudden arrest of the circulation by an infarct. Yet in these vessels, though the circulation has been gradually diminishing, its final arrest may be comparatively rapid, because of the formation of a thrombus at a point where the lumen of the artery has already been diminished. No organ of the body is free from the risk of vascular obstruction, but the two organs in which the symptoms are most marked and important are the heart and the brain, and the symptoms may, therefore, be divided into two great classes of cardiac and mental. All the symptoms may again be subdivided, according to their severity, into functional and organic. The term "functional" is in some respects objectionable, for it is very unlikely that any change in the function of an organ takes place without definite organic change, either physical or chemical, in the organ itself. Yet the term may be employed to indicate those slight alterations in function to which, on account of our imperfect knowledge, we are unable to assign an organic cause, but in which the cardiac disturbance is such as to indicate disordered innervation or weakness of the muscular fibre, or both conditions together. The actual weakness of the heart makes itself felt in ready exhaustion and shortness of breath on exertion, while the disordered innervation evidences itself in irregular action, discomfort or a feeling of constriction on the chest, or various degrees of pain up to the most severe. The discomfort or pain is generally increased by exercise, and consequently the patient is induced or compelled to give up the active employments or exercise to which he has been accustomed. Emotion has a similar effect to exercise, and the patient is apt to feel a great dislike to anything that calls for mental strain. The condition he suffers from is undoubtedly a complex one, for though the mental faculties are those which are called into play by emotion,

* Ziegler, *Op. cit.*, p. 73.

yet the effect of arterial degeneration upon them is probably due to an alteration in the heart as well as the brain.

Whenever any organ is called upon for increased exertion, whether it be a muscle, a gland, or the brain itself, an increased supply of arterial blood appears to be necessary, and in a healthy organism this increased supply is always provided to the organ by dilatation of the arteries which supply it. As Bernard has well shown, the artery of a secreting gland dilates, the capillaries enlarge, and the blood gushes through them into the veins. In a contracting muscle the vessels also dilate, and, although the current of blood during the actual contraction may be increased or diminished, yet the vessels of the muscles always dilate, and a full stream of blood passes through it either during the contraction itself or after the contraction is over. (Fig. 3.)

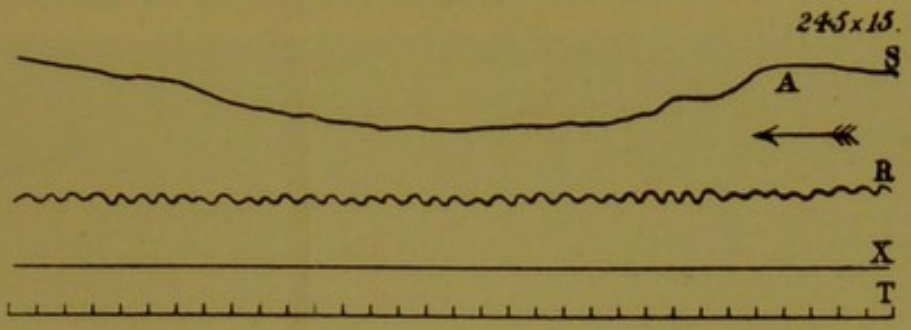
FIG. 3.

After Ludwig and Sadler. The marks along the base line indicate seconds; the height above the base line indicates the amount of blood flowing from the veins of the biceps of a dog during tetanus (T or tet), during rest (Ruhe), or during simple contraction (Zuck).

A similar dilatation of the blood vessels of the brain has been shown by Mosso, who found that even such a slight exertion as

doing a sum in arithmetic would make itself evident in the circulation of the rest of the body by the withdrawal of blood to the brain in order to maintain its activity. (Fig. 4.) But

FIG. 4.



To show the contraction of the vessels produced during the process of multiplying 245 by 15. S, Volume of left arm. A, Marks the point at which the calculation was commenced; after this point the pressure falls. B, Respiratory movement of chest. X, Abscissa. T, Time line; every upright marks an interval of five seconds.

when the vessels become atheromatous and rigid they can no longer dilate and supply an increased amount of blood to an organ when the necessity for it arises. The first organ to be supplied from the arterial system is the heart itself, and we find that an individual may complain of symptoms known only to himself, and which probably indicate commencing atheroma, when to all appearance he is perfectly sound, and when his friends very often say they never saw him looking fitter in his life. It has seemed to me that one of the first signs is that the patients complain that they "have lost their nerve" for all except ordinary work. They are perfectly fit for all ordinary occupations or businesses, for they can hunt or shoot, but when any call is made upon them for extraordinary exertion they feel themselves unequal to it. When hunting they no longer like to take a big jump, not that they feel physically unable for it, but they have a sort of indefinite fear of it, or, as they say, they "funk" it. They do not like any business question which involves sudden decision, and they may even go so far as to dislike meeting with strangers and having to talk to them on account of the extra exertion involved. Yet there may be no outward indication of all this, and the patient may be able quite successfully to conceal his feelings from everybody else. It is at present almost impossible to say how much of these

feelings are really due to commencing atheroma and rigidity of vessels, and how far they may be caused by mere alterations in tissue change, and more especially by the imperfect removal of uric acid and other products of tissue waste and their consequent accumulation in the blood or organs, as mentioned by my friend Dr. Mitchell Bruce in his admirable description of the gouty heart.* Nor will it be easy to decide such a question, for the same treatment that would be likely to remove the uric acid and other waste products will be likely to improve the condition of the vessels and to restore the patient, at least for a time, to comparative health. If the coronary arteries are more severely implicated the effect of imperfect nutrition of the heart itself will become still more evident, its impulse will tend to become feeble, its sound indefinite, the pulse feeble, irregular, or intermittent, the breath shorter, and the discomfort or pain on exertion more pronounced. There may be ringing in the ears, giddiness, and occasional fits of faintness or complete loss of consciousness. Here, again, it is difficult to assign an exact cause for such nervous symptoms. One is apt to say loosely that they are "due to a little weakness of the circulation," without attempting to formulate definitely the nature of this weakness. They may possibly be sometimes due to ptomaines or leucomaines, or they may be caused by minute hæmorrhages in the nervous centres from the bursting of capillary aneurysms, but the transitory nature of the symptoms seems to indicate that frequently they are more likely due to minute embolisms than to hæmorrhages.

