

Peculiarities of the Circulation

in different Organs

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W. R. C.

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# Peculiarities of the Circulation

in different organs

Lungs - Erectile Tissues - Liver - & Brain.

In the latter half of the 16<sup>th</sup> century, there was born a man of whom the medical profession has reason to be proud and to whom it shall ever be indebted. - We refer to the illustrious Harvey the Discoverer of the Circulation of the Blood, - and to him we beg for a short time to advert, before proceeding to what forms more immediately the subject of this paper.

William Harvey was born at Folkestone in Kent in the year 1578. At the age of nineteen he took the degree of B.A. at Cambridge, and immediately set off to Padua for the purpose of studying medicine under the accomplished Fabricius and other distinguished men of that, then, first school of medicine. He graduated at

Padua

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Padua - returned to London - Commenced  
practice there - and got married.

He was appointed lecturer on Anatomy and  
Surgery in the College of Physicians in 1615,  
and in his lectures in 1619 he first made  
known to his auditors the dawn of that brilliant  
discovery which has immortalised his name.  
He completed his discovery, so as to satisfy his  
own precise mind in the following year 1620,  
but "With a rare degree of philosophical  
forbearance, he spent eight years in digesting  
and maturing his ideas," and repeating his  
experiments, and at length in the year 1628,  
he published at Frankfurt his "Exercitatio  
Anatomica de Motu Cordis et Sanguinis  
Circulo in Animalibus" - a small work  
which is characterised by Aiken as "one  
of the most admirable examples of a series  
of arguments deduced from observation  
and experiment, that ever appeared on any  
subject."

To complete this brief outline of his life  
we may add that after holding the high  
office of Physician both to James I and  
Charles I for a number of years, he  
retired

retired from public life, and in 1651 published his "Exercitationes de Generatione Animalium."

Six years thereafter this illustrious member of his profession died, "after having had the satisfaction of seeing his views generally adopted by the best informed anatomists and physiologists, and after having enjoyed the glory due to so great and so valuable a discovery."

Previous to the discovery of the circulation by our distinguished Countryman - the opinions held regarding the course of the blood &c were equalled in number and variety only by their chimerical and unfounded character. Very long ago, it was believed that the arteries conveyed air (hence their name) while the veins conveyed blood; - that the fluids moved along the vessels in one direction during the day, and in the contrary direction during the night; and the Chinese with their characteristic punctiliousness described the commencement of the circulation of the "Radical humours and vital heat" at 3 a.m. - their passage through the

the Lungs in the Course of the Day, and their termination in the Liver at the end of twenty four hours!

Hippocrates and Aristotle while knowing that the blood moved, had not the slightest idea of the nature of this motion, or the Course of the blood - Galen believed the arteries to contain blood, and to arise from the heart, while the veins he thought - arose from the Liver - Later still we come upon Vesalius, Serretus, Columbus, and Casalpini, all of whom we are informed by Haller in his Elements of Physiology, had a pretty clear notion of the passage of the blood through the Lungs, but were quite ignorant of the true theory of the Circulation.

It is evident that the space which separated these distinguished investigators from the discovery at which they were aiming, was steadily being lessened - until at length, our illustrious Countryman, by one tremendous bound of his gigantic mind, cleared the space which yet intervened, and made known to the world the grandest discovery which has ever

ever been made in Anatomy or Physiology. How then was this Discovery, which many had so long been striving after, how was this Discovery received? Just as every great Discovery has been, and is, received, which causes a sudden shock in the human mind, overturns notions and beliefs which however untenable are cherished with desperate pertinacity owing to our having received them from our forefathers, - or, as it has been well expressed "which calls in question the revered authority of the Ancients." Instead of yielding to the Discoverer the Laurel-wreath which he might justly claim, and instead of ~~contributing~~ endeavouring to contribute to the promotion and further development of his views, his professional brethren and others set themselves to find out arguments wherewith to beat down this upstart, and failing in the discovery of these, or being envious of the scientific success of the Discoverer, meanly endeavour to make the world believe that after all it was no discovery - only a turning up

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up of an old story - a theory which was long ago known to many peoples, - the Chinese being in most cases of the kind, those who have the fortune or misfortune of being saddled with the merit of having known this dug-up question from time immemorial!

