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The Adult Circulation, Physiologicaly Considered

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Adult Circulation, Physiological considered.

Constantly circulating, through the various tissues of the animal organism, is that vital & nutritive fluid, the blood; By marking particularly this important fact, we observe one of the distinguishing characteristics between animals & vegetables. It is true that in all living vegetables there is a circulation; yet such a marked difference between the two circulations does exist as to require no mention of it in the present article: It is by a circulation of the kind which is continuously going on in man & other animals, by means of a heart, a set of arteries, of capillaries, & veins that the blood is enabled to perform that important office which it alone can serve, viz, to deliver to every portion of the body the materials for their renovation as well as the oxygen to be consumed by them, & also, to return to the various emunctories of the body, those effete particles of matter which they give up as worn out

in service. Upon the regular maintainance of such a circulation, we infer, That each is set of nutrified tissue is dependent for its integrity & health.

Important as is this truth, it is one which was not known to the ancients; & not until 1628 A.D. when Sir W. Harvey from previous investigations was enabled to establish the truth that the blood did circulate through this system was its truth verified.

Without mentioning any of the peculiarities belonging to the circulation, we proceed to consider in a general manner the adult circulation.

By physiologists the circulation is divided when it is described into two distinct circulations, viz, a pulmonic or that, which carries the blood to the lungs for the purpose of meeting with the changes it there undergoes & returns it again to the heart, & a systemic circulation, which is the circulation to all parts of the system. Another circulation is sometimes described as distinct from the rest, this is formed by the convergence of the veins of all the viscera

of the abdomen, of the spleen, of the stomach, of the pancreas, & of the sd small intestines, forming the vena porta, which carries the blood thus recieved to the liver which organ it ramifies & finaly terminates at the cells lobules of the liver, the blood here yielding a portion of its elements which go to form bile, is then taken up by the radicals of the hepatic vein which conveys it to ascending cava, through which in company with the blood from the lower extremities it is conveyed to the heart. This is termed the portal circle, & were it in possession of a separate propelling organ, we might assign to it a greater distinction, than under the present circumstances, it seems to merit.

Placed at the centre of the whole circulating apparatus is that principle propelling organ, the heart; without the agency of which the circulation under ordinary circumstances would cease. In discribing the heart it is necessary for the same reasons that divide the circulation into two, to divide the heart into the

same; for there is no communication whatever in adult life, & it seems as if by nature they were placed in this juxtaposition only for convenience of material & space We have, then, a pulmonic & systemic heart, the former sending blood through its own separate vessels to the lungs & the latter through its vessels to the system generaly. Considered as a whole, we may describe it as a muscular organ, consisting of four cavities two auricles & ~~two~~ ventricles & two ventricles, Each cavity is about the same size, containing about three ounces of blood; if any difference exist in their size the ventricles may be reckoned to be the largest. The auricles are seperated from the ~~au~~ ventricles by the auriculo-ventricular valves which are interposed between them, but the auricle & ventricle of the one side are seperated from the auricle & ventricle of the other by means of the muscular wall which serves as a part of the enclosure for each cavity. The muscles

are not attached as in other instances to solid substance but they unite with themselves alone, forming, thereby, a complete muscular ~~tuft~~ lump. The walls of the ventricles are much thicker than those of the auricles, & those of the left ventricle are thicker than those of the right.

The heart is an organ peculiarly vital in its properties; eminently endowed with the property of contracting which alternates immediately ~~xx~~ with relaxation. This qualification belongs to no other organ or tissue in the body. It has been termed the rythmical action of the heart: & it is indeed a rythm. for to notice the heart in an active & vigorous state of the circulation is but wonder at it. It requires the closest observation of a well educated eye, to distinguish the movements of the different parts of the organ, so intimately are they linked together. Careful observation, however, reveals the fact that all its parts do not act in unison.

The dyastole of the ventricles is found to correspond to the systole of the auricles, & conversely, systole of the ventricles is observed to correspond to dyastole of the auricles. But the systole & dyastole of the ventricles are synchronous with each other, whilst those movements of the auricles alike correspond. A moments reflexion informs us of the importance of this action of the heart, for without it, the circulating mass would lie clogged in its ~~the~~ vessels. — ~~Hast~~ past experience has long since taught the world of physiologists, that here, to say the least, the blood finds the principle force by which it is enabled to traverse the regions through which it passes in it's regular circuit.