When we look at the excavated surface of an atheromatous ulcer in the aorta we cannot help speculating as to where all the stuff which formerly filled it has gone, and, knowing as we do that embolisms are most likely to find a lodgment in the brain, we can hardly help trying to connect the various slight nervous symptoms which are so frequent in atheroma with the atheroma itself and with minute scattered plugs in the cerebral vessels arising from it. A glance at Fig. 5, which shows the distribution of vessels in the brain, and Fig. 6, which indicates the distribution of function in the cerebral cortex, will readily show how easily minute particles, by obstructing small vessels in different parts of the brain, may give rise to symptoms of the most various

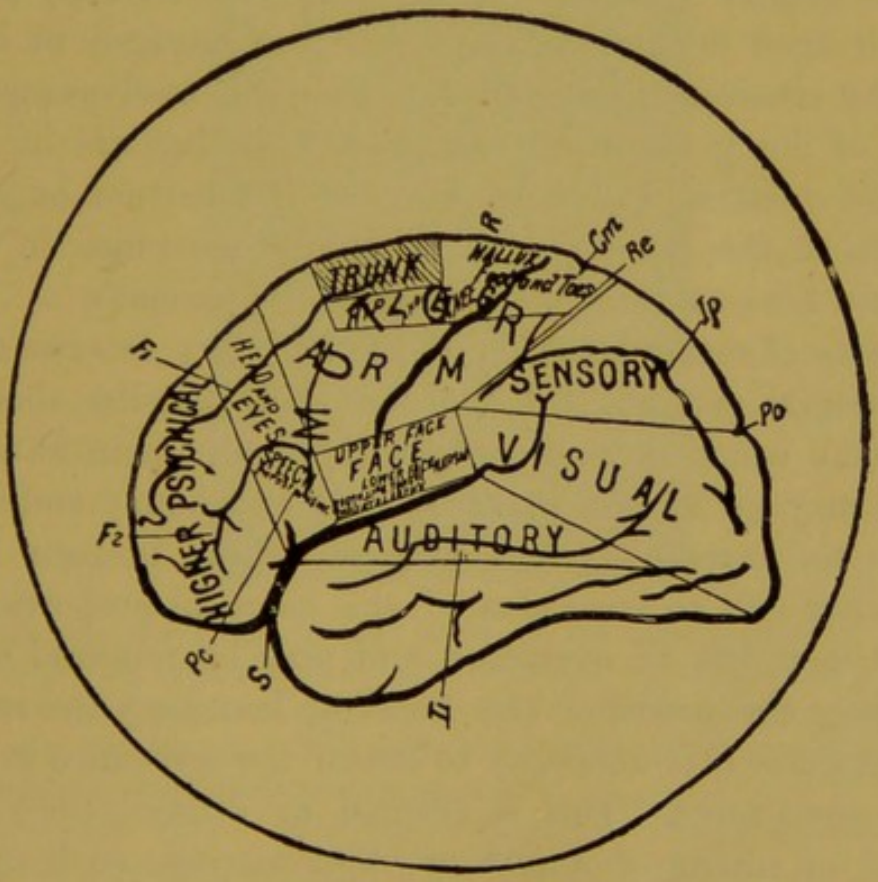
* *Practitioner*, January, 1895.

sorts—sensory, motor, and intellectual. The mental symptoms may be very slight indeed, and their presence may only be ascertained when certain things have to be done. Thus, a

Fig. 5.

After Ross. Distribution of the arteries in the brain.

Fig. 6.



After Osler. Cerebral cortex showing the distribution of function.

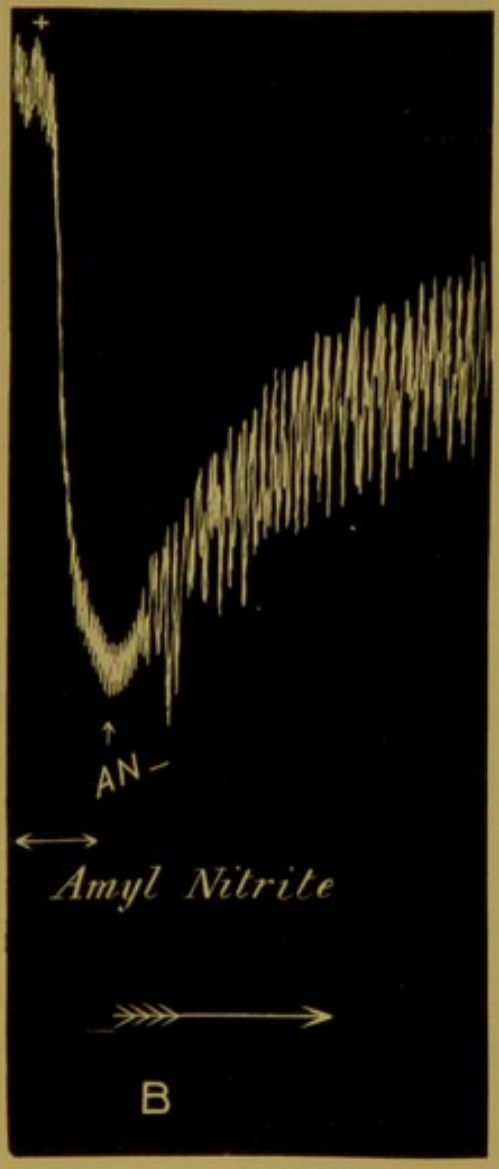
patient of mine, a strong, very energetic man aged 65, had a kind of fainting fit which left him a little stupid for a day or two. On returning to work he was perfectly well in every respect but one. He could conduct all his business, which was a large one, arrange every detail with one exception, for though he could write the correct sums and names on his cheques, and sign them perfectly, he could not put in the proper figures. Men with atheromatous vessels may go on for a number of years, and no accident may befall them, but if the atheroma is well marked I think it is right that both they and their friends should know that the man is rather unsafe, and that he may, without much apparent warning, do a foolish thing. It is in such cases that we hear the story that "Mr. So-and-so lost his money, and this preyed so much upon his mind that he went off his head." If the case had been correctly read it would probably have been that the man had atheromatous disease, leading either to embolism or to hæmorrhage in some part of his brain, which gave rise to no motor symptoms, but so disordered his higher faculties that he committed some folly, in consequence of which he lost his fortune. The process of cerebral degeneration, of which this was the first proof, then went on until it became evident to everyone. It is strongly advisable for men aged 60 and upwards, who are engaged in business, and have atheromatous arteries, to guard themselves against the chance of doing anything foolish, and, if they are in partnership, the question will arise how far the partner ought to be informed of the possibility of such an occurrence in order to safeguard his own interests as well as the patient's.

In cases of severe affection of the coronary arteries the chief risk is angina pectoris, although it is quite possible that sudden death may occur in such cases without any pain at all, and a patient may go to bed perfectly well and happy and be found dead in the morning. The pain of angina pectoris is in all probability due to weakness of the heart in proportion to the resistance it has to overcome, and may be removed either by increasing the power of the heart or lessening the resistance. In most cases it is necessary to lessen the resistance in order to obtain rapid relief. This is effected by dilating the vessels by the aid of nitrite of amyl* or other nitrites, such as that of

* *The Lancet*, July 27, 1867.

butyl, nitro-glycerine,* nitrite of soda, or hydroxylamine.† All these have practically the same action in causing dilatation of the arterioles. All these substances act in much the same way and dilate the peripheral arterioles so that they present less resistance to the flow of blood through them. The pressure falls, and the heart, having little resistance in front of it, is able to empty itself easily and thoroughly. This is readily seen from the tracings (Figs. 7 and 8), in which, as the pressure

FIG. 7.



Tracing showing the action of amyl nitrite on the blood pressure. The point where the administration was begun is marked by a cross; the point where it was discontinued by a small arrow. The horizontal double-headed arrow indicates the zero point of pressure; the single-headed arrow indicates the direction in which the tracing is to be read.