Such was exactly the case with this discovery of Harvey. He suffered considerably in his practice at first, as we find one of his professional brethren declare he knew those who "would not give threepence for one of his prescriptions, - and one could not know by his bills what he did aim at." - Senac - a French Physician of the last Century writes in his "Traite de Coeur" as follows: - "When Harvey discovered the circulation it was at once rejected, it was next doubted and when at length it was acknowledged, people disputed about assigning the glory of this discovery to this Great Man. They found it even in the writings of Hippocrates - writings which no one had looked at for centuries, and even to this day many authors accord liberally to

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to the ancient physicians the knowledge which has given a lustre to the last century."

To proceed now more immediately to our subject - It would have formed a most interesting topic - the peculiarities of the circulation generally - as well in the Lower Animals as in the Human subject, noticing such facts as the resemblance between the circulatory apparatus in the Fish and in the Human Embryo at an early period, - each of them having only a single auricle & ventricle. Again to trace the development of the circulatory apparatus in the Human Embryo from the formation of the Primitive groove in the germinal area, or Embryo of twenty-two days old, up to the complete closure of the Ductus Arteriosus in the Child, this, we say, would form an instructive and interesting subject. but confessing our inability for such a ~~subject~~ task we proceed to consider those peculiarities which the circulation presents in the adult in the Lungs, Erectile Tissues, Liver, and lastly, and chiefly in the Cranium.

The Course of the blood in the body

body, as discovered by Harvey is a thing which now-a-days everybody knows. As Senac expresses it in his work before mentioned - "Il se presente si Clairement aux yeux même les plus grossiers, qu'on a presque oublié la main qui a levé le rideau".

The circulation is double, - Consisting of two incomplete circles, each having its heart or organ of propulsion, that heart consisting of a single Auriel and ventricle. To commence with the left ventricle, - the blood from it passes into the aorta and thence into the systemic Arteries, being thence conveyed into those intermediate structures the Capillaries, from these into the systemic veins, and by these conveyed to the right Auriel. - Such is the systemic or greater circulation. - From the right Auriel the blood is forced into the right ventricle - thence into the pulmonary artery, along whose ramifications it is conveyed to the pulmonary Capillaries and returned by the pulmonary veins to the left Auriel, this constituting the pulmonary or lesser circulation.

9.

Circulation - From the left auricle it is forced into the left ventricle where we commenced - there to begin that endless round - endless at least so long as this wonderful organism retains that Collection of phenomena which constitute Life.

As to the causes which serve to keep up this constant Circulation we may mention the following: -

1. The contractions of the Heart.
2. The general tension which the vessels exert on the ~~capillary~~ fluid.
3. The movements of respiration; expiration favouring circulation in the Arteries, and inspiration that in the Veins.
4. In the venous system the action of the valves, and pressure of the surrounding parts.

Such then being the course of the blood, we have at length come perhaps by a very roundabout process to the peculiarity the circulation presents

1. In the Veins.

The peculiarity here is what has been already described as the Pulmonary or Lesser

Circulation

Circulation - The blood after having circulated through the System and parted with its nutritive elements to the various tissues it has supplied, returns loaded with impurities to the right side of the heart whence it is sent to the Lungs along the Pulmonary Artery. Thus we have an Artery conveying venous blood; An Artery in structure, An Artery in ramifications, An Artery in conveying blood divergently or spherically, And yet not conveying bright arterial but dark-coloured venous blood - The pulmonary Artery is a tube of true Arterial structure, its Coats being the same as those of any other Artery in the body - It ramifies like any other Artery, its branches not however anastomosing but proceeding in regular straight lines to the lung where they are very closely arranged on the outside of the membranous walls of the Air-cells. So closely indeed that the interspaces are even narrower than the vessels themselves. The meshes formed by the pulmonary capillaries, are with those of the Choroid Coat of the eye the closest in the body.

