CAUSES OF THE HYPERTROPHY OF THE VASCULAR SYSTEM IN GRANULAR DEGENERATION OF THE KIDNEY.

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(*Reprinted from the Edinburgh Medical Journal for October* 1876.)

It may be assumed as generally admitted, that in the bodies of persons whose kidneys present the appearances of advanced cirrhosis or granular degeneration, the vascular system shows the following abnormalities: dilatation and hypertrophy of the heart, dilatation and often chronic endoarteritis of the great vessels, hypertrophy of the muscular walls of the small arteries, with thickening and dilatation of their perivascular sheaths. It is well established that increased vascular tension is one of the earliest phenomena of this disease—a fact which even cursory exploration of the heart and arteries reveals to every observer, and which the sphygmograph demonstrates with scientific precision; moreover, I think it is not going too far to say, that it is getting to be, if it is not already, the current opinion, that undue vascular tension is a prodromal symptom of granular degeneration of the kidneys; lastly, clinical observation has led to the connecting together as antecedent and consequent that form of functional derangement of the liver which in some constitutions shows itself as gout, and in others is characterized by dyspepsia, accompanied by excessive excretion of lithates of soda and potash in the urine, with this condition of increased vascular tension. These being the clinical factors with which we have to deal, let us now see whether it is possible to deduce from them a satisfactory explanation of the foregoing pathological conditions; and, in the first place, let us inquire under what physical and physiological circumstances similar states of the vascular apparatus are apt to occur. Hypertrophy of the heart is a pretty frequent pathological phenomenon, occurring in one or other chamber whenever that chamber meets with an unusual difficulty in discharging itself, either from defect in the valves or from increased tension in the fluid contained in the cavity towards which it is propelling its contents. The facts are sufficiently familiar to make further illustration needless. Hypertrophy of the arterioles is not quite so familiarly known, as it is not observed except when they are examined with the microscope; but this condition is not less, indeed it is more, frequent. Hypertrophy of the arterioles is found in all cases where active hyperæmia has long persisted, as in the brains of chronic maniacs, especially in that chronic parenchymatous inflammation of the brain occurring in general paralysis; in the neighbourhood of all chronic inflammations, such as cirrhosis of the liver, and in all new formations of long standing, such as slowly-growing sarcomata. These appearances must be familiar to every microscopist, so I need not multiply instances. In all these the physical condition is the same—an increased local determination of blood stretching the vascular walls. We have therefore, as a constant antecedent, increased fulness of the vessels—a fulness, be it remembered, not quite unvarying in its amount, but somewhat intermittent, reaching its maximum as the column of blood receives the impulse from the contraction of the ventricle. But in granular kidney there is reason to believe that an increased fulness of the arteries is also a constant antecedent. Let us inquire whether this antecedent deserves to be considered an efficient cause of the general hypertrophy; but before proceeding to do so, let me say a few words on the cause of this increased fulness. Local increased fulness may be caused in two ways: 1, by an increased quantity of blood going to the part; 2, by a diminution in the loss of plasma by exosmosis into the tissues of the part. The first condition is well recognised, and probably explains the local fulness in the cases instanced above; the second is not so generally recognised, but probably occurs and co-operates with the other in the early stages of many hyperæmiæ. But in general increased fulness of the vascular system, the former cannot obtain; and the latter, diminished exosmosis, must be an important factor. In general fulness, moreover, another factor steps in, that is, increased endosmosis of fluid from the alimentary canal. The physical law regulating the passage of fluids of different densities separated by a membrane is, that a great deal of the less dense fluid will tend to pass into the space occupied by the more dense fluid, while a little of this latter will pass out into the less dense fluid. In the condition of the blood in granular kidney, have we not those physical conditions which, on the one hand, favour increased transudation of water from the alimentary canal, and, on the other, diminished exudation of plasma from the bloodvessels into the tissues?[1] We know that in gout the blood contains large quantities of uric acid, and probably other products of tissue metamorphosis; in lithuria we may reasonably infer a similar condition; furthermore, people who suffer from lithuria are usually of sedentary habits, a large part of the protoplasm of their body is in a comparatively quiescent state, not undergoing those active changes which call for constant supplies of nutrient plasma; furthermore, such a quiescent state

[1] The dilution of the blood by endosmosis will tend to readjust the exosmosis from the vessels into the tissues; indeed, we may expect it to become greater than normal.

of the muscular apparatus cannot have favoured a large capillary development, so that the superficial area of the vascular system is relatively small. I think, therefore, that we are not going further than the facts warrant, if we infer that we have here all those conditions likely to favour increased fulness of that system. Now, let us proceed to the inquiry to which these considerations were necessarily preliminary; that is, whether increased fulness of the vessels can be looked upon as the efficient cause of the hypertrophy of the muscular walls of the heart and arterioles.

