An account of the appearances observed in the dissection of two of three individuals presumed to have perished in the storm of the 3d, and whose bodies were discovered in the vicinity of Leith on the morning of the 4th, November 1821 : with some reflections on the pathology of the brain / by George Kellie.

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AND ON

CONGESTIONS OF THE BRAIN.

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APPEARANCES OBSERVED IN THE DISSECTION OF TWO OF THREE INDIVIDUALS PRESUMED TO HAVE PERISHED IN THE STORM OF THE 3D, AND WHOSE BODIES WERE DISCOVERED IN THE VICINITY OF LEITH ON THE MORNING OF THE 4TH, NOVEMBER 1821;

WITH

SOME REFLECTIONS

ON THE

PATHOLOGY OF THE BRAIN.

By George Kellie, M. D. &c.

PART I.

From the Transactions of the Medico-Chirurgical Society of Edinburgh.

On Sunday morning, the 4th November 1821, three dead bodies were discovered in the immediate vicinity of Leith:—the body of one man was found a little to the east of the Links, not far from Seafield Baths,—that of another near to Hermitage Place, also in the links,—and the body of an elderly female was discovered in the neighbourhood of Crown Street. The preceding night had been remarkably

tempestuous, cold, and dark; and as the discovery of three dead bodies extended on the ground, was an occurrence as singular as it was shocking, there seemed, from the first, little reason to doubt that these unfortunate individuals had fallen victims to the severity of the weather.

One of the bodies was immediately recognised as that of a well known pauper of the parish, and removed by his friends. The other two bodies were exposed in the portal of the church; and remaining still unclaimed on Monday, Mr Cheyne and I were requested by the Magistrates to inspect these, and report to them our opinion respecting the cause of death.

The one body was that of a middle-aged man, perhaps about forty years; the other that of an elderly female.

The countenance of the man was alike free from turgescence and collapse; the complexion was pallid, and somewhat sallow; his features were calm, and without distortion. No mark of external injury or violence could be discovered on any part of his body; even the neck, shoulders, back, and hips, were quite free from that redness, livor or ecchymosis, so commonly observed in the bodies of the dead. There was no discharge of blood or other fluid from his mouth or nostrils. The body, generally, might be described as presenting the appearance of more than usual freshness and soundness. The abdomen was flat, and not at all tympanised. The trunk and limbs had the usual rigidity of death. On di-

viding the scalp, it was remarked by Mr Cheyne, that very little blood flowed from the integuments of the head. On exposing the dura mater, its surface, where torn from the cranium, was observed to be studded with numerous bleeding points; the whole membrane was somewhat congested, suffused, and heightened in colour; and its sinuses were loaded with dark blood. The veins of the pia mater were very turgid, and extensively injected, so that the whole membrane had a more than usual vascular appearance, and somewhat heightened colour. Following the convolutions of the brain, there was a milky or œdematous appearance, arising from effusion of serum, between the arachnoid coat and pia mater. The cerebrum itself, in texture and colour, seemed perfectly sound. The choroid plexus presented no appearance of turgescence. In the ventricles of the brain, and at the basis cranii, were found between three and four ounces of serous fluid; perhaps rather more than one half of this quantity at the basis cranii, the remainder within the ventricles.

On opening the abdomen, our attention was arrested by the very deep colouring of the small intestines. The ileum in particular, through its whole extent, was very red, and presented a very beautiful example of vascular congestion. A fine net-work of injected vessels spread under the peritoneal coat, over the whole extent and periphery of the ileum and jejunum. The stomach and colon had nothing of this congestion or colouring; and

the contrast between the appearances of these and of the small intestines was very striking. The stomach indeed was remarkably contracted and pale, nearly empty, or containing only about two ounces of a grey-coloured pultaceous fluid, having a faint animal odour. Its peritoneal and muscular coats were natural. On its internal or mucous membrane were observed a few spots, of a coffee-ground colour, and ecchymosed appearance. The liver was congested with blood, but had, in all other respects, the natural and healthy appearance. The spleen was rather empty and flaccid. There was no deviation from the usual appearances in the other abdominal viscera.

The woman appeared to have passed her sixtieth year. Her complexion was more sanguine than that of the man. The corpse was equally free from blemish or injury. Here, too, Mr Cheyne remarked that very little blood flowed from the integuments of the head, when divided. The dura mater was not so highly coloured as in the man; its veins, however, were injected, and its sinuses were loaded with blood. The pia mater, and the veins between the convolutions of the brain, were fully injected, and very turgid. About three ounces of serous fluid were found in the ventricles of the brain, and at the basis cranii.

In the abdomen, the omentum was found large, and very much loaded with fat: the colon was also buried in fat. On raising the omentum, it was a very striking coincidence to observe, that here also

the small intestines exhibited precisely the same appearance as in the man; the same redness, not in patches, but over the whole extent of the bowel; and occasioned by the same general and minute injection of the vessels, profusely ramified beneath the peritoneal coat. The stomach and colon, too, were in this case of the usual pale colour, having no vestige of the same vascular congestion. The bowels were not tympanised. The stomach was not so contracted and empty as in the man: it contained about four or five ounces of viscous fluid, and a few pieces of indigested beef. There were on the mucous membrane of the stomach a few congested spots, of a florid purple colour. The pancreas was of an unusually dark flesh colour. The liver, spleen, and other viscera presented no uncommon appearance.

In our report, therefore, to the Magistrates, we considered ourselves justified in stating our conviction, that these unfortunate victims had not fallen in consequence of any violence or injury inflicted by themselves or others; and our belief that they had perished from the severity of the weather, to which they had, in some way or other, been exposed during the whole of a very tempestuous, cold, and dark night. That storm began early on Saturday evening. During the whole night it blew a furious gale, at first from the N.E., then from E.S.E., and again from the N.E., accompanied by violent drifts of rain, of sleet, and of snow. The night

was besides very dark; and from the violence of the wind, and the drifts of sleet, the air felt much colder than the temperature actually indicated by the thermometer, which, in this neighbourhood at least, never perhaps fell lower than, if indeed so low, as the freezing point. One thermometer, I have been informed, was observed at midnight to indicate 30°; but a register-thermometer, kept by an accurate observer in our immediate neighbourhood, at Hermitage Hill, had not sunk lower than 34°.

The neighbouring hills, and those on the opposite side of the Firth, were next morning seen whitened with snow; but no snow remained on our own roads or lower grounds, nor was there observed any appearance of actual congelation. This was not, therefore, a temperature capable of producing frost-bite, nor such as might not have been resisted by vigour of constitution, and persevering exercise. But the furious gale which blew, and the sleet and snow which fell, would greatly increase the benumbing influence of even this degree of cold, and impede the exertions of those who were exposed to it. If the struggle were once given up,—if those individuals, benighted, fatigued, faint, and worn out,—from the darkness of the night despairing of recovering their way,—lay down, and continued exposed for hours to such chilling blasts, we cannot wonder that they slept to wake no more. Nor does there appear any other probable cause which can be assigned for the simultaneous death of three individuals, but the one common to all,—the influence

f the cold and tempestuous wet weather, to which hey had been for many hours exposed. I know esides, from the case of a boy whom I attended ome years ago, and of which an account was pub-ished in the 1st volume of the Edinburgh Medical nd Surgical Journal, that a degree of cold short of ongelation may produce great torpidity, after long xposure, in a state of inactivity, to its influence.

I have not been able to collect any very accurate istory of our three victims. The pauper, who per-ished at Hermitage Place in the Links, was seen y a gentleman, who gave him weekly alms, be-ween nine and ten o'clock on Saturday night, then n his usual health; and it is presumed that about nis time he had walked towards the neighbourhood, here his dead body was found next morning, to all on another benefactor. The woman, we are in-ormed, left her house sober about the same hour, o procure water from a pool near to where she was ound dead: so that, with regard to these indivi-uals, we are pretty sure that they had been ex-osed to the influence of the storm from an early our on Saturday night. The man who was found o the east of the Links, we have learned was on is way to Musselburgh; but of the rest of his his-ory I know nothing. My own opinion is, that all hree had lost their way, and from the extreme arkness of the night, and the violence of the wind nd rain, had been unable to recover it, until they ropt or lay down from fatigue or despair. As it as Saturday night, when the labouring classes

usually receive their wages, and too often indulge to excess in spirituous liquors, it might indeed be that these individuals had been in some degree intoxicated when exposed to the sedative power of the weather. But there is no positive proof of this; while, on the contrary, the few particulars which we have learned bear rather against the supposition. Again, the contents of the man's stomach did not exceed two ounces, and were free from any spirituous or vinous odour; those of the woman's stomach Mr Cheyne did think had the smell of ale or beer, but this was not recognised by my own sense. It may still be alleged, that the want of this test is yet no argument against the presumption of previous intoxication. But, in the absence of other proof of the fact of intoxication, we must give some weight to this negative observation; as the state of torpor and insensibility would seem to be one rather incompatible with an activity of digestion and assimilation, such as could have altogether decomposed and changed any intoxicating fluid previously existing in the stomach; and, indeed, the pieces of unchanged meat found in the stomach of the old woman, are proof that the digestive process had been suspended.

In reviewing the appearances observed in the dissection of these two bodies, our attention cannot fail to be arrested by the striking resemblance which the one, in almost every particular, bears to the other. In both we observed the same soundness

and freshness of the bodies,—in the abdomen the same congestions of the same viscera, and especially the same remarkable redness of the small intestines, from turgescence of their bloodvessels,—the same absence of fœtor, putrescency, and tympanites,—the same perfection of the other viscera, with the exception of the pancreas of the woman;—in the head, the same bloodless state of the scalp,—the same turgidity of the vessels on the surface of the brain,—the same congestion of the sinuses,—the same soundness of the cerebral texture,—and the same serous effusion, amounting in the one to nearly four ounces, in the other to about three.

These cases appear to me the more interesting, that there are probably few histories of the dissections of those who have died of torpor from cold on record. My search at least after such cases has not been very successful. But the single case which I have met with agrees in what I am disposed to consider the most important point, with the cases of which an account has just been given. The case is related by Quelmalz, in the 6th volume of Haller's "Disputationes." On dissection, the vessels of the brain were observed turgid with blood, and in the ventricles was found an effusion of serous lymph *.