From

From these pulmonary plexuses the so-called pulmonary veins proceed - vessels truly venous in structure and in the convergent or centrical flow of their contained fluid - that fluid not being venous but pure arterial blood - Like their peculiar neighbours the pulmonary arteries, the veins also proceed in a simple convergent course - never anastomosing.

They have no valves. The arrangement of the pulmonary capillaries is such that between the blood in the vessels and the air in the cells of the lung, only the thin transparent membranous walls of the vessels ~~themselves~~ and cells, with the epithelial lining of the latter, intervenes - every particle of blood being for a few seconds exposed to the air. It is there that those changes take place which convert the claret-coloured venous into the bright scarlet arterial blood - As to what those changes are it does not fall under our subject to consider.

II

We next \*up the peculiarity \*take which

which the circulation presents

In the Erectile Tissues

That there is a peculiarity here is a fact of which every one is aware.

There are certain structures in the body which at one time soft and flaccid, become at other periods firm and distended. Such structures are termed erectile, and the condition into which at certain periods they pass is termed erection. In the majority of these structures this change of condition is owing entirely to the varying amount of blood which they contain; in others, to this chiefly, and in addition, to a certain amount of muscular action.

The structures in the body which present the phenomenon of erection are the following :- In the male the penis, - in the female the clitoris and certain tissues around the vagina and within the nymphæ and in both sexes the nipple of the mammae - In order to be able to explain the causes of this phenomenon we must in the first place become acquainted

acquainted with the structure which the erectile tissues present and secondly, with the manner in which the bloodvessels are arranged in those tissues.

As the Corpora Cavernosa of the male penis consist of erectile tissue in its most perfect form we shall take the structure of these as illustrating the structure of all the erectile organs.

The Corpora Cavernosa consist of an external investing envelope, pretty thick and very strong & elastic, being composed of white shining fibres very closely arranged. From the middle of this envelope there proceeds downwards a septum composed of the same dense fibrous tissue and from both sides of this septum, as well as from the inner surface of the external envelope project numerous fine lamellae or trabeculae as they are termed, - also of fibrous structure - into the interior of the organ. These trabeculae pass through the cavity in all directions, dividing it into a great number of very small compartments

Compartments, so that we have thus a Spongy structure formed, or in other words, what we have already been speaking of as, Erectile tissue.

Next, as to the arrangement of the bloodvessels in this trabecular structure, We find that the intertrabecular spaces are occupied by most intricate plexuses of veins, these vessels being very short, their walls very thin, and their anastomoses exceedingly close and numerous. Upon these veins depends the erectile property of the structure; during flaccidity of the organ they are collapsed but when the organ is in a state of erection, they are enormously distended. These veins open into the dorsal vein of the penis, the prostatic plexus of veins and, according to Kobelt, they communicate also with the cutaneous veins of the abdomen. The arteries are supplied by the pudic, and as was first pointed out by Müller are of two kinds, viz :-

1st A set provided for the nutrition of the textures, and terminating by communication through

through capillaries with the veins, in the usual way.

2<sup>nd</sup> Another set to which Müller has given the name of "helicine Arteries," which do not communicate with the veins in the usual way. With regard to the termination of these, two distinct views have been advanced.

(1) Valentin held that these arterial twigs terminate by suddenly expanding into funnel-shaped orifices, these communicating directly with the veins.

(2) Müller describes these arteries as terminating abruptly in dilated extremities, these projecting singly or by tufts into the veins, covered however by the lining membrane of the latter.

Of these two views the latter is the one now almost universally believed, the observations of Müller having been completely confirmed by Krause, Syrtl and others.