Mr Herbert Spencer (Principles of Biology, vol. ii. p. 351, *et seq.)*, in considering the development of muscular tissue, points out that contractility is a primitive property of protoplasm occurring amongst the lowest rhizopods, where no differentiation of structure has occurred. He says, it may be supposed that certain of their colloidal molecules have a tendency, under the influence of what we call a stimulus, to undergo an isomeric change, in which they occupy less space—a state of equilibrium from which, on the removal of the disturbing force, they tend to fall, so as to be again ready to undergo the change when the disturbance is renewed. He had before shown that it is probable that a molecule which has had its components re-arranged will tend to impress similar changes on neighbouring molecules, so as to cause isochronism in their respective molecular movements. "A portion of undifferentiated tissue, containing a predominance of the colloid that contracts in changing, will, during each change, tend to form new molecules of its own type from the other colloids diffused through it: the tendency of these entangled colloids to fall into unity with those around them will be aided by every shock of isomeric transformation. Hence repeated contractions will further the growth of the contracting mass, and advance its differentiation and integration. If, too, we remember that muscular colloid is made to contract by mechanical disturbance, and that among mechanical disturbances one which will most readily affect it simultaneously throughout its whole mass is caused by stretching, we shall be considerably helped towards understanding how the contractile tissues are developed." "The formation of a contractile layer in the vascular system becomes comprehensible; each dilatation of a bloodvessel caused by a gush of blood will be followed by a constriction; the heart will pulsate violently, in proportion as it is violently distended; arteries will develop in power, as the stress upon them becomes greater." Such being in all probability the manner in which muscle is developed by the direct equilibration of matter to external forces under primary conditions, it is not less probable that in the fully organized mammal a similar development occurs under like conditions. I have shown that the walls of the vessels are exposed to an increased strain; I have shown that this strain is probably due to an increased fulness, the result of increased endosmotic action from the fluids taken into the alimentary canal; I have pointed out that in the individuals liable to this disease causes exist tending, on the one hand, to abnormal diminution of the whole vascular area, and on the other to inactivity of exosmotic action; I have shown that this osmotic change is the result of the altered physical condition of the circulating fluid; I have pointed out that the strain acts with intermittent force, corresponding to the impulses received from the ventricle. We have seen reasons to believe that intermittent stretchings, or similar mechanical disturbances, are favourable to the development of muscular tissue. Moreover, it must be obvious that all that has been said of the vessels applies equally to the heart—fulness there must cause strain, and strain lead to increased muscular action and muscular hypertrophy. We are led, therefore, to conclude that the hypertrophy of the muscular wall of the heart and arterioles is directly due to the increased fulness of the vascular system.

Finally, let us endeavour to account for the thickening of the perivascular sheaths, and the formation of connective tissue in other parts of the body. Perivascular sheaths have been described in the brain, the kidney, the liver, and the spleen, and are supposed to perform the functions of lymphatics, because they are found to contain, especially under pathological conditions, products of disintegrating tissue. They are observed to be thickened as a change of senility, and in cases where the bloodvessels are hypertrophied. If they perform the function of lymphatics—and this seems to be generally admitted—it is not difficult to explain their thickening and dilatation under these conditions; for the hyperæmia must lead finally to increased transudation of plasma (the quantity of water obtainable from the alimentary canal being practically unlimited); this excess of nutrition will produce its accustomed effects on the quiescent protoplasm of the part, the connective-tissue cells will proliferate, and new connective tissue will be formed in the perivascular sheaths, as in the neighbouring structures. The activity of the processes will lead to increased disintegration of tissue, and a proportionate increase in the excrementitious matter which it is their function to remove. But in the case of granular kidney, another important condition exists in the state of the blood. Fluid passing from the bloodvessels into the tissues will be liable to contain in solution many of the organic salts circulating in the blood, which will further tend to increase the work the lymphatics are called upon to do. In this way we can easily account for the new connective tissue said to be formed in the wall of the heart, for the endoarteritis so frequently present, and for the degeneration of the kidneys, which is the most obvious pathological condition of all.

PRINTED BY OLIVER AND BOYD, EDINBURGH.