* "Confirmat id evidenter ipsa anatome senis septuage-
"simum ætatis annum transgressi, quam ann. 1726, demon-
"strationibus publicis tunc præfixus instituti. Cujus in iti-
"nere, mense Januarii, constituti, prope Zwenckaviam, frigo-
"re vehementi extincti oppressique, cadaver theatrum anato-

The effect of low temperature on the nervous system, in producing a torpid and lethargic state in certain circumstances of exposure to a cold atmosphere, is familiarly known by many recorded instances; and the progressive symptoms of this short but fatal disease, if so we may call it, appear to be weariness and faintness, debility, languor, lassitude, torpor, irresistible drowsiness, lethargy, profound coma, and death.

This state, then, seems, in its symptoms and progress, to bear a striking resemblance to other diseases of the order Comata. This affinity was remarked by Galen, and has been admitted by succeeding writers. Sauvages notes both a Carus and Lethargus à frigore, and gives examples of each; and Dr Cullen, after enumerating all the more acknowledged cases of apoplexy, admits this

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" micum delatum, blandoque calore, ob rigiditatem ejus fo-
" tum, præter alia in cunctis vasis sanguifluis, tam arterio-
" sis, quam venosis paullo capacioribus polyposas concretiones
" longas, teretes, figuram de reliquo vasorum suorum post ex-
" tractionem æmulantes, simulque vasa meningum sanguine
" turgida lymphamque viscidam in ventriculis observanda præ-
" bebat. Illorum igitur plerosque, quotquot gelu excessivo
" intereunt, ex apoplexia, perrupto vel sanguine, vel sero ac-
" cumulato in cerebri ventriculis succumbere, vero videtur
" simillimum. Ipse sopor vel somnus, in quem adeo proclives
" sunt, ante mortem, serumque largius in cerebri ventriculis
" post mortem repertum, non obscurum ejus rei præbet testi-
" monium."—Quelmalz, Progr. quo frigoris acrioris in corpore humano effectus expedit, Lipsiæ 1755. Halleri Disp. Medic. tom. vi. Lausannæ 1758.

ne; remarking, however, that cold is one of those auses which produce apoplexy, not by compression, ut by destroying the mobility of the nervous power. The signs, however, of what is considered compression, were found to exist within the heads of our ases, and of that related by Quelmalz. Congestion, indeed, and the effusion of from three to four unces of fluid within the head, are appearances ommonly considered as indications of compression, nd as affording no unsatisfactory explanation of the henomena of a previous disease, the symptoms of hich had been those of disorder or suppression of ne functions of the brain. If, on the dissection of patient, who had died of a disease characterised y all the ordinary symptoms of any of the comata, ne physician were to discover such appearances as ere found in these cases, he would be satisfied, ngratulate himself perhaps on the accuracy of his agnosis, and admire the correspondence between e symptoms of functional derangement, and the sions discovered in the organs of those functions. various head cases, I have certainly seen a less tisfactory concordance between the symptoms and e organic changes discovered on dissection; and ny such examples might easily be produced from e recorded experience of other physicians. I am ite aware of the objection, that these indications what is called compression, discovered in the in of those who have died from cold, are rather be regarded as contingent effects than the cause the apoplexy which terminated in death; or, in

other words, that the observed congestion and effusion are the effects of the retarded return of the blood from the head, the consequence of a general immobility of the nervous power induced by the sedative action of cold. The objection has been thus stated by the illustrious Cullen: "With respect, "however, to the circumstances which may appear "upon the dissection of persons dead of apoplexy, "there may be some fallacy in judging, from those "circumstances, of the cause of the disease. Whatever takes off or diminishes the mobility of the "nervous power, may very much retard the motion "of the blood in the vessels of the brain, and that "perhaps to the degree of increasing exhalation, or "even of occasioning rupture and effusion; so that, "in such cases, the marks of compression may appear upon dissection, though the disease had truly "depended on causes destroying the mobility of the "nervous power."

In admitting the force of this objection, I must remark, that the explanation cannot be limited to those cases arising from the action of narcotics and cold on the nervous system, but may, with great truth, be extended to many of Dr Cullen's cases of apoplexy from compression. In many, for example, where one or more attacks of simple apoplexy have been recovered from, and one at last proves fatal,—where a gouty, paralytic, or epileptic individual is suddenly taken off by a paroxysm of apoplexy,—where headachs, vertigo, sickness and lethargy, have slowly led on to fatal carus or apoplexy,

—or when death has been ushered in by hydrocephalic fever,—we may, on dissection, discover congestions and effusions of blood or of serum, which we justly regard as connected, in the order of cause, with the last fatal attack, or with the symptoms of the more advanced disease; but to which we should, I apprehend, err in attributing all the symptoms which marked the approach, or constituted the earlier stages of such cases. I am disposed, indeed, to consider the appearances of congestion of the brain observed in dissections, as always somewhat questionable and equivocal. It is certain, I think, that the appearances exhibited by the vascular system after death, give no very true or accurate representation of the balance of circulation as carried on during life. During life, the blood is shared, in some proportion or other, between the arterial and venous systems; and however much the balance may at different times vary between these systems, still the circulating fluid is constantly passing from the one to the other, and must, at every instant of time, be divided between them in such a way, that neither can ever be perfectly depleted or congested at the expence of the other. Not so when life has ceased; for then the arterial is found to be comparatively deprived of, and the venous system to be congested with blood. This is strikingly true in particular parts, and in none more remarkably than in the brain. In no part of the body, with the exception perhaps of the cavæ and sinus venosus, do we find on dissec-

tion so much of venous congestion as in the brain; the sinuses of the dura mater are almost always loaded, and the veins at the basis and on the surface of the brain are commonly distended with blood. In some cases this congestion is certainly more remarkable than in others; and often we are enabled to connect this greater than usual congestion, with symptoms which during life had seemed to predicate such a state. But here, too, we find but little blood in the arteries, and the less perhaps the more the veins appear congested. It may, therefore, be concluded, that the blood which after death we find congested within one set of vessels in the brain, is just that quantity of blood which was circulated within the head, and at every instant of time distributed, in some proportion or other, between the arteries and veins during life.

With regard to effusions, there seems less obscurity. Where three or four ounces of fluid are found extravasated, we can hardly doubt that this had been effused during life,—was the effect of some modification of the circulation, and the cause of some of the phenomena of that disease which terminated in death. The effusion which was discovered within the heads of our subjects, can hardly be regarded as a post-mortem production; nor can it be presumed that it existed previous to their exposure on that night which terminated their existence. The perfect parallelism of the two cases,—their agreement with another case by Quelmalz,—their simultaneous exposure and death on the same

night that another individual died under similar circumstances, render such a supposition highly improbable. If this serous effusion were not a post-mortem effect, and if it had no existence previous to the exposure of the individuals, then we must conclude that the whole, or the greater part, was effused in the short interval between their exposure and their death.

What this interval was we have not the means of determining with perfect precision; but we know that the maximum cannot exceed ten hours, and the probability is, that the interval was considerably less than this. Be it then from six to eight hours, and in this short interval from three to four ounces of fluid are effused within the membranes of the brain. When, however, the cavity of the cranium is actually encroached upon by the depression of its own walls, or by an effusion of fluid within its cavity, one of two things it is obvious must follow,—either the compression of its previous contents into less space, or the displacement and removal of an equivalent bulk of those contents. Adopting the latter alternative, some physicians have inferred, that the brain itself, in the case of serous effusion, has been, to a corresponding extent, wasted or absorbed; and Dr Cheyne, who favours this opinion, has, in his work on Hydrocephalus, considered effusion in the light of a salutary and counteracting event, by which that requisite equality of pressure, which would otherwise have been lost by the wasting or absorption of the brain, is continued and maintain-

ed *. I am not prepared to deny this doctrine in all cases; I believe, on the contrary, that in some instances such a diminution of the mass of the brain by absorption may take place. But in our cases it seems highly improbable that, in the course of a few short hours, from three to four ounces of brain could be wasted or removed by absorption; and the supposition is in some other instances, as in that of the sudden effusion of blood upon, or within, the brain, and of the fracture, or depression of the cranium, absolutely impossible.

It seems more probable that, in most cases of intrusion on the brain, compensation may be made at the expence of the circulating fluid within the head; or, that less blood is then admitted and circulated within the cranium than before such encroachment on its capacity had been effected. The argument has been already taken up and illustrated by Dr Abercrombie, who, in his ingenious analysis of apoplexy, has, from a consideration of the peculiarities of the circulation within the head,—of the physical necessity of the constant plenitude of the cranium, and of the incompressibility of its contents, endeavoured to shew the improbability of any intrusion being made on the brain without a corresponding displacement of some portion of its circulating blood †. I agree in most of the reasonings and conclusions of

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* Cheyne's Essay on Hydrocephalus.

† Observations on Apoplexy, Edinburgh Medical and Surgical Journal, vol. 14.

this intelligent pathologist and observant physician. I admit, that when the arteries are enlarged by plethora, the veins are not only prevented from a corresponding enlargement, but must, probably to the same extent, be narrowed and compressed, and that a certain derangement of the circulation will necessarily follow. My conception, however, of this derangement of the circulation is somewhat different from his: and if we differ only in terms, it may still be of some consequence to contrast these, as I cannot help thinking the language in which Dr Abercrombie has stated his opinions has led to still greater misconception of what was probably intended by him, of what, at least, I conceive to be the true state of the question. I cannot conceive an interrupted circulation of blood within the brain while life is continued; nor can I admit that the derangement being once established, more blood can continue to be admitted by the arteries, than is transmitted by the veins. If the tonicity of the arteries by any means become impaired, and their capacity be enlarged, if they receive an overcharge of blood, and do not transmit this directly to the veins, the arteries will become permanently plethoric; but the veins must, at the same time, discharge from the head a quantity of blood, equivalent to the permanent increase of blood in the arteries: Or, if the total quantity of circulating fluid within the head be Z, and the quantities contained respectively in the arteries and veins be X and Y, then $X + Y = Z$. If now, the circulation become de-

ranged in the way supposed, and if the surcharge *a* become permanently congested in the arteries, the accumulation within those vessels will now be $X + a$, and the contents of the veins $Y - a$; for on any other supposition than $X + a + Y - a = Z$, the total quantity of blood within the head would be increased, or diminished, which is at least contrary to the hypothesis.