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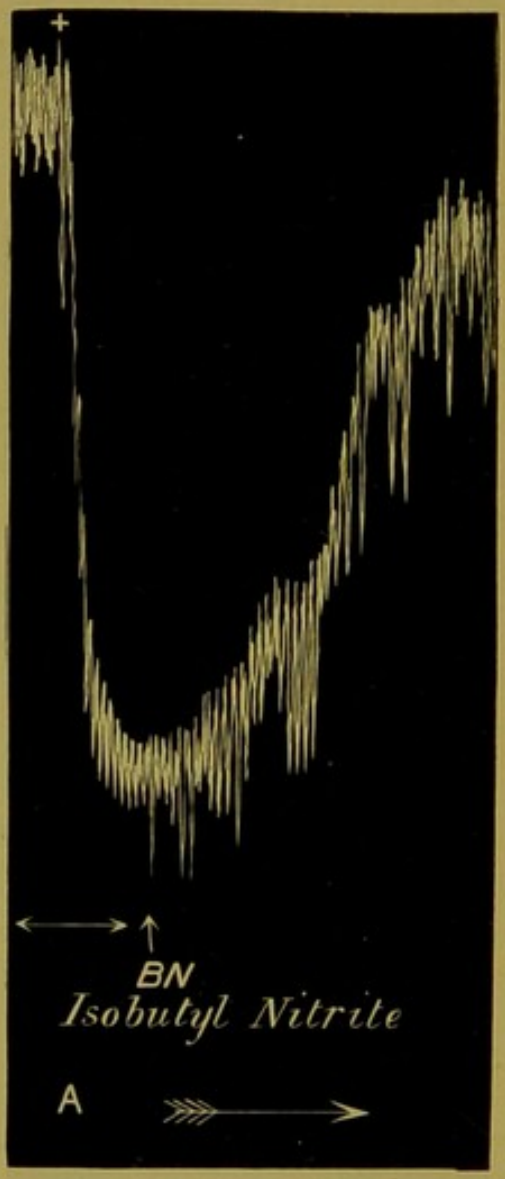
* *St. Bartholomew's Hospital Reports*, 1876, p. 144.

† *Royal Society's Proceedings*, 1889, vol. xlv, p. 352.

falls, the oscillations due to each beat of the heart become very much more marked than before. The nitrite of amyl (Fig. 7) and nitrite of iso-butyl (Fig. 8) are the quickest to act, and thus they afford relief more quickly than the others but

FIG. 8.



Tracing showing the action of isobutyl nitrite on the blood pressure. The indications on the tracing are the same as in Fig. 7.

nitrite of soda appears to have a more prolonged action, and so does nitro-glycerine, which, being on the whole the most convenient, has become more used than any of the others. The last substance that I have tried for the relief of angina pectoris is hydrochlorate of hydroxylamine.* (Fig. 9.) It seems to have a more permanent action than any of the others, but it tends to irritate the stomach, and the trials I have made of it

* *St. Bartholomew's Hospital Reports*, vol. xxx, p. 189.

have not yet shown it to possess such advantages over the others as are likely to make it displace them, yet at the same time it is a remedy worthy of a wider trial. But all these remedies are merely palliative; they tend to avert a fatal termination, but they do not have much effect upon the vascular

FIG. 9.

Action of hydroxylamine hydrochlorate on blood pressure.

condition of the heart and vessels which give rise to the pain. The drug which has hitherto appeared to be most successful, not only in relieving the pain of an aneurysm, but also in averting the occurrence of spasms of angina pectoris, has been iodide of potassium in large doses of from 10 to 30 grains three times a day. The beneficial effect of iodide of potassium in cases of cardiac or vascular disease due to atheroma, as well as in rheumatic affections of the joints, affords further confirmation of the likeness which Virchow has pointed out between "arteritis deformans" and "arthritis deformans." But we know only too well that in cases of arthritis deformans, more com-

monly known under the name of rheumatic gout, iodide of potassium may be administered in large doses until both patient and medical man are sick of the remedy and hopeless of cure. In such cases a visit to Bath, Buxton, Harrogate, or Aix may afford in a short time relief which has been sought for in vain by months of treatment at home. A course of baths, a course of water-drinking, and more especially massage of the joints, clear away the chronic thickening, remove pain, and restore flexibility to the joints. The mere use of an abundance of water as a beverage at home may, if continued for a sufficiently long time, prove successful as a remedy. I saw a very instructive case of this a short time ago. A patient suffered from a rheumatic affection of his thumbs which rendered the metacarpo-phalangeal joints quite stiff, so that the thumbs stuck out rigidly from the hand. He went to Buxton, improved somewhat, though not greatly. After his return home he drank a pint of hot water every night and morning steadily. For months no improvement was manifested, but at the end of a year the joints became supple and are now as limber and useful as they ever were in his life. This patient's case, I think, teaches us very strongly the necessity of long-continued treatment and of not giving up in despair because no improvement is manifested even after it has been continued for months.

The kidneys are the natural emunctories of the body, and through them the products of tissue waste ought to be eliminated. But some of these products, such as uric acid and urate of soda, are very sparingly soluble, and if little water be drunk they may remain embedded in the tissues instead of being eliminated. Many patients, and especially those having a gouty tendency, hardly ever touch water pure and simple. They may take a little in the form of soup, tea, or coffee, but their chief drink with their meals is wine, and between meals they do not drink at all. In the treatment of atheroma, then, as well as of rheumatic joints, I regard the administration of hot water as a most useful agent, and one which ought to be continued for months or years together. But when we look at an atheromatous artery, the condition seems quite as unpromising and as unlikely or even more unlikely to yield to treatment than that of a deformed joint. It is quite natural that one should be sceptical as to the advantages to be derived from the

use of hot water in either the one or the other, yet the case of the man I have just mentioned may make us hopeful in regard to atheroma as well as to arthritis. His cure was, however, a very slow one, and not to be compared in rapidity with those which are of everyday occurrence at Bath and Aix. There can be little or no doubt that at these places the use of massage in affections of the joints greatly contributes to the rapidity of the cure. Is it possible, then, to exercise anything like massage upon the heart and vessels? Before answering this question it may be well to consider what massage really is. Under the name are included kneading, stroking, and tapping with various degrees of force. The main object of the procedure is to imitate artificially the arrangement which exists naturally in all organs of the body for getting rid of waste products from the organs in which they are produced, and for increasing the supply of fresh blood to these organs. As Claude Bernard has well put it, all the cells of which our bodies are composed live in a liquid medium—viz., the tissue juice in which they are all bathed. This tissue juice fills up the interstices between the cells. It derives fresh nutriment and oxygen from the blood in the capillaries. These it yields up to the tissues and receives from them in return their waste products, which it sends out partly through the veins and partly through the lymphatics. In some cases the lymph spaces appear to communicate directly with the lymphatics, while in others they appear to communicate only indirectly, no definite opening being visible through which the tissue juice can flow into the lymphatics, but yet it may pass readily into them even although it has to traverse endothelial cells. The effect of alternate pressure on a flow of lymph has been made a special study by Ludwig and his scholars. Muscular exercise, for example, is found greatly to increase the flow of lymph, and the mechanism by which this is effected appears to be the following. Each muscle is surrounded by a strong fascia consisting of two layers. Between each there exists a lymph space. When a muscle is relaxed and elongated, its transverse diameter becomes less—or, in other words, it shrinks away from its sheath and thus tends to drag the internal layer away from the outer. (Fig. 10, A.) It thus tends to create a vacuum between the two layers of the fascia, and into this the tissue juice of the muscle is drawn.