Received as the blood is by the right auricle of the heart from the two venae cavae, it is by the contraction of the walls of this cavity forced through the auriculo ventricular opening into the right ventricle, the opening of the two veins emptying into the auricle, at the same

tinae closing to prevent regurgitation. The blood, being now received by the right ventricle, is sent, by the contraction of the walls of this cavity into the pulmonary artery, any reflux of blood into the auricle is prevented by the contraction of columnae carnae, which puts chordae tendinae upon the stretch, & the blood getting behind them, at the same time, thus closes the Tricuspid valve. The blood, by this movement is sent with some force into the pulmonary artery; but here, again, a reflux of blood might take place were it not for the interposition of the semilunar valves, which, by the contraction of the walls of the artery & the regurgitating force of the blood, are thrown directly across the opening, thus forming, (for the time), an impermeable septa. Passing to the lungs, the blood then percolates its tissue, & undergoes the changes to which it is there subservient, (the principle of which is to give off oxygen in exchange for carbonic acid)

it is then returned to the ~~heart~~ ~~by the~~ left auricle of the heart by the means of the pulmonary veins. This vessel ~~pass~~ forces it through a similar opening to that at the same point on the opposite side of the heart, into the left ventricle:— it is then, by a power here given it, greater than that which it receives at any other point in the circulation, sent into the great systemic vessel, the aorta— regurgitation being prevented in a manner similar to that in the pulmonic heart.

What important agent it is that gives rise to this rythmical action of the heart is yet an unsettled question. So opposite are the opinions of those who have examined the subject with a view to ascertain the precise agency, that an inquirer at present must receive more of resistless confusion that definite conclusions. As yet, we must regard it as one those intricate problems, hidden by Nature within a recess. To fathom which requires more of investigation & endeavor than has yet marked the Tablet of science,— or that the right solution

of which remains yet to crown the efforts of a new Harvey. Perhaps it is going too far to say that an approximation as to the general cause has not been attained. Indeed, some very ingenious & plausible theories have been offered upon the subject — in fact, so much light has been shed upon it as serving to dispel the darkness which at first overshadowed it. Any attempt, therefore, which the present essay is to might make to elucidate the subject, would tend to involve the subject still deeper into the mystery from which so many noble efforts have been made to eradicate it — it is enough to say that he is still stumbling in the confusion of which the investigation of this subject is so fruitful a source.

It is thought that the heart possesses in an eminent degree the property of irritability, that is, that its muscular fibres are so nourished as to give to it, to a greater extent than any other muscular fibres of the body, the power of contracting & relaxing.

Thus giving it a self moving agency.. a capacity to generate within itself, a cause which would give rise to these motions. This was termed its motor force or power of motility. It was thought too that the motor-force was imparted to it at each act of nutrition, As it is known too, that the heart from its regular & repeated exercise, & its peculiar endowments of vascularity, that it receives nutrition oftener & is oftener in need of it, than any other organ in the whole animal fabric; it is inferd, therefore, that the heart is capable of receiving & of discharging this motor-force, just as the Leyden-jar is capable of receiving electricity, by previous acts of the electrical machine & of discharging it by means of the discharger. But against this view it is urged that if the heart is dependent upon its nourishment for its motility, that its motions should cease when the ~~the~~ heart is excised & placed in a vacuum, - where it is known to continue its motions for several minutes. This theory alone is sufficient

to invalidate the theories of those who either advocate either that the heart is dependent for the agency requisite for the performance of these movements upon the stimulus which the presence of the blood, only can impart, or upon any agency which may be exerted by either the pneumogastric or sympathetic nerves. But, again, this agency has been referred to the presence of carbonic acid, & were it not for the fact mentioned above, viz, that the heart will act when placed in vacuum, more importance might be attached to this view than is. We remember to have placed the finger upon a negro who was hung this winter at Gallatin, & felt its accelerated movements as soon as the respiration was prevented by the tightening of the rope around his neck. Now, in such a state we know that there must be an accumulation of this acid in the blood, for then its proper elimination is prevented. It seems difficult, too, to refer this fluttering movement of the heart to any

other cause, Again, it is known that the heart when taken from the body & placed in a jar containing only carbonic acid that its movements under such circumstances, is observed to continue longer & with greater rapidity than when placed in any other circumstances of the kind. But to prove that this kind of stimulus is not the essential one we have only to recollect that the usual rythm of the heart is present even when it is robbed of such influence, as when it is in a vacuum.

Now we cannot agree that either of these causes when operating singly are the agents essential in the operation. Yet, admitting the probability, that they all exert an influence in normal circumstances, is it not probable that operating together as they do in the body it takes the whole of them to furnish the required agent?

We know of no other conclusion to arrive at just now. We agree to say, however, that we know not why the heart has a rythmical movement.