Whilst, then, such derangement of the circulation is producing within the head, to whatever extent the one set of vessels is becoming overcharged, to the same extent, it seems probable, is the other set becoming voided. But this derangement must have its limits, for were it repeated at every systole of the heart, one set of vessels would at length become entirely voided and compressed; the circulation would then indeed be interrupted, and instant death rather than apoplexy be the consequence. While life continues, the effect of this derangement, whether in the case of *arterial* or *venous* congestion will, in truth, be a retarded rather than an interrupted circulation of blood through the brain; for, in the one case, the diminished quantity of blood which is transmitted from the head by the narrowed veins will be the exact measure of that which, at each systole of the heart, can be forced into the plethoric and congested arteries; and, in the other, the quantity which the compressed or contracted arteries can admit, will measure the quantity carried from the head by the enlarged and congested veins; or the derangement once established, more blood

cannot continue to be admitted by the one than is discharged by the other.

The circulation within the head is, in truth, of a very peculiar description. The brain itself, little compressible, is contained within a firm and unyielding case of bone, which it exactly fills, and by which it is defended from the weight and pressure of the atmosphere,—a force constantly acting on every other part of the system,—a force, therefore, which must be constantly operating to maintain the plenitude of the vascular system within the head.

If these premises be true, it does not then appear very conceiveable how any portion of the circulating fluid can ever be withdrawn from within the cranium, without its place being simultaneously occupied by some equivalent; or how any thing new or exuberant can be intruded, without an equivalent displacement.

One of my oldest physiological recollections, indeed, is of this doctrine having been inculcated by my illustrious preceptor in anatomy, the second Monro,—a doctrine which he used to illustrate by exhibiting a hollow glass ball, filled with water, and desiring his pupils to remark that not a drop of fluid escaped, when inverted with its aperture downwards. His opinions, however, on this subject stand recorded in his work on the Brain and Nervous System. "For," he observes, "as the substance of "the brain, like that of the other solids of our "body, is *nearly incompressible*, the quantity of "blood within the head must be the same, or

" very nearly the same, at all times, whether in " health or disease, in life, or after death, those " cases only excepted in which water or other mat- " ter is effused, or secreted, from the blood-vessels; " for in these, a quantity of blood, equal in bulk to " the effused matter, will be pressed out of the cra- " nium *." It can scarcely, I think, be supposed that this doctrine should have been thus broadly maintained by so practised an anatomist, so acute an observer, and so excellent a pathologist, on speculative grounds only. The fair presumption, on the contrary, seems to be, that, in the course of his very extensive experience, he had observed nothing in the appearances of the vascular system of the brain, under the varied circumstances of health and disease, which seemed to militate against the hypothesis. It is, at least, by such an appeal to nature that the merits of the hypothesis are to be tried.

1*st*, Is it then true and consistent with experience, that we cannot lessen, to any considerable extent, the quantity of the blood within the cranium, by arteriotomy or venesection? In diseases of the head, in those, especially, presumed to arise from plethora and congestion of the vascular system of the brain, and distinguished by such symptoms as have been conjectured to indicate compression of that viscus, we bleed generally and topically, with the intention of obviating or removing this local

* Monro on the Brain, &c.

plethora; the brain, in fact, recovers its energies as we thus lessen the quantity of the circulating mass; and it seems natural to infer, that the vessels within the head have been proportionally unloaded.

By bloodletting we may, indeed we must, lessen the force of that general pressure, which, through the medium of the circulation, is constantly exerted on the brain;—a pressure, however, which (like that applied to water, or other inelastic and incompressible fluids) I can conceive to be increased or diminished to a great extent, without compressing it; and yet, to modify and influence the functions of this wonderful viscus. Nay, as Monro has well remarked, "the less compressible we suppose the "substance of the brain to be, the more readily we "understand how the whole of it may be affected "by a plethora, or increased momentum of the "blood."

By abstracting, then, from the general mass, we perceive, at least, the possibility of relieving the brain from inordinate pressure, and of restoring the disturbed balance of its circulation, without having actually lessened the quantity of fluid circulating within its own vessels. It would seem, indeed, that a certain range of pressure is necessary for the due performance of the cerebral functions, as comatose and convulsive symptoms are induced by depletion and diminished pressure, as well as by plethora and inordinate pressure *.

* "Σπασμὸς γίνεται ἢ ὑπὸ πληρωσιος, ἢ κενωσιος."—Hippocratis Aphorism. s. vi. λ. θ.

I believe it will be found nearly true, that there are such obstacles as the hypothesis supposes to the free depletion of the vascular system within the head.

In our dissections, we do not meet with very striking varieties in the appearances of those vessels: the sinuses of the dura mater, and the veins in general, are found filled, or congested. Even the brains of those who have been largely depleted during life, or who have sunk from inanition, do not appear much voided of their blood *. The brains of our apoplectic patients themselves, whom we have, in the course of one or two days, of a few hours perhaps before death, bled to a great extent, with the very purpose of unloading their vessels, are still found

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* "There may be determination of blood to the head, and "great turgescence of vessels, even when the patient appeared "to have died of hæmorrhage."—An important observation, to which Mr Cooke, in his abridgment of Morgagni, adds the following: "After uterine hæmorrhage, and also after copious de- "pletion, on account of pulmonary and other inflammations, I "have frequently observed the symptoms of cerebral conges- "tion, and which has generally appeared to arise from the ex- "citement occasioned by some mental effort, though occasion- "ally it has arisen without an evident cause; whilst the other "parts of the body appear comparatively bloodless, the vessels "of the head throb violently; there is severe pain; confusion "of intellect, sometimes to such a degree as to threaten deli- "rium."—*Cooke's Morgagni.* I have myself seen many such instances. I may add here another observation which I have frequently made,—that fits resembling Apoplexy and Epilepsy, as well as fits of Syncope, occasionally supervene to ordinary venesection at the arm.—G. K.

congested with blood. In animals bled to death, the brain still retains much of its blood; the vessels on its surface are red, well filled, and sometimes exhibit the appearance even of turgidity and congestion. I had hoped, without any new cruelty, to have been able to determine the extent of this fact by a reference to the brains of the sheep and oxen which are daily slaughtered, by bleeding, in our markets. But, it was objected, that, by the division of the intercostals and eighth pairs of nerves in the way in which these animals are killed by the butcher, their death might be accelerated, and time not allowed for a more full and perfect depletion of the sanguiferous system.

While meditating this subject, I learned indeed, that some experiments of this kind had been already made with another view, by Dr Sanders and Dr Seeds, of which an account had been published by the latter in his Inaugural Dissertation, "De Sanguine Misso," printed at Edinburgh in 1815. These experiments consisted in bleeding dogs to death, with the view of determining the comparative effects of arteriotomy and of venesection; and the results, in so far as they affect the subject of our present enquiry, appear to be, that the brain could never be entirely depleted of its red blood;—that the sinuses and veins of the brains of animals bled to death from veins, are commonly more turgid, than they are found to be in those which have died from arterial hæmorrhage;—and

that in both, there was found more or less of serous effusion within the head *.

So far, then, these experiments seem to confirm the proposition, that no part of the circulating fluid can be withdrawn from within the cranium, without its place being simultaneously occupied by some equivalent.

Having obtained permission from a butcher, I opened the carotid artery of one of his sheep, and the jugular vein of another, in presence of Dr Duncan junior, Dr Anderson, and Dr Combe. The moment the artery was opened, the blood was projected with great force to a distance of several feet; soon after, it flowed more slowly, and per saltum only, and the jet gradually became smaller and smaller. We observed (as Dr Parry had done) the gradual contraction of the calibre of the artery as the vascular system became emptied, and we saw that it has itself no pulsatory motion, or alternate dilatation and contraction.

Ten minutes after the carotid had been opened, the breathing was hurried and laborious, and the animal was slightly convulsed. The blood for ten minutes trickled more slowly down the neck; the eye became heavy and listless, and the breathing more and more oppressed; and at twenty minutes from the commencement of the experiment, there

* Si sanguis plurimus sive ex arteria, sive e vena effluxeret, aqua intra caput effunditur.—Seeds, *Dissert. Inaug. de Sanguine Misso, &c.* 1815.

as a general convulsion, and the animal instantly xpired.

When the vein was opened, the blood gushed ut in a copious stream, but soon began to issue ore slowly. In twelve minutes, the sheep was nvulsed; and in twenty-one minutes from the me of opening the vein, he died. These sheep ere immediately fleeced, and cut up in the usual ay by the butcher; and the heads were separated, belled, and set aside for examination on the fol- wing morning.

A, The sheep bled from the carotid artery.— he dura mater contained but little blood; the nuses were full; the pia mater was well injected; nd the vessels following the convolutions of the ain were seen full, tortuous and anastomosing eely; the choroid plexus was well filled with rid blood.

B, The sheep bled from the jugular vein.—The teguments of the head of this sheep were ob- rved to yield more blood when divided than the ead of the former. The dura mater was rather ler; the larger vessels of the pia mater were well led, but the minute injection and colouring of the embrane was less remarkable than in the sheep ed from the carotid. The sinuses at the basis anii were loaded with dark coloured blood. The oroid plexus was not so well injected, and not so rid as in the first animal.

C, We examined the heads of two sheep, which d been slaughtered for the market by the butcher

in the usual way. Blood was found in all the sinuses; several florid red vessels were seen ramifying over the brain and membranes; but these brains were decidedly paler, and we all agreed that they contained less red blood than the brains of the two sheep whom we had bled. They had a more watery and serous aspect as it were, but there was no palpable effusion of serum on their surface, or within their ventricles.

Some days after, having obtained three other sheep, one of them was slaughtered in our presence after the usual manner by the butcher, that we might ascertain the quantity of blood lost by the animal, and note the time, and manner of its death.

D, Sheep slaughtered in our presence by the butcher.—The blood rushed out in torrents. In one minute after the infliction of the wound, the animal became convulsed, and in two minutes died. The quantity of blood lost was exactly thirty-four fluid ounces.

The heart was found to contain about two drachms of blood. There was nothing remarkable in the other thoracic or abdominal viscera. The sinuses at the basis of the brain were full of blood. The veins on the surface of the brain, cerebellum, and medulla oblongata, were also filled. A fine web of vessels over the corpora striata, was beautifully injected with florid blood. A very little serum was found in the ventricles.

E, In this sheep, I first tied both carotids; and

ur minutes after, I opened the jugular veins. ne blood flowed at first very freely, but afterwards ore slowly, unless when the animal was convulsed, ien the hæmorrhage was constantly observed to rease. In two minutes after the veins had been ened, the breathing became very laboured, and n convulsive. In seven minutes the sheep was verfully convulsed, and again, and repeatedly erwards for ten minutes more, the last convul- observed being at eighteen minutes from the e of opening the jugulars. The blood now ved slowly and by occasional drops only, and at nty-three minutes after the veins had been nded, the animal died. The quantity of blood was thirty-eight fluid ounces.