When a muscle again contracts and shortens, it becomes at the same time thicker, and pushes the internal layer of the fascia against the external. (Fig. 10, B.) The fluid is thus driven out of the lymph space onwards into the lymphatics, and its return is prevented by the numerous valves with which these lymphatics are furnished. Each time that a muscle contracts it

FIG. 10.

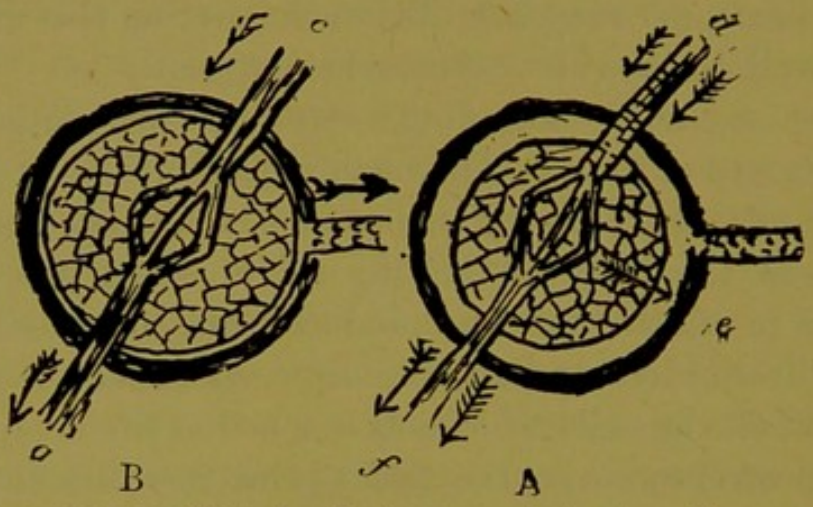


Diagram of transverse section of voluntary muscle to show the pumping action exerted on the muscle, juice, and waste products during action. The blood-vessels cross diagonally. To the left (B) the muscle is contracted and presses the two layers of the fascia together, so as to drive the muscle juice out into the lymphatics. To the right (A) the muscle is relaxed and tends to draw the layers of fascia apart and suck the juice out of the muscle into the lymph space. *c*, Artery. *d*, Artery. *e*, Lymphatics. *f*, Vein. *g*, Vein. The double arrows in (A) are intended to indicate the increased blood flow through the muscle, and the single arrow within the muscle to indicate the passage of fluid from the muscle into the lymph space between it and the surrounding fascia.

drives the fluid onwards; each time that it relaxes it sucks its tissue juice and products of waste into the lymph spaces, and thus the more it acts, up to a certain point, the more thoroughly are its waste products eliminated. The result of such action is well seen in an old cab horse on a frosty morning. For the first half-mile or so the poor creature seems as if it could hardly put one foot before the other, then its pace quickens, and after it has gone some distance its legs are supple and its pace is rapid. A similar condition is noticed in muscular rheumatism in man, where the slightest movement causes pain at first; but, after a little exercise, the waste products being pumped out, the muscle recovers its normal condition, the pain is

eased, and its function becomes normal. At the same time that the action of the muscle thus pumps away its waste products, provision is made for a fresh supply of nutriment, and as the muscle contracts its arteries dilate, and a free flow of blood occurs through them. Sometimes the mechanical obstruction presented to the flow of blood by the contracting muscle may retard the circulation during the actual contraction, but after it is over, the circulation through the muscle is greatly increased. (Fig. 3.) In glands the increased flow of blood in itself and the dilatation of the vessels in the gland will tend to press out the lymph, for the gland is almost always enclosed in a firm fibrous capsule.

The peritoneum, pleura, and pericardium are all lymph spaces, and the manner in which fluid is absorbed from the peritoneal cavity by the central tendon of the diaphragm, and from the thorax by the costal pleura has been beautifully shown by Ludwig and his scholars, although von Recklinghausen was the first to observe the absorptive power of the diaphragm. The more the diaphragm acts the more quickly is fluid absorbed by it from the peritoneal cavity, and the more the thoracic walls act the more quickly is liquid pumped from the pleural cavity. The mere act of respiration tends to pump out the lymph from the peritoneum and pleura, and thus to maintain perfect nutrition in these important cavities. In the pericardium a pumping action is kept up both by the respiration and by the pulsations of the heart itself. We may understand this more easily if we look at the diagrams of Figs. 11 and 12. In Fig. 11 I have tried to represent the condition of inspiration and cardiac systole. In inspiration the chest walls expand and tend to cause a cavity between the two layers of the pleura. The suction action which they thus exert is evident, not only from the entrance of air into the lung through the normal air passages, but from the way in which air will rush in when any opening has been made into the thorax between the ribs. This suction action is not only exerted upon the lungs, but upon the pericardium, which it tends to withdraw from the heart. If at the same time the heart is contracting it tends to create a cavity in the pericardium, and thus suction is exerted upon the pericardium and upon the heart itself, which will not only tend to draw fluid into the pericardial space, but also fresh tissue

Fig. 11.

Diagram of a transverse section of the thorax during inspiration and cardiac systole. It shows the tendency to the formation of a vacuum in the pleural and pericardial cavities.

Fig. 12.

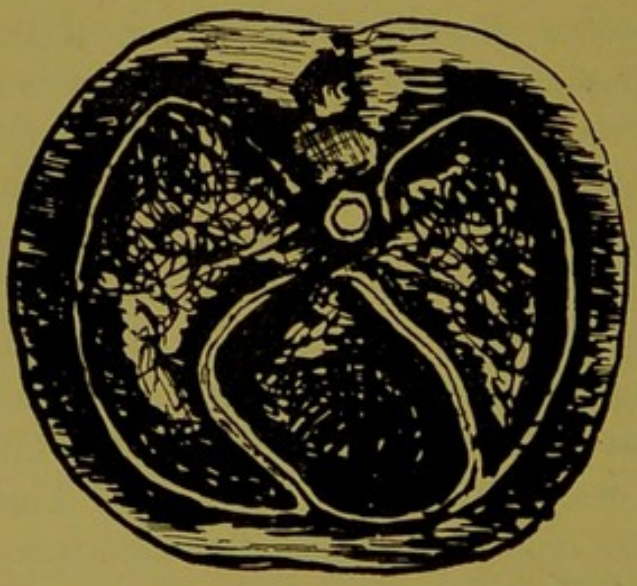


Diagram of a transverse section of the chest during expiration and cardiac diastole, showing the pressure of the walls of the pleural and pericardial cavities against each other.

juice into the substance of the heart. In Fig. 12 I have tried to represent very diagrammatically the condition during expiration and during cardiac diastole. The chest wall, sinking down upon the distended lung, will tend to press any fluid in the pleural cavity into the lymphatics of the chest wall, and will also tend, along with the diastolic expansion of the heart, to press fluid out of the pericardium into its lymphatics, and out of the muscular substance of the heart into its lymphatic vessels. In

this way we can see that the movements of respiration, as well as those of the heart itself, constitute a kind of massage to the lungs, thoracic walls, pericardium, and heart—a fact which was clearly pointed out some years ago by my friend, Professor Hugo Kronecker. Nor is this all, for the walls of the arteries are themselves likewise subject to a kind of massage by the alternate systole and diastole of the heart (Fig. 13), and this

FIG. 13.