It has been as yet found impossible to decide whether these dilated extremities of the helicine arteries open into the venous cavities or are mere arterial diverticula whose distension assists that of the venous areolae  
to

\* the erection, but as merely causing.

to produce erection. Thus we have seen that the condition of erection is due chiefly to dilatation of the veins and perhaps too of the sacculated terminations of the arteries arranged in the trabecular structure which we have described.

But we have yet some arrangements to look at before leaving the subject. We need but mention in passing the action of those muscles around the penis which assist in the erection of that organ, and which are very important for keeping it in a state of erection for some time; for without these muscles, which by their contraction compress the veins, and prevent to a certain extent the efflux of ~~the~~ blood, the erection of that organ could not be maintained long enough for the performance of its important function. These therefore are not to be considered as causing its completion and maintenance for a time; they are no essentials of erectile tissues and exist only in the penis and its homologue in the female - being provided with special reference to function.

There

There remains however yet one structure believed to be an essential of erectile tissue, which we have not mentioned, viz, certain reddish fibres which were first described by Kölliker, and found by him to exist in large amount in all parts capable of erection, situated in the trabeculae and thus passing in all directions among the veins. This tissue is believed to be non-striated muscular fibre, inasmuch as it resembles muscular substance in yielding no gelatine on boiling and in its solution in acetic acid being precipitated by Ferrocyanide of Potassium. Kölliker maintains that these fibres by their contraction prevent the distension of the venous plexuses during the periods of non erection of the tissues, but that on being acted on by the nerves they become immediately relaxed and thus the distension of the veins and consequent erection of the tissue is the result. If this view be correct, it will serve to explain how the circulation in such an organ as the penis is so directly under the influence of the nervous system, as we know it.

it to be. Holliker advances in support of this view the fact of the extreme contraction and shrinking of erectile organs under the effects of cold, and the exactly converse effects of warmth - fulness and distension.

To these views of Holliker, Carpenter makes the following grave objection "It is rather difficult to admit" (says he) "the power of nerves to cause relaxation of muscles which this hypothesis requires; and also to explain, in accordance with it the fact of a very familiar occurrence that the application of moderate cold as in putting on a clean shirt, frequently occasions erection of the male nipple."

To sum up - we have found that erection is chiefly owing to distension of the venous plexuses with blood - and that in some organs such erection is completed and temporarily maintained by the action of voluntary muscles. - While in all, it is probable that the non-voluntary fibres described by Holliker are essential to the occurrence of erection in the manner already described.

III. We now come upon the peculiarity  
 which the Circulation presents  
 In the Liver

or, more properly, the peculiarity of the  
portal Circulation -

The venous blood of the stomach,  
 intestines, pancreas and Spleen, instead of being  
 conveyed directly to the vena cava inferior,  
 to be by it ~~directly~~ conveyed to the heart, passes  
 through a sort of intermediate circulation  
 termed portal, by which it is conducted through  
 the liver, and there deprived of certain of  
 its constituents or subjected to certain changes.  
 These changes here for their object the forma-  
 tion the formation of a secretion which is  
 also an excretion - the blood being by this  
 process purified of matters, which if retained  
 in it would poison the system, while the  
 newly absorbed materials it contains under-  
 go Assimilation -

The vena portae is formed by the  
 confluence of the superior mesenteric and  
 splenic veins behind the pancreas, - the  
 superior mesenteric joining frequently the  
 former but more generally the latter, which  
 receives

receives in addition the coronary, left gastro-epiploic, pancreatic and duodenal veins. The portal vein thus formed passes up to the transverse fissure of the Liver and after receiving the veins of the Gall bladder, enters the substance of the liver and ramifies in it like an artery, receiving within it the venous blood from the capillaries of the hepatic artery - the artery which supplies arterial blood for the ~~supply~~ nutrition of the coats of the vessels, ducts &c. in the liver - corresponding to the bronchial artery of the lung.