When the heart contracts it produces considerable change in

in its position, From the direction of the muscular fibres of the apex of the heart (which is formed by a portion the left ventricle) their contraction tends to bring it from behind forwards, from right to left, & lastly from before backwards. This movement first throws the heart against the chest, thus producing the impulse which is then felt during the spiration, This impulsive movement too, aids materialy in the production of one of the sounds of the heart. The heart, (it is known) gives off two sounds: which, in the order of their occurence are termed the first & second sound of the heart.— Thus the first sound is that one which occurs first after the interval, which happens immediately after the two sounds occur, The next one is called the second sound. Both may be very correctly imitated by the low pronunciation of the sylables lub-dub. The time occupied in the production of the two sounds together may be said to be equal to the interval of silence which soon follows.

Much controversy exists concerning
the cause of the first sound of the heart. Some
contending that the impulse of the heart against
the ~~ventricles~~ chest during its ventricular contraction
is sufficient of itself to produce this sound. - Some
that the collision of the particles of blood against
each other & the sides of the vessel which contains
them would produce the sound, - & some that
the muscular sound given off during the contraction
of the walls of the left & right ventricle is sufficient
for the purpose. We know that there is a sound
heard when we listen attentively during the contraction
of almost any muscle; whether it be sufficient
, though, in the case of the ventricles to answer
this purpose or not we cannot say. Thus, if we
place the ear upon the arm whilst it is being
slowly & firmly flexed upon itself, we hear the
ordinary contractile sound of muscles. If, now,
either one of these causes, refered to, be not sufficient

to produce the sound, & is it not right & to think, with Dr Carpenter, that their united sound is the first sound of the heart, ? By taking this view of the subject we can understand more readily, why in certain diseases there is an interruption in the sounds of the heart.— we could infer that there is derangement in some of the causes of the regular sounds of the heart. As to the production of the second sound of the heart, the general opinion is that it is the result of the collapse of the semi-lunar valves after the ventricles have discharged the blood into the arteries, & of the reflux of blood back against them.

The average force by which the heart contracts is supposed to be great enough to sustain a weight of thirteen pounds; this, though, is a point not definitely determined, & perhaps the doubt which yet exist upon the subject is reasonable. The frequency is supposed in the adult to be a about seventy two

times per minute; This, however, is liable, even in the limits of health, to modification, by age, by sex, by stature, by the state of the mind, by the state of digestion, & by position of the body. To say nothing of the variations which disease may make.

The arteries, as already mentioned, next receive the blood & convey it to all parts of the system. They have been compared to the trunk & branches of a tree, & were it not for the fact that they inosculate with each other the comparison would be more striking. Than it is, it is strong enough, though, to give a very good idea of the origin & distribution of the arteries. Arising from a common trunk they ramify & inosculate until they finaly terminate into a capillary plexus.

Arteries have an internal, middle, & external coat. The external consists of condensed cellular membrane, whilst the internal is a serous membrane. The middle coat is composed of yellow fibrous

tissue, which is more dense near the heart than at the periphery. On the internal surface of this coat are those ring like muscular fibres, which give to the arteries their contractile property: these are more numerous at the ending of the vessel than at the begining. The elasticity of the arteries is due to the fibro-elastic tissue of the middle coat. It is by this elastic property of the arteries that the jetting force of the blood, propagated by the action of the heart, is regulated; so that by the time that it reaches the capillaries it has assumed a continuous current. By the action of the muscular fibres, too, the circulation is greatly aided in different parts of the body. It is this intermitting impulse of the blood, imparted to the finger when applied to an artery, that is termed the pulse. This, as already stated, occurs at the average rate of seventy two times per minute; all extraneous circumstances being considered.

The capillaries next receive the blood from the arteries, of which they are the ~~commencement~~ termination, & deliver it to the veins, of which they are the commencement. These vessels have distinct membranous walls in all parts which they ramify, except the spleen, through which the blood passes in minute passages formed in the parenchyma of the organ. The capacity of the capillary system is supposed to be about four-hundred times greater than that of the arterial. It appears then (as is a fact) that the rapidity of the blood ~~was~~ in the capillaries must be about four hundred times less than that of the arteries, otherwise they would deliver more blood than could be given to them by the arteries. The capillaries are much more densely distributed in parts in which the blood itself is destined to undergo some change than in those parts which are only to be nourished by it. Yet they are found more numerous in the nervous & muscular

tissue, because their functional activity requires it. Their walls consist of a delicate membrane apparently homogeneous, but, unlike the arteries they have no muscular fibres. Some nucleated cells of various shapes appear on their external surface, when closely examined. Their diameter is proportionate to the size of the corpuscles which passes through them.