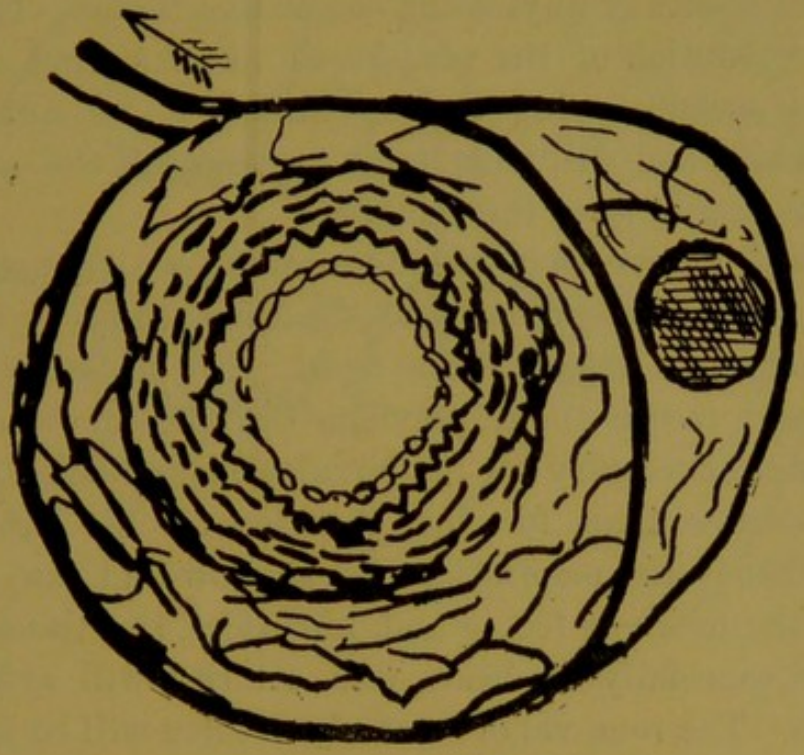


Diagram of artery and nerve in a sheath of connective tissue.
A, Lymphatics. B, Sheath. C, Nerve.

fact is of great importance. Between the intima and media, and probably in the media itself, there are lymphatic spaces, and in the adventitia there are distinct lymphatic vessels. Encased as many of the arteries are, in a strong fibrous sheath, their alternate distension and relaxation at each pulsation will tend alternately to drive the internal layer against the middle and the middle against the outer, so that any fluid lying between them will be driven onwards into the lymphatics with each systole of the heart, and during the diastole the arterial coats will tend to separate from one another and thus draw in fresh supplies of tissue juice from the vasa vasorum. The mechanism by which the nutrition of the arteries is maintained is thus seen to be very much like that of the muscles. In some animals, instead

of there being merely lymph spaces or small lymphatic vessels between the artery and its coat, a regular lymphatic vessel is seen to surround the artery, which forms, as it were, the core of the lymphatic. This condition is seen in the aorta of the tortoise, and it occurs also in the vessels of the brain. Nor is the utility of the massage action exercised by the alternate dilatation and contraction of the artery confined to the nutrition of the artery itself, for not infrequently we find that a nerve trunk—*e.g.*, the vagus—runs along with the artery enclosed in a common sheath of unyielding connective tissue. The contraction and dilatation of the vessel will exert a kind of massage upon the accompanying nerve, similar to its action on the arterial walls, and will thus tend to maintain the nutrition of the nerve as well as of the artery.

It is well known that without exercise we cannot have the muscles in first-rate order, and the same thing is universally acknowledged in regard to the heart. No athlete would think of running a race without previous training—a training which is even more necessary for his circulation and consequent wind and endurance than for the muscles of his limbs. It is obvious that if the respirations be shallow and few, and if the beats of the heart be feeble and imperfect, the thoracic organs, and more especially the heart and arteries, will suffer in their nutrition. The removal of waste from them will be less perfect, and they will be liable, not only to the accumulation of such forms of tissue waste as will render them functionally feeble or irritable, but also to the distinct organic changes which we know as atheroma. Feeble action of the heart, although in some respects it may be a safeguard against rupture of weak or brittle arteries, is in itself a distinct evil, as lessening the nutrition both of the organ itself, of the arteries which convey the blood, and of the tissues which they should nourish. How, then, is the nutrition of the heart to be improved, and its power increased? As I have already said, if the difference between systole and diastole is great, the removal of waste products will be more perfect, and this difference may be increased by causing the circulation to become more rapid, lessening the resistance in the arteries so that they present no obstruction to the heart's emptying itself, and allowing the blood to pour rapidly through the venous system back into the heart so that it is thoroughly

filled during diastole. There are three large systems, or vascular districts as we may term them, in the body. The first is the skin, the second the intestines, and the third the muscles. (Fig. 14.) It is exceedingly curious to note how little the

FIG. 14.