Not one of the veins which go to form the vena portae possesses valves, and "it may be surmised" says Carpenter "with much probability, that the purpose of their absence is to allow of an unusually free passage of the blood from one part of the systemic circulation to another, during the very varying conditions to which it is subjected." The absence of valves would also seem to be a very good argument in favour of the spleen acting as a diverticulum to the blood of the portal system, or

or as a safety-valve in preventing congestion of other organs, by its capability of rapid distension, for, owing to their absence there is a free communication to the spleen by its vein. In fact it has been proved by experiment that any obstruction to the hepatic circulation causes rapid enlargement of the spleen, for after the portal vein had been tied, the spleen of an animal which previously weighed 2 oz. was found to weigh ten times as much or  $1\frac{1}{4}$  lbs. This view is further confirmed by the observation of Mr. Dobson, that the spleen attains its maximum volume at the end of the process of Chymification - a large increase of blood being then received from the food - Seven hours after this, it is small and contains little blood, if no food have been taken during the interval.

Further, by this absence of valves in the veins which form the portal, we account for the congestion of the roots of the portal vein when there exists any obstruction to the venous circulation through the liver - a common cause of haemorrhoids, diarrhoea, haemorrhage from

from the bowels and ascites. Still further, it enables us to account for the benefit derived from the application of leeches to the anus in cases of Congestion of the Liver.

But to return to the portal vein:— After entering the liver, it divides and subdivides forming at last small trunks which lie between the lobules of the liver— and are hence termed interlobular veins— from which proceed capillaries into the interior of the lobules. From these the blood passes into the intra lobular veins, after undergoing certain changes owing to their contact with the hepatic or bile cells. These intra-lobular veins by their confluence form the hepatic veins by ~~the~~ means of which the blood is conveyed to the vena cava inferior.

Thus we see that the blood which goes to the liver by the portal vein, is made to pass through two sets of capillaries before it reaches the vena cava, viz first, capillaries on the intestines &c.

And

And secondly, the Portal Capillaries in the liver.

Such is the peculiarity of the portal circulation in the adult human subject, and it may be useful as well as interesting to look for a moment at its arrangement in the foetus and in some of the lower classes of vertebrates.

In the foetus, the omphalo-mesenteric vein which is formed by the confluence of the veins of the Yolk bag and of the intestinal canal, as soon as the liver is formed, becomes connected with it both by afferent and efferent trunks, the former of which remain as portal, the latter as hepatic veins. The omphalo-mesenteric vein then itself becomes obliterated between the portal and hepatic veins, its afferent and efferent trunks, and the portion of it above the hepatic forms the upper portion of the vena cava inferior. Thus all the blood which the omphalo-mesenteric vein brings must pass through the liver. The chief quantity of the blood of the Umbilical vein therefore passes by this route.

the

the remainder going directly into the vena cava through the Auctus venosus.

A direct communication between the portal system and the vena cava exists permanently in fishes, and to a less degree in other oviparous vertebrata. Bernard has described also five direct branches of communication between the vena cava and vena portae in the horse - These are situated behind the Spiegelian lobe of the liver and open into the vena cava by square apertures.

In the lower classes of vertebrata - fishes and reptiles - the blood from the digestive and generative organs together with part of that from the posterior part of the body and tail, is conveyed to the liver and kidneys and there purified by the elimination of the respective secretions of these organs, before it is conveyed to the oxygenating apparatus.

There remains yet one peculiarity which we cannot help mentioning. It exists in the Polis, one of the Gasteropoda, a class of Mollusca. "This Animal"

Stamps

says Carpenter in his Comparative Physiology, "has a peculiar contractile cavity (freely communicating with the pericardium, which seems to act as a kind of auricle to it,) situated at the commencement of what may be designated the 'portal system' of the liver. Venous blood is returned into this pericardium from the body without passing through the skin, and this having been distributed through the liver by vessels proceeding from this 'portal heart' is collected by a system of more definite veins than are seen elsewhere, and is returned to the systemic heart after passing through the branchial circle."