The ventricles of the heart were nearly empty, ontained no appreciable quantity of blood. The ses of the head were in their usual state; those ie basis of the brain contained less blood than ave hitherto found in them, and the veins on hemispheres of the brain were less filled; the oid plexus was pale and empty; the vessels on basis of the cerebrum were better filled, those fying on the basis cerebelli were minutely in- l. There was a slight but very decided se- effusion within the ventricles.

In this I commenced by passing ligatures on the jugular veins, and thus obstructing the of blood from the head; and in five minutes after I opened the right carotid. The bleed- as profuse and rapid. In two minutes after-

wards, there was strong convulsion, and uneasy respiration; and in nineteen minutes from the commencement of the hæmorrhage, this sheep died; the quantity of blood lost being thirty-seven and a half fluid ounces. The heart was nearly voided. The sinuses of the dura mater were found loaded with blood. The veins of the pia mater were also well filled. Numerous vessels on the basis of the brain, on the medulla oblongata, the tuber annulare, and the quadrigemina, were beautifully injected with florid blood. The choroid plexus was remarkably turgid, and there was a fine web of vessels well filled on the corpora striata. No serous effusion.

G, A dog weighing twenty pounds, and bled to death from the femoral arteries. In a few minutes he was convulsed; he survived the experiment fifteen minutes, having lost just fifteen fluid ounces of blood. There was somewhat more than one drachm of blood in each ventricle of the heart. The arteries were every where empty. The cava contained blood and air. The mesentery and intestines were pale and bloodless. Not a drop of blood could be expunged from the liver or the spleen, when divided and pressed. The kidneys were also drained of their blood. The sinuses within the head were loaded with dark blood. The dura mater was pale; but the vessels of the pia mater were delicately filled with florid blood. There was no palpable serous effusion.

H, A dog weighing between forty and fifty

pounds bled from the carotids, lost thirty-seven unces of blood, and died in seventeen minutes. The heart and larger vessels were found nearly mpty; the lungs were much blanched; the liver oo was pale, and nearly bloodless. The viscera in eneral were well drained of their blood. The dura ater contained little blood. On the pia mater ere several vessels of a florid colour, but not tur- dly filled. This brain seemed upon the whole ore depleted than usual. The lateral sinuses ere however well filled; and a small quantity of rum was found within the ventricles, and at the sis of the brain.

I, Both jugular veins of a dog weighing eighteen unds, were opened at the same instant. In three nutes he was convulsed, and died in rather less an six, having lost eleven ounces of blood. The t side of the heart was found empty, but the ht was filled with blood. The lungs were pale. e abdominal viscera were nearly bloodless, with exception of the liver and spleen, which still re- ned a moderate quantity. The dura mater was e, and the sinuses moderately filled. There re numerous vessels on the surface of the brain pia mater moderately injected with red blood. membranes were slightly coloured red, exhi- ng somewhat the appearance of what is called dshot; and there was slight serosity in the tricles.

K, This dog had both carotids tied; the es (it is believed the eighth pairs), being inci-

dentally included in the ligatures. The dog became instantly uneasy and much agitated. The respiration was slow; there were attempts to cough and vomit, and two or three times a little bloody froth was expectorated. For several hours he could move about when roused. He was dull, but not lethargic He refused food and drink, and died in about eleven hours. Many vessels of a florid colour, but not greatly distended with blood, were seen ramifying on the dura mater. The veins on the surface and between the convolutions of the brain, were neither so numerous nor so distended, as we have seen them on other occasions. But the membranes were covered with numerous minute vessels, delicately injected with bright red blood. The sinuses at the basis of the skull were filled with dark blood.

L, Both carotids, (including nerves), and both jugulars, were tied in this dog, an operation which he survived twelve hours. The symptoms were much the same as in the preceding dog.

His eyes (especially the left), were red and suffused. The vessels of the dura mater were remarkably turgid, and all the sinuses were much loaded with blood. Both the larger and the smaller vessels of the pia mater were fully injected with red blood. Not only the pia mater through its whole extent, but the cineritious substance of the brain itself, had a suffused, reddened, and as it were bloodshot appearance. In short, this brain was

gorged with blood in all its minuter vessels, and there was a little serum in the ventricles.

M, This dog was poisoned with prussic acid.—He became insensible and motionless in one minute from its administration, and in three minutes the heart ceased to pulsate. The brain was every where turgid with blood. The veins and sinuses were loaded and congested; and it was quite evident, that this and the brain of the dog L, contained beyond all doubt or dispute, a much larger quantity of red blood than the brains of any of the animals which had been bled to death.

A, G, and H, are examples of depletion from simple arterial hæmorrhagy; B and I, of uncomplicated venous hæmorrhagy. C and D afford examples of more rapid hæmorrhagy and death, from the knife of the butcher. In E the carotids were tied, with the view of arresting the supply of blood to the brain, and the jugulars were opened for the purpose of general depletion, and with the expectation of voiding the brain to the greatest possible extent. In F, on the contrary, the jugulars were tied with the view of obstructing the return of blood from the head, while one carotid artery was laid open, and the animal allowed to bleed to death as a comparative experiment. The brain of E was accordingly found to be much more depleted of blood than the brain of F.

I know that the carotids, jugulars, or both, may be tied in dogs with impunity. We attribute, therefore, the death of K and L to the inclusion of the

eighth pair of nerves in the ligatures. K and L, therefore, afford examples of brains not depleted by previous hæmorrhagy. With the same view, the dog M was killed by the prussic acid. And these comparative experiments afforded us the most satisfactory proof, that the other brains had been really depleted by bleeding, and their vessels drained of a very sensible proportion of the red blood usually contained by them.

It is remarkable, I think, that in whatever manner these animals were bled to death, whether from arteries or veins, or both,—whether the hæmorrhage was rapid or slow,—whatever time, in short, was necessary to terminate their life, death did not take place till nearly the same or a proportional quantity of blood was lost. The sheep D, slaughtered by the butcher, died in two minutes; E, bled from the jugular, survived twenty-three minutes; and F, killed by arterial hæmorrhage, lived nineteen minutes; and the quantities of blood lost by them respectively, were thirty-four, thirty-eight, and thirty-seven and a half fluid ounces. Of the dogs, one of twenty pounds weight lost fifteen ounces from the femoral arteries; another weighing between forty and fifty pounds, lost thirty-seven ounces from the carotids; and a third, whose weight was eighteen pounds, lost from the jugular veins eleven ounces of blood *.

* Drelincourt obtained sixty ounces of blood from a mastiff in half an hour: "Sanguis, universè collectus, uncias

The summary of these observations, in so far as they apply to our present subject of inquiry, may be thus stated,—that though we cannot, by any means of general depletion, entirely or nearly empty the vascular system of the brain, as we can the vessels of the other parts of the body, it is yet possible, by profuse hæmorrhagies, to drain it of a sensible portion of its red blood;—that the place of this spoliation seems to be supplied both by extra and intravascular serum, and that watery effusion within the head is a pretty constant concomitant or consequence of great sanguineous depletion.

If, instead of bleeding, as in our examples, "usque ad mortem," we were to bleed animals more sparingly and repeatedly, I have no doubt that we should succeed in draining the brain of a much larger quantity of its red blood; but in such experiments we should, I think, find a larger effusion of serum, and be satisfied that many vessels, destined to circulate red blood, were filled with serum only, and even the larger trunks with a very thin and diluted blood.

In cachexies, in cases of inanition, and in cases of great sanguineous depletion, whether by venesec-

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"quadraginta octo pependit. Amissam reputo libram unam: "sint ergò medicæ libræ quinque intra horam dimidiam, "arteriis molossi propulsæ." He does not give the weight of this dog, which, according to our observed proportions, must have exceeded seventy pounds at least.—Drelincourtii *Canicidia*, can. 1ma.

tion or by spontaneous hæmorrhage, we might expect the brain to exhibit such appearances as are here supposed. Lieutaud, in his Précis de la Médecine Pratique, has described a cachexia of this kind, by the very characteristic name of Anæmia. In this disease the vessels are found nearly drained of their red blood; and Lieutaud tells us, that he has met with cases in which, on opening the head, the chest, and abdomen, all the vessels, large as well as small, were found containing scarcely any blood; and he mentions one case of a man forty-five years of age, who, after having been most profusely bled for an acute disease, under which he had for some time before laboured, died suddenly of syncope, and in the vessels of whose brain he could scarcely discover a trace of blood *. There is an account of a singular disease, which is said to have appeared some years ago as a local epidemic amongst the workmen of a particular gallery in the coal-mines near Valenciennes, by Professor Hallé, in the 9th volume of the Journal de Médecine. This disease seems to have begun with symptoms of gastric and intestinal irritation, and to have terminated in anæmia. Four individuals suffering under this disease, were sent to Paris for examination. The whole surface of the body was without colour; not the skin only, but the conjunctiva, the inside of the eyelids, of the lips, mouth and tongue, were deprived of their na-

* Précis de la Médecine Pratique, p. 72.

tural colour. Even the larger veins in the bend of the arm and on the back of the hand, we are told, were so empty, or at least so devoid of colour and convexity, that they could not be discerned. One of these died, and on dissection all the vessels, arteries, and veins, in the three cavities of the body, were found nearly destitute of blood, or containing only a small quantity of serous fluid. The vessels of the trunk were equally empty. In the left ventricle of the heart a coagulum was observed, without any perceptible portion of colouring matter, and the heart itself was as pale as muscles are found to be after washing or maceration. Within the cranium the sinuses were nearly empty, the brain itself was white, its cineritious substance was pale, and little distinguishable from the medullary. Between two and three scruples of serum were found in the left ventricle, and the choroid plexus was of a palish red *.