The principle force by which the blood is circulated through the capillaries is undoubtedly that which it recieves from the heart & arteries. Circumstances, however, do arise, from the consideration of which, it appears that they are capable of continuing the circulation through them, after this vis-a-tergo has been cut off, & that they are capable of restraining it when the heart & arteries are in active operation. The general opinion, therefore, is that, for the right circulation of the blood through the capillaries, that another agency must be called into operation.

This agency is thought to exist in the affinity which does exist between a nutricious substance & that particle of matter which is to be nourished, — Thus the nutricious matter being once put in motion by the vis-a-tergo, & this affinity acting as a vis-a-fronte is sufficient to keep up the current untill it arrives at the substance to be nourished & then the effete matter which the cells is set at the same time gives off joins in the current so established, & so by continuous operation of this kind the venous blood is finally delivered up to the veins & the circulation thus kept up. Indeed, it is by an operation of a similar nature that the sap rises in plants. We know, however, so little about the matter that we do not feel prepared, just now, to spend an opinion.

After passing through the capillaries, the blood is next received by the veins, through which it passes back to the heart. The system of venous

vessels is of nearly identical structure with that of the arterial: being composed of an external, middle, & internal coat of the same substance, save that the veins are not so abundantly supplied with muscular fibres as the arteries. They have a few of these contractile fibres found mostly in & near the valves of the veins,- which valves constitute another important difference between arteries & veins, for it is to be remembered that arteries have no valves. These valves are formed by a duplicature of the lining membrane of the the veins; are not found in all parts of the venous system:- for instance the sinuses of the brain, the veins of the lungs, & those belonging to the viscera of the abdomen are destitute of these valves. They are found mostly in parts which are muscular, where the veins are liable to compression. By this arrangement we see at once the importance of the office of these valves. We know that when

a vein is exposed to compression, (as they are in those parts) that the onward flow of the blood would be prevented, were it not for the interposition of these valves: but, when a vein is compressed, the valves are closed upon each other or against the opposite wall of the vessel, & the compression instead of causing a reflux of blood as it would otherwise do, only aids in the onward movements of the blood toward the heart.

The capacity of the veins is estimated to be about two & a half times larger than that of the arteries, the circulation through them, therefore, must be proportionaly less rapid.

The force which sends the blood through the veins is likewise a subject of dispute. It is thought that the force which the blood recieves from the heart & arteries is sufficient for this purpose. But unless we admit the principle of Hydraulics this cannot be true. for we know that the force of gravity

acts in opposite directions in different portions of the body,- thus in the veins of the upper extremity its tendency is to bring the blood to the heart, & in those of the lower extremity it tends to draw the blood from the heart. Now, if it was the heart & arteries which alone supplied this force, it follows that the veins of the upper extremity would, as they offer less resistance to the return of blood, than do those of the lower extremity, would deliver the blood much sooner to the heart than would the veins of the inferior parts, & thus there would not be that equilibrium in the rapidity of the blood in the two returning veins as does exist. It has been thought, too, that a power like that of suction, produced by the vacuity formed in the auricles when they dilate, & in the cavity of the chest at each inspiration, spent some influence in this

spiration, as a vis-a-fronte force. But when we consider that no force like that of suction can be exerted upon a substance within a membranous tube at any distance from the point where the force is applied, we see at once the fallacy of the assertion, For it is well known that a collapse of the walls of the vessel would take place & thus the force would be spent upon the vessel itself. In truth, so far as regards the vacuity formed in the chest we think that it is soonre filled by the more movable substance the air, which distends the lungs so rapidly that we might almost say that no such a vacuum is formed, We would rather consider the respiratory pulse to be the result of the thoracic viscera compressing, during expiration, the vessel & causing its distension rather than the want of such vis-a-fronte to empty it: & as invalidating this hypothesis

we think it is only necessary to remember that in foetal life no such force does exist, but the circulation does. Nor can we believe that the action of the muscles supplies this agency, admitting, however, that they possess the power of accelerating it; but as their contraction does not always alternate with relaxation, as they do not act at all during ordinary sleep, & as there are many parts in the circulation which cannot be acted upon by muscles, we infer that the venous circulation is not constantly aided by such force.

Now, if we cannot conceive the idea, that from the small amount of resistence offered to the venous circulation, a force does exist in the power which the heart & arteries do exert as a vis-a-tergo, however weak it may be, & in the action of the muscular fibres found in & near the valves which is sufficient to answer the end in

question, we must then, like the unsettled question concerning the rythm of the heart, & the capillary circulation, consign it, for future developements, to the deep research of those by the sound inquiry of whom Physiology arose from the recesses of original darkness. to the glorious light of the present day: else like many other unintelligible points in Nature, which yet clogg the wheel of progressive science, it must, yet awhile, rest beneath the veil thrown around it by its own, great, original, Designer

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