IV And lastly, we take up the peculiarities presented by the Circulation Within the Cranium.

A subject of great interest and of immense importance as is well shown by Dr. John Reid in the following sentence: -  
 "The Arrangements of the Circulation within the Cranium are so often followed by such serious consequences, that it becomes an object of the highest importance"

importance to endeavour to ascertain the nature and cause of those derangements, and of course the first and indispensable step in an investigation of this kind is to obtain an accurate knowledge of the manner in which the circulation is carried on in the healthy state. There is no one organ in the body, upon the healthy and diseased states of which the medical man is so often called upon to decide as the encephalon, and there is none upon which more serious errors are committed in this respect - errors not only involving the reputation of the practitioner, but which is of infinitely more importance, exercising an influence in medico-legal cases, upon the momentous consequences of innocence or guilt - of acquittal or punishment."

There are certain peculiarities noticeable in the arrangement & structure of the bloodvessels within the cranium which we ought to mention before proceeding to the <sup>chief</sup> peculiarity of the Cerebral

cerebral circulation. One such peculiarity is the confluence of the two vertebral arteries to form the basilar, two arterial trunks uniting - as venous branches do - to form the ~~basilar~~ one. Again that remarkable vascular arrangement at the base of the brain termed Circle of Willis deserves to be mentioned as a peculiarity. This arterial communication is formed by the anterior communicating branch, anterior cerebrals and internal carotid arteries in front; - and by the posterior communicating, posterior cerebrals and basilar artery behind.

Then with regard to the veins we find that the cerebral and cerebellar veins are characterized by the absence of valves, and the extreme tenuity of their coats, while those of the dura mater are most peculiar in structure, and have received the special name of sinuses. A sinus (anatomically) is a canal containing venous blood excavated in the structure of the organ in which it exists, and lined on the interior by the internal or epithelial coat of a vein. Thus the

Sinuses

sinuses of the uterus consist externally of the tissue of that organ, and those of the bones have their external investment formed by the lining membrane of the cells and canals. Similarly in the cranium the sinuses are bony and fibrous canals formed by the splitting of the layers of the dura mater, and lined internally by an epithelial coat which is continuous with that of the veins. On account of this structural peculiarity these sinuses always retain a uniform diameter and cannot collapse.

Passing over these minor points however, we beg now to direct attention to what is known par excellence as the peculiarity of the Cerebral Circulation. This peculiarity was first pointed out by the second Morro - His doctrine as given in his "Observations on the Nervous System" in the year 1783, is as follows:-  
 "As the substance of the brain like that of the other solids of the body is nearly incompressible, the quantity of blood within the head must be the same at all times, whether

whether in health or disease, in life or after death, those cases only excepted in which water or other matter is secreted or effused from the bloodvessels; for in these cases a quantity of blood equal in bulk to the effused matter will be pressed out of the Cranium."

This doctrine was next taken up by Dr. Keilic of Leith and by him proved to be correct by a number of experiments.

He bled animals to death in various ways, by opening sometimes the carotid arteries and sometimes the jugular veins and so on, and found in all that while the rest of the body was completely drained of blood the cranial vessels contained their ordinary quantity. When, on the other hand, he made an opening with the trephine in the cranium, and then bled the animal to death he found the vessels within the cranium as completely emptied of blood as were those of any other part. From many such experiments his conclusions are recorded in the following words:—

"We cannot, in fact, lessen to any  
considerable

Considerable extent the quantity of blood within the cranium by arteriotomy or venesection; and when, by profuse hemorrhages destructive of life we do succeed in draining the vessels within the cranium of any sensible portion of red blood, there is commonly found an equivalent to this spoliation in the increased circulation or effusion of serum, serving to maintain the plenitude of the cranium."