Now, in cases like this, where little or no red blood remains in any part of the system, it seems no way surprising that the vessels of the brain should exhibit at least the appearance of great depletion, while they might, in fact, contain no small quantity of serous fluid, or of the almost colourless blood, which was circulated during life. I do not hazard this observation on mere conjecture. I have just had

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* Journal de Médecine, Chirurgie, et Pharmacie, &c. par Corvisart, Leroux, et Boyer, tom. ix.

an opportunity of examining, along with my friend Dr Combe, the body of a man who exhibited, during life, as perfect an example of anæmia, as any perhaps on record. This man had been for eight months under the regular care and observation of Dr Combe, by whom, perhaps, a full account of this interesting case may at some future meeting be laid before the Society. At Dr Combe's request, I had visited *Hind* two or three times while under his care; and, after the most minute examination, I confess I was unable to give to his complaint any other more definite designation than that of cachexia or anæmia. His countenance and his skin every where was of a pale transparent yellow bombycinous colour, such as, on a first inspection, would naturally suggest the possibility of a liver disease; but then the conjunctiva had nothing of this yellow tinge, neither the urine nor stools gave evidence of any hepatic obstruction, and neither pain nor fulness could be detected in the hypochondriac or epigastric regions. His lips were pallid and bleached; and thus he languished for months, without his complaints assuming any more marked or decided character. For some days before his death his breathing became more difficult than usual; the last twenty-four hours of his existence were passed in a state of lethargy; and on the 29th of January he died.

For our present purpose, it is enough to remark, that the viscera of the thorax and abdomen exhibited no appearance of structural disease. The

heart was flaccid and remarkably pale, containing no blood, with the exception of a web-like, soft, and pale coloured coagulum, loosely attached to the valves and columnæ carneæ. The large bloodvessels were quite empty, with the exception of the abdominal cava, in which was found a thin darkish-coloured fluid, which seemed also scantily to pervade other vessels of the abdominal viscera. The body in general was, however, nearly bloodless. On dividing the integuments of the cranium, a reddish serum only flowed out. The bones themselves were bleached, insomuch that the cranium, instead of its usual blue and sanguineous hue, displayed a whiteness as perfect as the best prepared skulls in our anatomical museums. The dura mater was uncommonly pale, bloodless, and transparent, except only in the course of the longitudinal sinus, which was distinguished by a faint pink tint. About an ounce of thin pink-coloured serum seemed to escape from between the membranes. The sinuses contained only a serum of the same description. The larger vessels ramifying over the hemispheres, and between the convolutions of the brain, were all conspicuous, from the colour given to them by the same pale pink-coloured fluid, with which they were filled, though not distended. The vessels of the basis of the brain, cerebellum, and medulla elongata, contained little or no coloured fluid. The medullary part of the brain was uncommonly white, and the cineritious part was of the palest grey colour. About

three ounces of pink-coloured serum were found occupying the basis cranii and vertebral theca. The choroid plexus was very pale, but its vessels not emptier than usual. The ventricles, corpora striata and thalami, were pale and bloodless, and within the ventricles there was perhaps about a drachm of fluid. The brain generally might be described as soft and watery. Upon the whole, in the examination of this body, we could find little to which the pathologist could attach any importance, other than the want of the usual circulating fluid, and a remarkable ossification of a portion of the dura mater.

The vessels of this brain, however, are far from furnishing an example of unqualified depletion. Compared with the rest of the body, I would say that they contained more than the usual relative quantity of fluid which had circulated during life; a pale and colourless blood, it is true, but in such quantity within the head, that had it been less serous,—more highly coloured,—more, in short, like true blood,—the vascular system of this brain would have presented little more striking or remarkable to the eye of the dissector, than a somewhat less than usual turgescence perhaps of the sinuses and larger vessels, and a profusion of effused and interstitial serum.

Having brought these reflections on the depletion of the vascular system of the brain to a close,

we should next have proceeded to investigate the question relative to the repletion or congestion of those vessels, had I not already too far encroached on the time and patience of the Society;—the subject, however, will be resumed at a future meeting.

REFLECTIONS

REFLECTIONS

ON THE

PATHOLOGY OF THE BRAIN.

By George Kellie, M. D. &c.

PART II.

In the course of those reflections on the pathology of the brain, which I had the honour to lay before the Society at our meeting on the 6th February, I endeavoured to shew, that there are natural obstacles to the free depletion of the brain, which have no existence in any other part of the system; —that we cannot, in fact, lessen, to any considerable extent, the quantity of blood within the cranium by arteriotomy or venesection;—and that when, by profuse hæmorrhagies, destructive of life, we do succeed in draining the vessels within the head 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.

If this be the peculiar condition of the brain, and if the obstacle to the free depletion of its vessels depend mainly on the cerebral system being defended from the weight and pressure of the atmosphere by the solid and unyielding cranium, it seemed probable, that, by removing a portion of the skull, and allowing the atmosphere to gravitate upon the brain, we should succeed in producing a much greater depletion of its vessels by general bloodletting than can be otherwise effected.

To ascertain this point, a portion of the cranium of a dog was removed by the trephine. The dura mater was wounded by the saw, and blood flowed from the surface of the brain. The brain was observed to rise and fall alternately, but so as always to fill the cranium; so that the rise was a sort of protrusion through the opening which had been made. One of the carotid arteries was opened, and in a minute or two afterwards there was an evident gradual sinking of the brain from the margin of the opening. While the blood yet flowed from the carotid, the animal was suspended by the ears, with the view of producing the greatest possible depletion of the vessels of the brain, and allowed to remain in this posture for three hours after death. The brain was sensibly depressed below the cranium, and a space left, which was found capable of containing a tea-spoonful of water. On removing the upper portion of the cranium, the brain appeared of diminished size, or shrunk in its dimensions, so that the membranes, instead of be-

g stretched, seemed loosely extended over it rivelled-like and unfilled. The membranes and the ain itself were pale and bloodless. No blood was und in any of the sinuses, except at the very ter- nations of the lateral, at the basis of the cranium. ne vessels of the pia mater ramifying between the nvolutions of the brain were shrunk, and dwindled the size of small threads. The choroid plexus s also bloodless, and about a drachm and a half of rum was found effused at the basis of the skull.

Another dog was trepanned with more care, so at a circular portion of bone was removed with- t wounding the dura mater, which was separated m its adhesion to the cranium for some way und the margin of the opening, by means of a unt instrument introduced for that purpose. The imal was then bled to death by opening at once e carotid and jugular of one side, suspended by e ears as the former, and examined three hours er death. The brain did not appear so much runk within the cranium as in the former dog; t was sensibly depressed. The vessels on its sur- e were reduced to mere hairs. The brain was narkably pale, and the choroid plexus bloodless. o blood was found in any of the sinuses, except the exit of the lateral ones. About a drachm of um was found at the basis of the brain.

A third dog was trepanned. The dura mater s slit open, the carotids and jugulars were then unded, and the animal suspended by the heels. ree hours after death, the lateral sinuses at the

basis of the skull contained a good deal of blood. There was a little also within the longitudinal sinus, and about a drachm and a half of blood was found effused between the dura mater and pia mater. The vessels on the surface of the brain were a little more distinct than in the other two dogs, but still very small and bloodless. The substance of the brain, the corpora striata, and choroid plexus, were all very pale. The cerebellum was more vascular and better coloured than the brain. There was a very little serum at the basis.

Comparing, then, these with the observations made on animals bled to death by simple hæmorrhage, it appears that, when the head is entire, the brain still contains a considerable quantity of blood, —when previously perforated, very little: the brain continues to fill the cranium in the one case, and subsides within it in the other.

The same causes which maintain the plenitude of the cranium, and oppose the depletion of the vessels of the brain, may be presumed to present also natural and constant obstacles to the repletion of those vessels; or, as from a consideration of the structure and situation of the brain, it does not appear very conceivable how any portion of its circulating fluid can be withdrawn from within the cranium, without its place being simultaneously occupied by some equivalent; so neither does it seem consistent with the notion of a constant plenitude, that any greater quantity of blood can be forced

within the vessels of the brain, without an equivalent compression or displacement.

There are occurrences and accidents in human life, and some diseases also incident to man, which bear on the question of repletion and congestion, with all the force of direct experiment; for, in these, all the conditions required by an experiment, instituted for the very purpose of ascertaining the possibility or impossibility of forcing more than the natural quantity of red blood into the vascular system of the brain, are present.

I. The first case of this description which offers itself to our consideration, is that of death from suspension, suffocation, or drowning. In all these modes of violent death, respiration is immediately and completely interrupted. The lungs and right side of the heart become congested, and a general obstacle is interposed to the return of the blood by the veins from every part of the body. In the case of suspension, besides the interruption of respiration, the carotid arteries supplying the greater part of the blood to the brain, and the jugular veins returning almost the whole of what is circulated within the head, are compressed by the cord; while the vertebral arteries remaining free from obstruction, are presumed to continue to transmit blood to the cerebrum, so long as the heart continues to act.

For some minutes, then, after the victim has been suspended, blood will probably continue to be

sent to the brain by the vertebral arteries, if not also, in some quantity, by the carotids, while its return from the head must be nearly or altogether intercepted by the compression of the veins, and the interruption of the respiration. Thus the conditions of the case are such as ought to produce fulness and turgidity of the vessels of the brain, if these be capable of such repletion in a healthy state of the viscus; for the vessels of the head, face, and neck, exterior to the cranium, are, from similar conditions, found in a highly gorged and congested state. It was for a long time accordingly believed by physicians, that death from strangulation is necessarily connected with cerebral congestion and apoplexy. The fact, however, is, that the appearances presented by the brains of those who have suffered by hanging or drowning, afford no countenance to this opinion.

Neither Valsalva, nor Morgagni (who discusses the question at some length), seem to have found any signs of plethora or congestion within the heads of the executed criminals, whose bodies they had opportunities of examining. In one dissection, for example, "Cutis cranium tegens interiore facie "sanguiferis turgebat vasculis. Cerebrum nihil, "quantum judicare sensus poterant, ab naturali "constitutione discrepebat;" and so in other cases *.

De Haen, in whose time the question regarding the cause of death in the drowned and suffocated

* De Sedibus et Causis, epist. xix.

continued to be much agitated, furnishes us also with several interesting observations and experiments, which prove that neither suspension nor submersion kill by inducing an apoplectic or congested state of the brain. In the dissection of those who had perished in either way, he observed no such appearances. In one hung person, "Ventriculi cerebri superiores nonnihil lymphæ habuere, vix tertius, nihil quartus. Plexus choroidei naturales. Modicus admodum in sinibus lateralibus sanguis." And in another, "In hoc corpore notamus, in suspenso deesse apoplexiæ signa,—adesse peripneumoniæ." In a drowned boy, "Dura mater omnino naturalis; pia nonnihil rubicunda; ventriculi vacui omnes; plexus autem choroidei solito turgidiores. In sinibus lateralibus sanguis admodum paucus *." Again, in thirteen of the fifteen dogs which were hung or drowned for the purpose of ascertaining the morbid appearances, he could find no signs of apoplexy, neither fulness nor congestion, nor rupture of bloodvessels, within the head †.