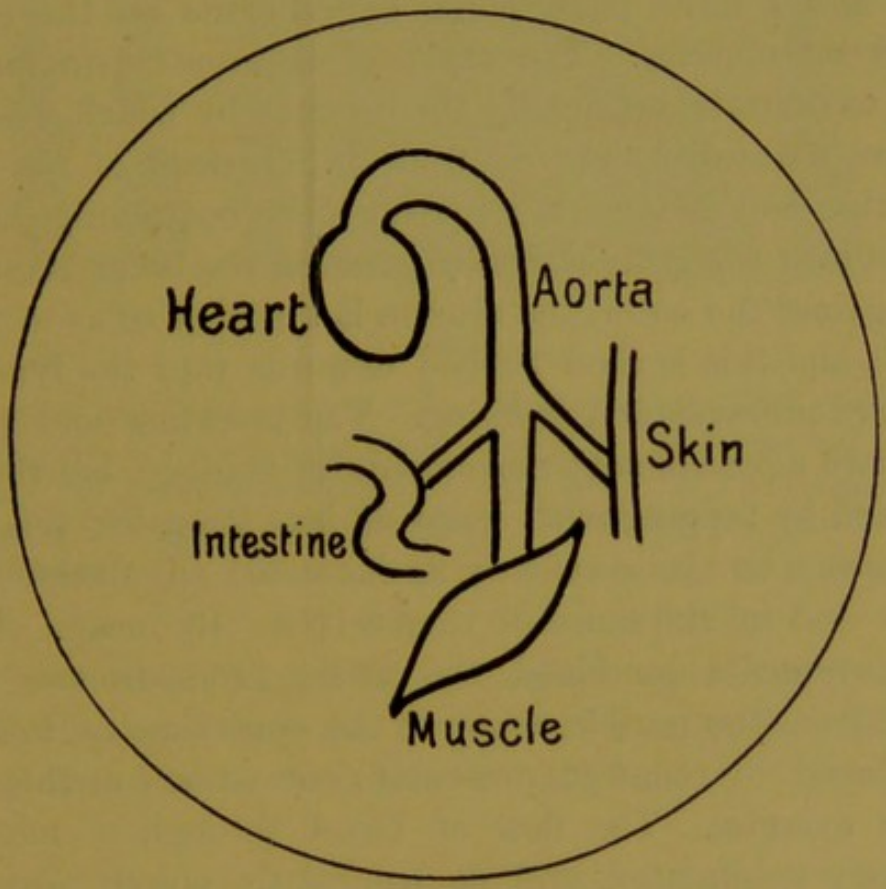
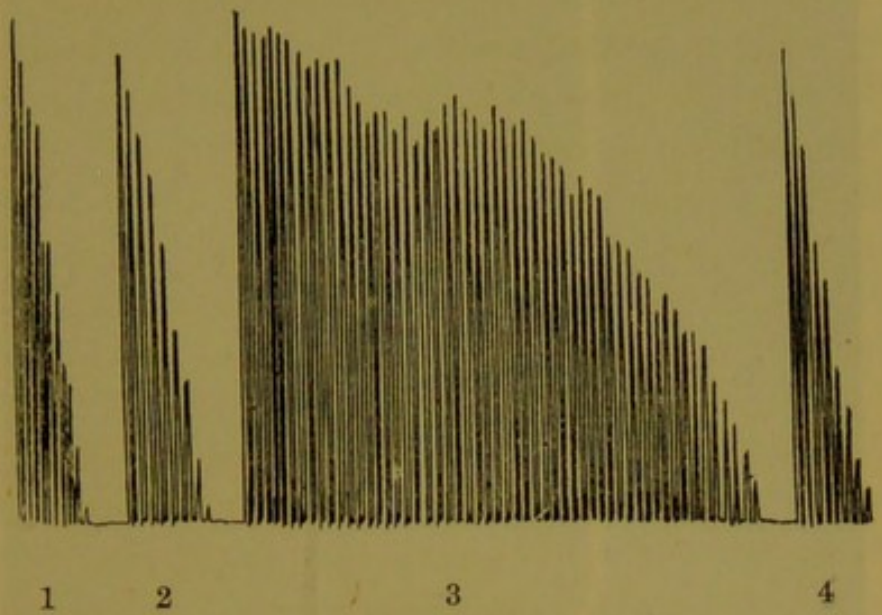


Diagram showing the three great areas for the distribution of blood in the body, viz., the muscles, the intestine, and the skin.

enormous vascular district of the muscles is taken into account even in recent works on physiology, and how all the variations in blood pressure are referred to contraction of vessels either in the skin or in the intestines. And yet the vessels of the muscles are as important as both the other two taken together. When the vessels of the muscles dilate during exercise they allow the blood to flow rapidly through, but during the muscular contractions the flow may first be interrupted mechanically, and the general blood pressure may rise. (Cf. Fig. 3.) This rise, slight though it may be, is sufficient in some cases of weak heart to produce intense pain and danger, so that a man suffering from angina pectoris is obliged to desist from attempting to walk up even a slight incline. Yet if he can continue the

muscular exercise the pain passes off and he gets freedom of action resembling that commonly known as "second wind," a condition which is probably also connected with the circulation through the muscle. In such cases some good results on the circulation may be obtained without any risk by substituting massage of the muscles for actual exercise. My friend Dr. Tunnicliffe and I have made some experiments on the effect of massage on muscles. The effect of massage upon muscle is simply to imitate artificially the process by which waste products are naturally removed from it. Instead of the muscle contracting and driving on its tissue juice containing the waste products into the lymphatics by pressing the inner layer of the fascia against the outer, the muscle is kneaded so as to express its juice, and this is then rubbed onwards into the lymphatics by upward pressure and stroking. The kneading and stroking are the two most efficient movements in massage, but they may be assisted by tapping with more or less force, for this movement appears to excite reflexly an increased circulation both in the skin and in the muscles themselves. By means of these three movements combined the waste products are readily removed from the muscle, while at the same time no fresh ones are produced by renewed muscular contractions as they are in ordinary exercise. The flow of blood through a muscle is enormously accelerated, and its contractile power correspondingly increased. Even when a muscle has been so much fatigued that it can hardly contract any more its contractile power is restored by massage, as is evident from the tracings (Fig. 15). These are made by bending the finger with a weight attached to it until it is so exhausted as to be unable to contract any more. The movements are recorded by a point upon a blackened cylinder. From the tracings it is evident that a few minutes' massage increases the power and endurance of exhausted muscles up to or even beyond their normal. On comparing the effect of massage of muscles on the circulation through them, as observed by Dr. Tunnicliffe and myself, with the results obtained by Ludwig and Sadler after stimulation of the motor nerves of muscles, it will be found that they are very similar. The effect of massage when seen in actual experiments is even more striking than as it appears in the diagrams. To say that the flow of blood through a

FIG. 15.



After Maggiora and Vinaj. Blät. f. Klin.: Hydrotherapie, 1892, p. 6. 1. The fatigue curve of the left hand raising a weight of 3 kilogrammes every two seconds. 2. The fatigue curve of the right hand. 3. The fatigue curve of the left hand after five minutes' massage. 4. That of the right hand without massage.

muscle is increased threefold by massage means a good deal, but it hardly suggests to one the tremendous gush with which the blood does flow through the muscle (Fig. 16). By the use

FIG. 16.

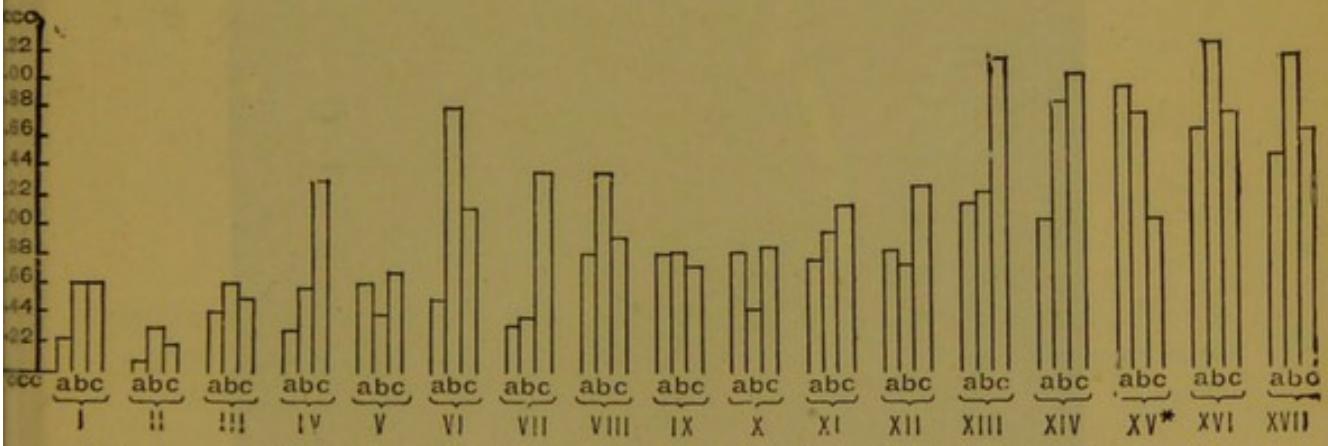


Diagram to show the effect of massage on the flow of blood through muscle. a. Shows the amount of blood in cubic centimetres which flowed from a muscular vein when it was simply opened. b. During massage. c. After massage.