Still later, Dr. Abercrombie founding on Dr. Keilie's experiments wrote as follows:—"The cranium is a complete sphere of bone, which is exactly filled by its contents, and by which the brain is closely shut up from atmospheric pressure and from all influence from without, except what is communicated through the bloodvessels which enter it. In an organ so situated, it is probable that the quantity of blood circulating in its vessels cannot be materially increased, except something give way to make room for the additional quantity, because the cavity is already completely full, and it is

is probable that the quantity cannot be materially diminished except something entered it to supply the space which would become vacant." This doctrine then became one of the received doctrines of medicine and was adopted by the highest medical authorities.

Dr. Clutterbuck in his article on Cerebral Apoplexy in the Cyclopaedia of Medicine asserts that "a plethoric state, or overfulness of the cerebral vessels altogether, though often talked of, can have no real existence, nor can the quantity of blood within the vessels in the brain be diminished."

In March 1843 however, Dr. Burrows in his Lumberian lectures first opposed this doctrine, adducing certain experiments performed by himself, similar to ~~of~~ those of Dr. Kellie, from which he derived conclusions exactly the converse of those we have just stated. His arguments although most successfully refuted by Dr. John Reid in the year 1846 (immediately after the publication of Dr. Burrows' work on the "Disorders of the cerebral circulation") gained many supporters amongst  
London

London Physicians and others, his most distinguished proselyte being Dr. Watson who announces in the fourth edition of his "Lectures on the Practice of Physic" his adoption of Dr. Burrows' views, and praises that Gentleman "By the refutation of a prevalent error, has done the science of medicine an essential service" -

We shall not occupy time by going over Dr. Burrows' experiments, but shall merely mention his chief objections to the old, and what we believe to be the true doctrine and also the manner in which these have been answered.

1st. Dr. Burrows denies that the structure of the cranium is such that its contents are unaffected by atmospheric pressure (save that through the circulation): arguing thus. "If in the natural state of the parts, the brain is defended from atmospheric pressure, should we not expect to find the functions of that organ disturbed in some way when part of the walls of the sphere is wanting?" He instances the absence of

of any such disturbance in children with open fontanelles, or in adults whose skulls have been trephined.

To this Dr. Reid answers :- "We for our part would never expect any disturbance of the circulation within the cranium under the circumstances mentioned by Dr. Burrows, and we should have wished to learn the grounds on which he founds his expectations."

The atmospheric pressure is always exerted on the brain through blood entering the cranium, and the removal of a portion of the cranium does not alter the amount of pressure exerted, but only alters the manner in which it is exerted - being in the one case direct, and in the other through the medium of the circulation.

2<sup>dly</sup> Dr. Burrows' next objection is :-

"It is maintained" he says "that when hemorrhage takes place from the general system, it does not affect the quantity of blood in the brain.

The experiments I have performed lead me

me to the opposite conclusion."

Now here Dr. Burrows completely <sup>mis</sup>represents the doctrine held by Dr. Millie and the others whom we have mentioned. It was never asserted that the quantity of blood in the brain may not undergo variation, - on the contrary we know that it may and constantly is varying. The proposition was that "When hemorrhage takes place from the general system it does not affect the quantity of fluids within the cranium."

3<sup>rd</sup> Dr. Burrows next says: -

"Posture of the body after death is said not to affect the quantity of blood within the head. My experiments show, that posture has a most striking influence upon the quantity of blood in the cerebral vessels." Dr. Burrows found that in rabbits hung up by the heels immediately after being killed by prussic acid and left so suspended for twenty-four hours, the brain presented a red appearance which contrasted well with the paleness of the brains of

of those hung up by the ears, and supposes this to be owing to the greater quantity of blood present in the one case - being gravitated to the most depending part - These experiments have been repeated by Dr. Bennett, who, - after Dr. Reid - explains this apparent objection in this way :- "The paleness which results from hemorrhage, and the difference observable in the colour of the brain when animals immediately after death are suspended by the ears or by the heels, is explicable by the diminished number of blood particles in the one case, - and their gravitation downwards in the other. That the amount of fluids within the cranium was in no way affected is proved by the plump appearance of the brains figured by Dr. Burrows, and the total absence of that shrunken appearance so well described by Dr. Hallie."