The question was some years ago renewed in our own country, the subject having acquired a fresh interest from the discoveries which were making in the physiology of respiration, and from the institu-

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* De Submersis, caput ii. Ratio Medendi, tom. viii. par. ii.

† De Resuscitanda Vitæ Suffocatorum, Suspensorum, &c. caput ii. Ratio Medendi, tom. ix.

tion every where of societies for the restoration of suspended animation.

Mr Kite and Mr Coleman were the most distinguished champions on either side of the question, the former defending the old doctrine, and the latter the new. Mr Kite accordingly affirms, that he and his friends generally observed in the brain of drowned animals a certain degree of fulness or distension of the veins *. Mr Coleman, on the other hand, asserts, as the result of numerous experiments, that the vessels of the head exhibit no appearance of distension in hung or drowned animals.

The trachea of a dog was laid bare, and secured by a ligature; in less than four minutes he ceased to struggle. The veins of the head, Mr Coleman assures us, were less distended than natural. The two carotids of a dog were secured, and in half an hour afterwards he was hanged. On removing a large portion of the cranium, the vessels, says Mr Coleman, were much less distended than in ordinary death †.

On this subject I am indebted to the liberal courtesy of Dr Monro, to whom, as Professor of Anatomy in this University, the bodies of executed criminals are commonly sent for dissection, for some very interesting information, and for an opportunity of myself examining the brain of one who had been hung. "I may mention a fact," says the Professor

* Essays on Submersion.

† Coleman on Natural and Suspended Respiration.

in one of his communications which I omitted formerly, viz. " that I examined the brain of a per-
" son who was hung, and found no internal conges-
" tion, but a great deal of blood accumulated in the
" vessels of the integuments."

Shortly after this, I think on Friday, the 7th of December last, a female was hung at Montrose, and the body being forwarded to Dr Monro for dissection, he very obligingly favoured me with the following notes of the observations which he had made on her brain : " The veins of the integu-
" ments of the head were much distended with
" blood. There was a slight effusion of a bloody
" water between the arachnoid coat and pia mater;
" and, on removing the membranes, the brain was
" found to be rather of a paler colour than usual,
" and felt remarkably soft, so that it gave way at
" the corpus callosum, upon which some reddish
" coloured fluid was discharged from the lateral ven-
" tricles, but owing to the rupture I could not as-
" certain its quantity. The brain was much softer
" internally than externally, so that I could not de-
" monstrate any of the deeper parts to my pupils,—
" a circumstance which never before occurred to me
" during the nineteen years I have been a professor.
" Since I wrote to you I have found a few observa-
" tions I had made on the brain, and, amongst them,
" particular mention is made of the softness of the
" brains of criminals."

On the 9th January last two pirates, Heaman and Gautier, were hung at Leith, and Dr

Monro very politely afforded me the opportunity of being present at the examination he was to make of the brain of one of them immediately after execution. The bodies, on arriving at the theatre in the College, were still warm, and their limbs flexible. Their countenances were livid, not much swollen, and no way distorted. Their mouths were shut, and their eyelids open. One eye of each subject was more reddened and suffused than the other. There was no frothy mucus about their mouths, nor did the rectum or bladder of either appear to have been voided during execution. I have been informed, indeed, that these men seemed to die speedily, and with little struggle or apparent suffering. There was no dislocation of the neck, no wound nor laceration of the integuments, though the mark of the rope was distinctly visible on the neck of each. I have remarked that one eye only of each subject was much reddened and suffused, and I observed also that the corresponding side of the face of each was evidently more livid than the other, and the truth of this observation was admitted by several of the gentlemen present, to whom I made the remark. The manner in which the instrument of death is adjusted affords, I think, a ready and natural explanation of the fact. As the noose of the cord is adjusted by the executioner on one side of the neck, it becomes, as it were, the point of suspension, so that, by the weight of the victim, it slips upwards from the neck on that side towards the mastoidal process behind the ear; and

there is, consequently, a space on this side corresponding to the rising of the noose, which is not embraced by the cord, and where the veins, returning the blood from the head, are subjected to little, if any, pressure. The mark of the rope, accordingly, did not form a circle round the whole neck, but was observed to rise obliquely upwards, behind the ear, on that side on which the eye was the least suffused, and the countenance the least livid.

On dividing the scalp the blood flowed freely, and in such quantity as to afford ample proof of the congestion of the vessels exterior to the cranium. The dura mater adhered very firmly to the bones, but exhibited no deviation from its usual appearance. All the sinuses contained blood, but in no extraordinary quantity. The larger vessels on the surface, and between the convolutions of the brain, were but moderately filled, and the pia mater was, upon the whole, paler, and less vascular, than we often find it in ordinary cases. About half an ounce of colourless fluid was found at the basis cranii, and there was some appearance of serosity between the membranes. The texture of the brain was rather soft, but the cineritious and medullary portions of its substance exhibited, as to colour and vascularity, nothing characteristic or remarkable. No sooner was the brain removed than the blood, yet warm, began to rise and flow profusely from the divided sinuses and vessels at the base of the skull. Rather more than a pound escaped in this way, and afterwards coagulated on the floor.

It is remarked by Morgagni, that the fluid state of the blood in the dead bodies of those who have suffered by suspension or strangulation, accounts for the little appearance of fulness of the vascular system within the head, although the integuments of the head and face are gorged with blood: For, on the removal of the cord, he observes, that the fluid blood will easily flow back from the brain and its sinuses, towards the heart, through uninterrupted vessels, so large and pervious as the internal jugulars are, while it cannot so easily find its way through the numerous ramifications of the smaller cutaneous veins *.

But if we consider this matter rightly, we shall, I think, be led to a very different conclusion. The

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* Porro, idem sanguinis fluor, qui in iis erat quos, cum sani essent, violentia externa strangulavit, admirationem minuit quod in iisdem Valsalva cerebrum invenerit ab naturali statu nihil discrepans, aut crassioris meningis vasa nonnihil dumtaxat sanguine turgida, cum interea cutis cranium tegentis interiora vascula, et quæ oculis circumjecta sunt, aut per retiformen horum tunicam, aut per aurium tympanum feruntur, adeo turgerent; ut aliæ harum partium inflammatæ viderentur, nonnullæ, ut membrana tympani, et annexa ossicula, tinctæ etiam sanguine apparerent. Soluto enim laqueo, amplissimisque viis internarum jugularium venarum redituro sanguini reclusis, multo maxima hujus, quippe fluidi, pars è cerebri sinibus, venisque majoribus in hos desinentibus, facile defluxit, cum is qui per anfractus, angustiasque magis dissitarum venularum minus expeditum haberet, in iis subsisteret, nonnullis earum exceptis, quas aut magis plenas, aut minus resistentes laqueus ante disrupisset, aut alia exterior violentia.—*Morgagni*, Epist. xviii. 11.

cord cannot be, and never is, removed till the subject is cut down and laid in the horizontal posture, when the blood can have no tendency to gravitate towards the heart. The occurrence, indeed, which took place after the removal of Gautier's brain proves the contrary,—that, in the horizontal posture, the blood, while fluid, must be rather gravitating upon the brain, and that the fluid congested in the right side of the heart, cava, and jugulars, is actually pressing upon that within the sinuses of the brain, for when the vessels were divided within the head, the blood flowed upwards into the skull.

I have long known, indeed, that, in consequence of this very circumstance, much more blood has seemed, in many cases, to have been contained within the head than actually existed within its vessels. Sometimes in opening the head, the sinuses are wounded by the saw, or torn in removing the upper portion of the skull from its strong adhesion to the dura mater, and then I have not unfrequently seen blood continue to escape in such quantity as the sinuses themselves were incapable of containing, and that, too, without the veins on the surface of the brain appearing to have been thereby emptied, so that I have never doubted that the greater part of this blood had pressed upwards from the jugulars and cava. When the brain is removed it is very usual for the blood to press upwards, and flow into the skull.

I have sometimes, however, called the attention of those assisting me in dissections to a very diffe-

rent state of the vessels within and without the head, —cases in which the jugulars and cava were empty, while the sinuses and veins within the head contained their usual quantity of blood. This state of the vessels was observed in the case of anæmia, given in the former part of this paper, and in the following case.

Mr L.'s child, a girl about two years of age, was, on the 12th November last, attacked with symptoms of acute bronchitis, a disease at that time very prevalent among young people. The case was from the beginning actively treated by bloodletting, blisters, and antimonials, and, in a few days, the dyspnœa, and more urgent symptoms, seemed considerably relieved; still the child did not convalesce, but continued hectic and feverish. Nothing farther remarkable occurred till the 2d December, when it was reported to me that the child for a day or two had at times experienced great difficulty in swallowing, and that now the dysphagia was complete. A careful examination of the external and internal fauces satisfied me that there was no inflammation or tumor. A blister was applied to the nape of the neck, and in a few hours from the time it began to act, the power of swallowing was recovered. On the 4th, however, the dysphagia returned, and was again relieved by blistering the external fauces. The relief, however, was of short duration. On the 6th the child could swallow nothing, and notwithstanding every remedy used, the power of deglutition could never be restored. She was thirsty and

anxious to swallow, but not a drop of any thing whatever passed downwards from this time till the 12th, when she sunk apparently from mere exhaustion. On dissection, the fauces, pharynx, and œsophagus were found in a perfectly natural state. The trachea and bronchiæ were loaded with purulent fluid, and there was adhesion of the left side of the lungs to the pleura. All the abdominal viscera were remarkably pale and bloodless. Very little blood was found in the heart. The sinus venosus and cava, and the carotids and jugulars of both sides, were perfectly empty. The sinuses of the dura mater were well filled, and the veins of the pia mater ramifying between the convolutions of the brain, were plethoric and congested. At the basis cranii, and in the vertebral theca, there was found rather more than an ounce of serous fluid, but none in the ventricles.

I have seen, also, in the animals which we bled to death, the vessels of the neck, till they entered the bony foramen of the cranium, empty, though the communicating sinuses within the skull were well filled with blood.

I consider these observations on the relative state of congestion of the veins, within and without the head, as good illustrations of the difficulty of repleting, or depleting, the vascular system of the brain; for, on the one hand, we find blood pressing upon the brain from the congested jugulars, cava, and right side of the heart, without finding any entrance into the head, till the sinuses are wounded,

and the brain removed; and, on the other, the vessels within the head are found replenished with blood, though their continuations without the head are empty.