of massage, then, the circulation is quickened, the resistance is diminished (Fig. 17), the filling of the blood during diastole increased, and thus the pumping of waste products out of the

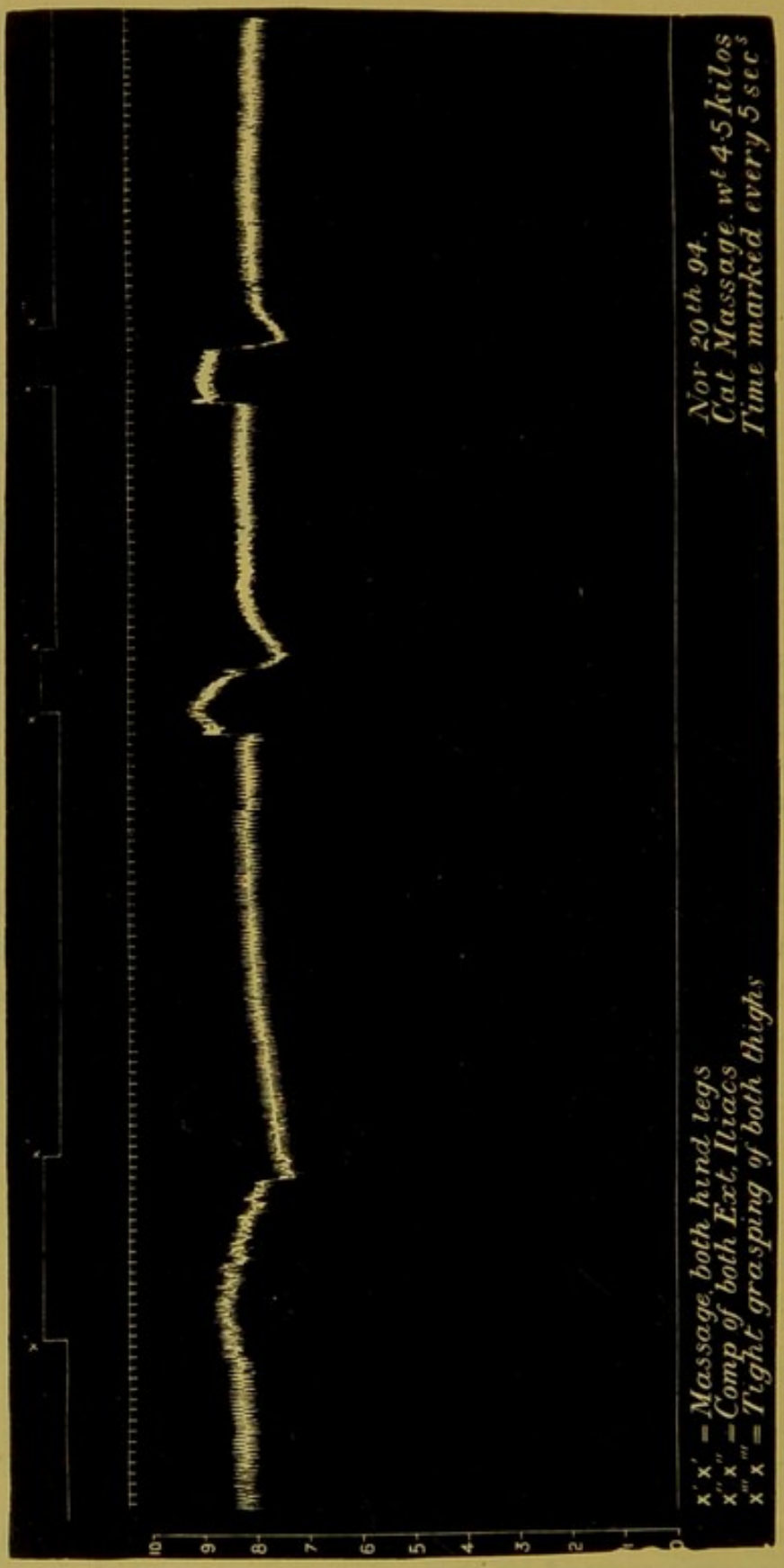


FIG. 17.

Tracing showing the effect of massage on blood pressure.

heart itself is more thoroughly effected. At the same time there can be little doubt that a similar increase of blood supply to the heart itself takes place even if the coronary arteries are contracted; and as it is called upon to make no extra exertion, but, on the contrary, to work against less pressure than before,

we may expect it to become better nourished and better able for the work. But simple massage will not increase the thoracic movements, and these, as I have mentioned, are important adjuncts. Therefore it is that, if the patient be strong enough, carefully graduated movements may be added to massage or replace it entirely. For these movements will increase the flow of blood through the muscles, and have all the other useful actions I have mentioned as resulting from massage. Massage in the treatment of heart disease is, I believe, first mentioned by Harvey, but its employment was first reduced to a system in Sweden by Ling and others. The Swedish cure attracted but little attention in this country or on the Continent until the system of treatment by baths and movements was taken up by the Brothers Schott and Nauheim, and the great success which has attended the use of this method seems likely to lead to its general adoption and recognition. The method consists chiefly in the use of graduated movements, which are made at first against very slight resistance, the resistance being increased as the patient is able to bear it, until at last the patient may be obliged to use a considerable amount of muscular effort. Under this treatment dilated hearts become rapidly smaller, at least up to a certain point, as is shown by the accompanying figure (Fig. 18), which I owe to the kindness of Dr. Schott. But it is evident

FIG. 18.