4<sup>th</sup> Dr. Burrows asserts in the next place in opposition to the doctrine of Dr. Hallie that "In the different kinds of death by apnoea there is great Congestion of the cerebral vessels, and that where it is  
About

absent, it may be accounted for, on Anatomical and physical principles."

Now if Congestion of the vessels within the Cranium could be produced in any way, it would be in that of death by hanging, where all the veins except the small vertebral are obstructed - these being not at all proportionate in size to the vertebral arteries - But in a number of cases of persons so put to death, examined by Drs. Monro, Kellie, Abercrombie Reid, Watson and others there was found no congestion whatever of the cranial vessels, however gorged the scalp and face might be - Dr. Burrows attempts to account for this by supposing the great vessels of the neck were cut and the thoracic viscera removed from these bodies before opening the cranium, thereby allowing the blood to escape from the head.

Of course Dr. Burrows unless very hard put to, would never have advanced such an explanation, which is well known to be contrary to fact, as the bodies in those cases were intended for dissection, and

And no incisions were therefore made in the neck nor ~~was~~ were the thoracic viscera removed -

In opposition to these cases, Dr. Burrows cites one or two cases of sanguineous apoplexy, occurring during the process of hanging, by the rupture of a blood vessel within the cranium. "That a blood vessel" says Dr. Reid "should occasionally give way within the cranium and that blood should escape when the vessels are prematurely weak, is nothing more than what we would expect; for as it is more difficult to obstruct the passage of blood along the arteries than along the veins, and as it has been proved by experiment that in asphyxia as the blood passing along the arteries becomes more venous, there is an increased pressure upon their inner surface, if there be any tendency to sanguineous apoplexy it is apt to occur at this particular time. These cases therefore have no bearing upon the question in dispute."

dispute."

Such are the objections of Dr. Burrows to this doctrine of the unvariable amount of fluids in the cranium, and such what we deem the successful answering of them. With regard to the movements seen in the brain when a portion of skull is removed - these which were supposed from reasoning by Dr Reid not to exist when the cranium was entire, have now been proved not to exist in the unimpaired cranium by the experiment of M. Donders of Berlin, who after removing a portion of the skull of a rabbit fitted a piece of glass into the opening so as to restore the entirety of the air tight case, observed that those movements do not then occur.

From this consideration then of both sides of the question we may conclude in the words of Dr. Bennett "That there must always be the same amount of fluids within the cranium so long as it is unimpaired. In

Morbid

Morbid Conditions, these fluids may be blood, serum, or pus; but in health, as blood is almost the only fluid present (the cerebro-spinal fluid being very trifling), its quantity can undergo only slight alterations. There are circumstances, however, which occasion local congestions in the brain, and consequently unequal pressure on its structure, in which case another portion of its substance must contain less blood, so that the amount of the whole, as to quantity, is always preserved. These circumstances are mental emotions, haemorrhages, effusions of serum, and morbid growths. Such congestions, or local hyperemias, in themselves constitute morbid conditions; + + + +

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"On the whole, whether we adopt the terms of local congestion, of change of circulation within the cranium, or of unequal pressure, our explanation of the pathological phenomena may be made equally correct, because each of these modes of expression imply pretty much the same thing. But if we imagine that

that

that resection will enable us to diminish the amount of blood in the cerebral vessels, the theory points out that this is impossible, and that the effects of bleeding are explained by the influence produced on the heart, the altered pressure on the brain exercised by its diminished contractions, and the change of circulation within the cranium thereby occasioned".

Donald McRae