II. Another condition, which has been presumed to have a tendency to produce fulness and congestion of the vessels of the brain, and consequently to act as an occasional or exciting cause of apoplexy, is stooping or other low positions of the head. I believe, however, that the influence of posture has, in this respect, been somewhat overrated. I think it quite certain, at least, that in a previously sound and healthy condition of the brain and its vessels, no change of posture can impel into, or confine more or less blood within those vessels than naturally belongs to them, though I am willing to allow that the general pressure of the circulating fluid may, in this way, be, under certain circumstances, increased or diminished, and the circulation through the head accelerated, retarded, or disturbed.

Healthy individuals may stand on their head, hang by their heels, or change the posture of their bodies in every possible way, as we observe in the gambols of school-boys, or the more curious feats of adult and professed tumblers, without sustaining the slightest injury or inconvenience. Many of the occupations and employments of industrious life are carried on in a continued stooping posture, as in the acts of weeding, reaping, gleaning, planting, digging, washing, and many such like. Miners, shoemakers

too, and other artizans, work the whole day in very constrained and stooping postures; and the sailor, in the act of furling and reefing, hangs over the yard-arm in such a way that his head is not unfrequently the lowest part of his body. In some instances of deformity, decrepitude, and disease, we occasionally observe individuals bent almost double, and compelled to move about with their head stooping almost to the ground. Yet in these, and many other such examples of constrained situation and stooping posture, whether from choice, necessity, or infirmity, the circulation within the head continues to go on freely, and these subjects have not, I apprehend, been observed to be more prone to congestive diseases of the brain, to palsy and apoplexy, than those whose more fortunate circumstances permit them "erectos ad sidera tollere vultus."

The heart continues to pulsate for several minutes after every other sign of life has been destroyed, by an adequate dose of hydrocyanic acid, and the blood continues fluid for a still longer time. In order, therefore, to ascertain, as far as such an experiment can do, the total effect of the gravitation of the blood upon the vessels of the brain, I immediately, after administering a destructive dose of prussic acid to two dogs, suspended the one by the heels, and the other by the ears, and allowing them to remain thus suspended for eighteen hours, they were taken down for examination.

In the dog suspended by the ears, the muzzle, gums, tongue, and integuments of the head were

found pale and bloodless, and the jugulars empty. The dura mater had few conspicuous vessels; those of the pia mater were tolerably large and numerous, but not turgid; the brain itself was well coloured, seemingly with arterial blood, especially within the ventricles; the sinuses did not contain much blood; the serous effusion at the basis of the brain amounted to nearly a drachm. In the dog suspended by the heels, all the external parts of the head were much congested and highly coloured, and there was a small effusion of blood under the fascia of the temporal muscles; all the veins of the head, and the jugulars of the neck, were loaded with blood, even to turgescence. The dura mater exhibited no increase of vascularity. The veins of the pia mater were rather more filled, and the sinuses were decidedly more turgid than in the other dog, but there was no palpable quantity of serum in any part.

Thus, the effect of posture on the parts exterior to the skull is very great; in the one dog, the integuments were pale, and the vessels completely empty; in the other, they were filled and congested to the greatest possible degree. Within the head the contrast was but trifling. The sinuses beyond all doubt were loaded in the one case, and rather empty in the other; the difference of appearance in the other parts of the brain was but little striking.

III. Some diseases of the heart, and of its larger

vessels, constitute cases in which we might expect to find the brain more plethoric and congested than usual. In obstruction of the auriculo-ventricular valves, an obstacle exists to the free return of the venous blood from the head; and in muscular enlargement of the heart, not unfrequently complicated with contraction of the descending aorta, the impetus of the blood upon the brain is often powerfully increased. Sometimes, too, these conditions, either of which seem so well calculated to produce fulness and congestion of the vessels within the head, are found united in the same case, obstruction viz. to the return of venous, and increased impetus of arterial blood. Yet, I believe it will be found that, in a sound condition of the brain and its vessels, such diseases of the heart have little or no tendency to produce lethargy, palsy or apoplexy, nor by consequence plethora, congestion, or disordered circulation within the head, although the livid, bloated, and sometimes swollen countenance, and the turgid and throbbing neck, bear ample testimony to the existence of plethora, obstruction, and congestion, in the vessels exterior to the cranium. Of the several cases of enlargement, and of other structural diseases of the heart, which have come under my own observation, not one of the patients had lethargic or apoplectic symptoms. One only had a partial paralytic affection of the right arm.

During the spring 1814, Mr B. had been complaining a good deal, but without any peculiar or

definite symptoms. It had merely been remarked by his friends, that he was looking ill, and did not enjoy his usual health and spirits. He continued, however, to vacate his affairs during a time of great commercial embarrassment, without any particular inconvenience or inability. On the 1st March, he complained to me for the first time of an inconvenience he experienced in the act of writing, a necessity of writing more slowly than usual, and an inability of forming the letters with his accustomed accuracy. This disability was accompanied with headach and vertigo, and being considered by me as a paralytic affection, depending on increased pressure on the vascular system of the brain, he was bled on the 3d, 7th, and 12th March. His bowels were kept open, and an antiphlogistic regimen enjoined, by which means these symptoms were relieved, but not removed. He continued, however, to go abroad, and do business as usual, so that after the 12th March I ceased to visit him at his house, and occasionally only used to meet him in the street.

On the 1st May I was again consulted, and informed that his nights were restless and sleepless, —that he complained of a sense of oppression at the breast, and of suffocation at the throat, whenever he laid himself down on bed, or assumed the horizontal and recumbent posture,—of palpitation, of headach, and vertigo,—of costiveness, and of discharge of blood by the anus,—of breathlessness on the slightest exertion, and of general prostration of

strength. These symptoms led me to examine very particularly the condition of the heart, and of the larger vessels of the thorax and neck. From the tumultuous throbbing over a great extent of the chest, the laboured action of the heart, and the pulsation of the aortic arch, both felt and seen immediately above the sternum, I entertained little doubt of the existence of aneurism of the aorta, and of enlargement of the heart. Yet I did not at this visit consider things so far advanced as immediately to endanger life. The action of the heart was, however, too powerful, and could not be controlled; the blood was projected with surprising force upon the aortic arch, the carotids, and the head; alarming hæmorrhagies took place both from the nostrils, and per anum; the horizontal position was insufferable, and several days and nights were passed without sleep in the chair. The stomach became affected and retained nothing,—violent sickness and bilious vomiting ensued,—he was restless, anxious, and uneasy, and on the 13th of the same month he died.

The heart was found enlarged to twice the usual size, not by simple dilatation, but by a real increase of muscular structure, as well as of capacity. The aorta, also, from its origin, through the whole extent of its arch, had nearly twice the ordinary capacity;—its coats were thickened,—the internal coat was inflamed and studded with several gritty tubercles or ossifications. All the valves were sound. There was an ounce of water in the peri-

cardium. The lungs and abdominal viscera were sound. The head was not opened.

Now, notwithstanding the slight paralytic affection of the right arm, and the headach and vertigo of which Mr B. complained, I consider this, upon the whole, as one of those cases where an apparent exception may be said rather to confirm than invalidate the rule; for powerful and awful as were the exertions of this heart, there was yet no stupor, no lethargy, no apoplexy, no congestion therefore, no rupture of vessels within the head, although such congestion and rupture happened in other parts of the system.

Mr G., with a numerous train of distressing symptoms, which too well marked the existence of enlargement of the heart, and of the violent propulsive energy of that viscus, had one only characteristic of any disturbance within the head. On looking upwards to the whitened ceiling of a room, he saw a darkened spectrum which vanished and reappeared with great regularity. It was soon discovered that the appearance of this umbra was synchronous with the systole of the heart, so that he used often, in my presence, to count his pulse with the utmost precision, by keeping his eye fixed on the ceiling, and numbering every appearance of the spectrum. But, independently of this curious symptom, every other function of the brain, during a protracted state of suffering, remained undisturbed till the last moment of his existence.

On dissection, the heart was found greatly en-

larged, but without any increased thickness of its parietes. The auricular valves on the left side were rigid and thickened.

Mr L.'s case was very similar in its progress to the preceding. I had no doubt of the nature of the disease from the moment he consulted me. The heart acted with amazing force; the pulse varied from a hundred to a hundred and twenty; the respiration was easily affected by the slightest exertion, and there was much of anxiety and restlessness. The more urgent symptoms were occasionally relieved and parried by bloodletting. After several months of suffering, his legs began to swell,—his breathing to be more and more difficult, and in one of those paroxysms of dyspnœa he died. But the functions of the brain remained unimpaired and unaffected during the whole of his illness.

The heart was much enlarged; the ascending aorta was rather larger than usual, but immediately below the origin of the left subclavian, there was a remarkable contraction to the extent of fully one-half of its diameter, below which the vessel again swelled out into a sort of aneurism by dilatation. In this case, then, with an enlarged heart pulsating with furious energy, and an aorta strictured just below the origin of those vessels through which the blood is directly impelled on the brain, we had yet no symptoms of congested or deranged circulation within the head.

A still more remarkable case of solid enlarge-

ment of the heart, with obstructed aorta, is recorded by Dr Graham, in the 5th volume of the Transactions of the London Medico-Chirurgical Society.

The walls of the left ventricle were about an inch in thickness. The aorta expanded unusually near its origin, so as to form a kind of pouch, but after giving off the branches to the head, and superior extremities, its diameter was preternaturally contracted. It was continued of this diminished size till after its union with the canalis arteriosus, where it was completely impervious. The arteria innominata, the left subclavian, the superior intercostals, and mammary arteries, were much enlarged. The throbbing of the carotids and subclavians was very remarkable; there was dyspnœa and palpitation of the heart; the pulse was at one report 100 and firm; at another it is described as full, strong and sharp; he had febrile attacks, pain, nausea and vomiting; but in the whole account of this interesting case, I do not find the slightest notice of any symptom marking disorder of the circulation within the head *.

Few physicians have enjoyed more extensive opportunities of observing the effects of structural diseases of the heart than Corvisart, and yet with a strong prejudice in favour of the supposed connection between these diseases and apoplexy, he frank-

* Transactions of the Medico-Chirurgical Society of London, vol. v.

ly avows that his practice does not furnish him with a single fact of this kind, which he adds is a little extraordinary, considering the numerous cases of this disease which have fallen under his observation *.