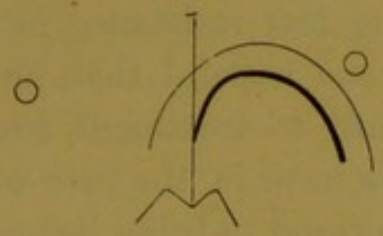
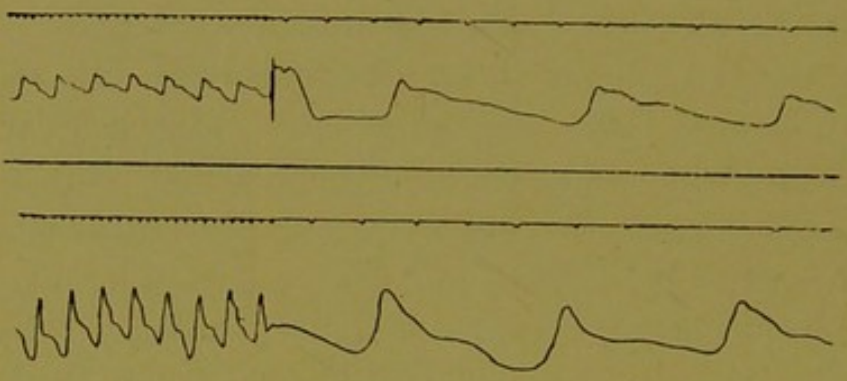


Diagram of the cardiac dulness before and after a bath. A similar effect is produced by gymnastic exercises. The thin line shows the graduated dulness before and the thick one after. A. Nipple. B. Nipple. C. Ensiform cartilage.

that the alternate expansion and contraction of the arteries may be very slight, and their self-massage, as we may term it, very imperfect if the arterial tension be high, as we often find in gouty patients, even although the heart may be strong. Can anything be done to remedy this condition permanently? I believe it can. I have only begun to use the treatment, and I

can only give you at present one example; but from it you will see that a systematic course of exercises has brought about in the case of a gouty man the precise alteration in the pulse for which we would seek—a diminution in the resistance and a more powerful action of the heart (Fig. 19)—so that instead of

FIG. 19.



Pulse tracing, showing the effect of massage and graduated movements. Each tracing is taken partly with a slow and partly with a quick movement of the sphygmograph. The upper shows high tension and a feeble heart; the lower shows less tension and a stronger heart. These tracings I owe to the kindness of Dr. Gustav Hamel, to whose treatment I had recommended the patient.

a pulse tracing with a slow ascent, indicating feebleness of the heart, in proportion to the resistance, and a slow descent, indicating contracted arterioles, we get a rapid and much larger ascent, indicating increased contractile power of the heart, and a quicker fall, showing less resistance in the arteries. Such a case as this makes one hopeful that, unpromising as arteritis deformans is in regard to treatment, we may yet have such power to cure it as we have in the case of arthritis deformans. I should not have ventured to bring before you a plan of treatment based upon one case alone, were it not that this, although the only one that I have, is simply one of many that have been recorded. Nor does it seem much to claim for the plan of treatment, for it is a fact that many, perhaps most, people in civilised countries either cannot or will not take enough exercise, or exercise of the right sort, and it is an exceedingly common thing to hear a man's friends remark that if he would take more exercise he would be perfectly well. But a mere walk along the flat cannot be regarded as exercise for many people. It may be all that they are able to take on account of the weakness of

their muscles or the flabbiness of their heart, but it is insufficient to produce the cardiac, vascular, and respiratory self-massage of which I have spoken, and if the patient tries to do more he may overstrain himself and do more harm than good. The whole essence of the treatment which I have been advising for atheroma and its consequences may be shortly summed up in a few words, namely, water drinking and graduated exercise, passive and active. Simple as these remedies are, they are, I believe, the most potent of all in improving, or even, perhaps, removing completely, a condition which is of the utmost gravity from its relation both to the heart and the brain. It is, indeed, natural to expect that they should be powerful curative agents, for they are neither more nor less than the means by which Nature itself keeps up the healthy nutrition of every organ in the body, where the utmost pains seem to have been expended upon mechanisms whereby not only fresh nutriment should be supplied, but waste products should be removed with greater or less speed, according to the greater or less functional activity of each organ.

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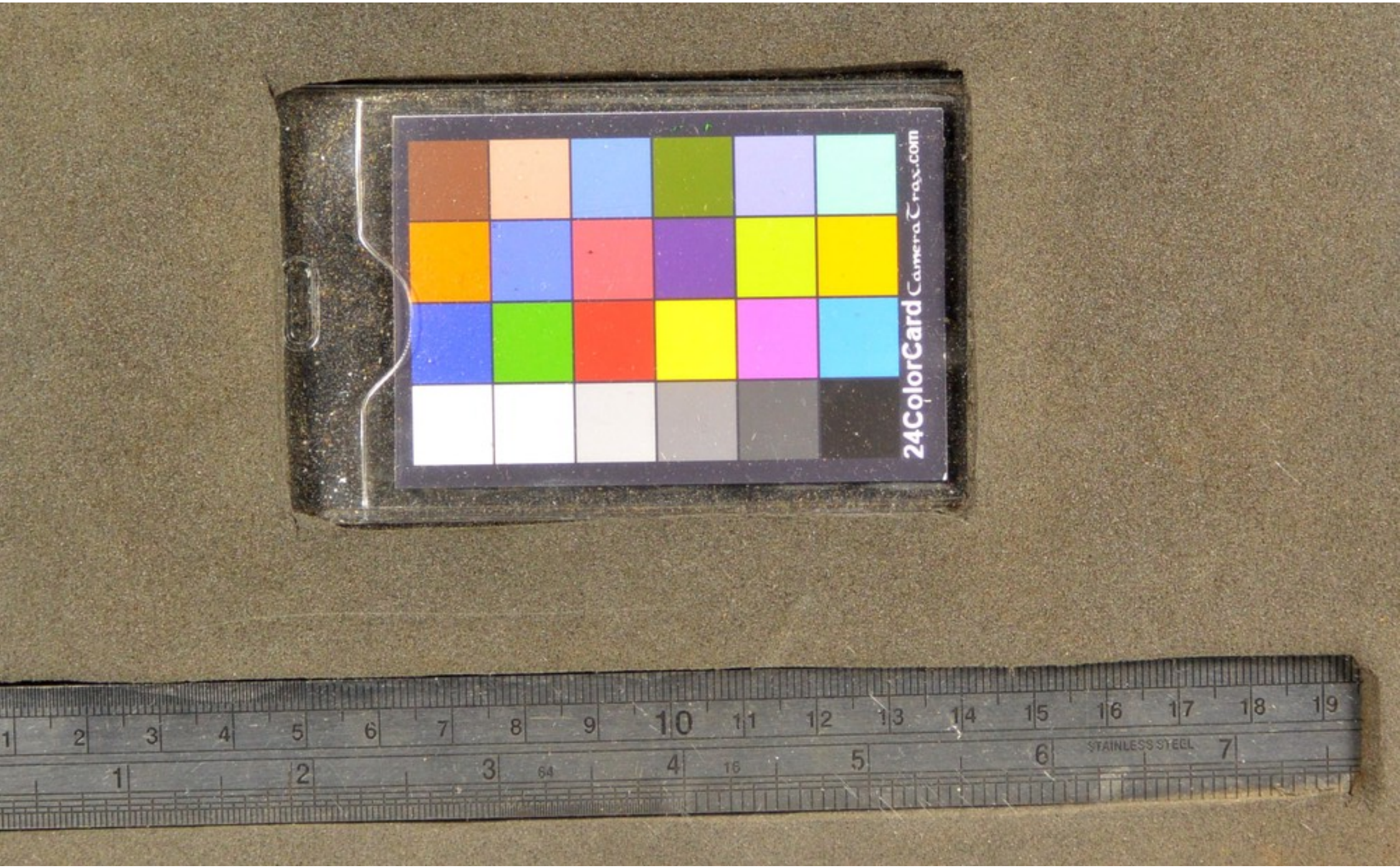
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