The proper inference, I think, is, that such structural diseases of the heart, however much they may seem calculated to force blood upon the brain, or to impede its return by the veins, have yet little or no effect on the circulation within the head; or, that whatever tendency such diseases of the heart and larger vessels may have to produce plethora, congestion, or deranged circulation within the head, that tendency is opposed and counteracted by the physical situation of the brain, and the peculiar confinement of its vascular system.

It would be still more extraordinary, however, if coexistent diseases of the brain and of the heart were not occasionally met with.

The texture of some part of the brain may be softened or otherwise diseased, tumors or changes of structure may be formed or advancing to maturity within the head, or the arteries of the brain may be themselves in a morbid state, dilated, atheromatous, ossified, or aneurismal. In all or any of these cases, the coexistence of structural diseases of the heart, and larger vessels, may materially influence the character, severity, and progress of the cerebral disease. Thus may a subject with struc-

* Maladies de Cœur, par Corvisart.

tural disease of the heart, have symptoms also of a morbid condition of the brain; or, be simultaneously affected with headach, vertigo, amaurosis, paralysis, or coma, or die suddenly from apoplexy; and the sooner, perhaps, that a diseased heart was propelling the blood with increased energy upon, or retarding its return from the brain. In fact, if we attend to those cases where cerebral symptoms have coexisted with those of diseased heart, we shall often, perhaps always, find that there was an independent disease of the brain itself, quite adequate to the production of all the symptoms referable to that organ, though no disease whatever had existed in the heart or larger vessels.

For example, a mantua-maker, twenty-four years of age, who laboured under symptoms of active aneurism of the heart, had also complete paralysis of the left side. The heart on dissection was found to occupy "the greater part of the chest, and had "acquired," says Corvisart, "an extraordinary size, "considering the small stature of the subject. The "cavity of the left ventricle had acquired a very con- "siderable size, and its parietes were much thicker "than natural. The aortic opening and sigmoid "valves were free and natural, but the mitral valves "were tuberculated *."

Now, had the chest alone been opened in this case, it might have been produced as an example of paralysis, arising from the increased propulsive

* Corvisart.

nergy of this enlarged and obstructed heart, for-ing into or confining too much blood within the essels of the brain. But on opening the head, the ubstance of the right hemisphere of the brain was ound in a state of manifest decomposition, of a rey colour, and of the consistence of thick paste.

Malpighi's case, too, which Corvisart cites as an example of connexion between apoplexy and dis-eases of the heart and large vessels, is still, in my apprehension, one rather of coexistence than of causal connexion. This eminent person was af-flicted with gout and stone, was subject to palpita-tions of the heart, and died of a second stroke of apoplexy. The heart was found to be thickened and enlarged, and the right ventricle of the brain is said to have contained two pounds of blood. But, then, all the cerebral vessels were varicose and diseased, one of the most common perhaps of all the causes of sanguineous apoplexy with rupture of vessels and effusion of blood *.

I had lately an opportunity, along with more than one member of this Society, of witnessing the dissection of the body of a man who had died rather suddenly in one of our public institutions. This man, thirty-two years of age, was admitted on the 9th of January last, for the treatment of amaurosis. He complained besides of pain of head, particularly over the right eyebrow. The right eye had be-come suddenly affected about five months previous-

* Vide Baglivi, Morgagni, and Corvisart.

ly, and shortly after the left one. He had been subject to headach for six years, though in other respects his general health appeared good. On the seventh day after admission, he complained of great pain over the right eye, had dyspnœa, cough and vomiting, frequent pulse, and thirst. On the ninth, without any alleviation of the previous symptoms, he had great tendency to sleep; coma supervened with laborious respiration, his countenance became pale and ghastly, and at one o'clock next day he died.

"Upon examining the brain, the veins upon the "surface were not much distended with blood, nor "were the smaller arteries very conspicuous. There "was a slight effusion of serum under the arachnoid "coat. The brain throughout felt particularly firm, "but, when cut into, did not exhibit any marks of "great vascularity; and there was no fluid in the "ventricles. Upon examining the basis of the brain, "there was no effusion as on the surface, but there "was a marked change in the arteries. The carotids, "the vertebrals, basilar, and those vessels forming the "circle of Willis, were much thickened in their coats, "and felt extremely tough; and the branches sup-"plying the brain, particularly the anterior cerebri "of the left side, were studded with various spots of "ossification, which, however, did not render them "brittle. The carotids, where they were in contact "with the optic nerves, were much thickened in their "coats, and the whole of the arteries felt so tough that "they could easily be followed out. The optic nerves "were also very firm. The cavity of the thorax was

" quite healthy, excepting the heart, which was much " enlarged; when cut into, the ventricles, particu- " larly the left, were found much thickened. There " was a large polypus of a yellow colour distending " the right auricle, and passing for some way into " both cavæ; it descended for some way into the " ventricle, and completely obstructed the passage. " All the valves of the heart were healthy *."

I have produced this case as a very interesting example of the coexistence of structural disease of the heart and brain, and of their mutual independence. The power of the systemic heart was greatly increased, and the pulmonary was much obstructed. It was just such a heart as seems calculated at once to force blood upon the vessels of the brain, and to retard its return by the veins, and so to produce plethora, congestion, or rupture of those vessels. The cerebral arteries were themselves diseased, enlarged somewhat, changed in structure, and here and there studded with atheromatous or ossified spots;—they were, in short, in a state of predisposition to congestion and rupture; and I do not, I think, hazard much when I take it upon me to say, that this man was thereby predisposed to apoplexy, and that, if his heart had been perfectly sound,—had he laboured under no other disease or predisposition than what was found to exist in the arteries of the brain,—he might indeed have lived longer, but would sooner or later have become paralytic or apoplectic. The predisposition, however,

* Extract from the Public Records of the Charity.

was not as yet sufficiently far advanced; and thus even so powerful an exciting cause as an enlarged and obstructed heart, was unable to produce congestion or rupture of diseased arteries,—and if not of vessels in a well known state of predisposition, how little reason does there remain for believing, that structural diseases of the heart and larger bloodvessels have any great efficiency in the production of plethora or rupture within the head, in a healthy state of the vascular system of the brain?

IV. Ligatures and tumors compressing the vessels of the neck, so as to impede or retard the free return of blood from the head,—the pressure of thoracic and abdominal enlargements and tumors on the aorta or cava, or other impediments to the free passage of the blood to or from the heart, constitute another class of cases, which have commonly been considered as having a natural tendency to force more than the usual quantity of blood upon the brain, and which have accordingly been very generally regarded as efficient occasional causes of apoplexy. I think, however, it will not be difficult to shew, that even these have little influence upon the circulation within the head, in a sound and natural condition of the brain and its vessels.

Mr Abernethy tied the carotid of a man who had been gored in the neck by a cow. The patient soon after became delirious, convulsed in the left side, paralytic in the right, and died thirty hours after the ligature of the artery. Appearances of

inflammation and effusion of blood were found on the surface of the brain, a gelatinous deposition beneath the arachnoid membrane, and watery effusion within the ventricles. Upon reflection, Mr Abernethy observes, "I can form no other opinion of the "case than that which first struck me, which is, that "though stopping the supply of blood to the brain "did not for several hours produce any apparent de-"rangement in the functions of that organ, yet such "a state was gradually occasioned by it, and which "was attended, like the effects of concussion of the "brain, with inflammation." And he adds, "that "an effusion of blood in the left hemisphere of the "brain would affect the opposite side of the body "in the same manner that cutting off the supply "of blood to the left side appears in this instance "to have done*."

At a time when we had but little, if any experience of the effect produced on the circulation within the head, by the ligature of one of the principal vessels supplying the brain with blood, Mr Abernethy's reflections were quite natural, as the event of this unfortunate case was in perfect accordance with, what I may be pardoned for calling, a pathological prejudice of our schools; so that, if this had remained a solitary experiment, it might now have stood in our way as a good illustration of the common doctrine.

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* Surgical Observations, by John Abernethy, F. R. S. London 1804.

The carotid, however, has been since so frequently tied, and with such unvaried success, as to convince us that the obstruction of this vessel has no tendency whatever to produce derangement of the circulation within the head, or of the functions of the brain, insomuch that, in cases of aneurism, the ligature of the common carotid has now become an established and fearless operation of surgery. So little, indeed, is this operation, in so far as its influence on the functions of the brain is concerned, now dreaded, that surgeons have even ventured to tie the common carotid, with the intention, and with the effect too of interrupting or weakening vascular action and turgescence of parts exterior to the cranium, without, however, the fear of deranging, and without actually having deranged, in the slightest degree, the circulation within the head, as in those cases of aneurism by anastomosis in the orbit, which have been cured by tying the common trunk of the carotid by Mr Travers and by Mr Dalrymple *.

There is probably no known case in which the circulation through both carotids has been interrupted in man; but in the lower animals, whose brains are supplied with blood by arteries similar in their origin and distribution to our own, both carotids have been tied with perfect impunity. The ancients indeed believed, that the compression of

* Medico-Chirurgical Transactions, vols. ii. and vi.

those vessels was followed by stupor and lethargy *. But we have a series of experiments on the ligature of the carotids, from Galen down to Valsalva, and to the present day, which prove, contrary to this prejudice, that the ligature of both arteries produces no disturbance whatever in the functions of the brain †. The animals on which I have repeated this experiment, though kept alive for several days afterwards, appeared to suffer no inconvenience whatever.

Almost the whole of the blood circulated through the brain, is returned to the heart by the internal jugulars, and yet the obstruction or ligature of one of these veins at least, does not appear to be productive of any derangement of the circulation within the head,—of none at least capable of disturbing the functions of the brain.

Mr Simmons, in extirpating a tumor from the neck, divided and tied the internal jugular vein. The patient recovered; and it is especially remarked, that no morbid affection of the head was the consequence of this operation ‡.

A similar case is related in the 5th volume of the Edinburgh Medical Essays. After laying the

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* Carotides (vel arteriæ somniferæ) a ΚΑΡΟΣ, *sopor*.

† Non parvi momenti est pro Galeno, de tribus canibus, in quibus Valsalva ejus iteravit experimentum, ne unum quidem fuisse qui aut sopore, aut obmutescentia corriperetur.—*Morgagni*, Epist. 19-29.

‡ Medical Facts and Observations, vol. viii.

vein bare a considerable way, Dr Simson observes, "I found it confounded at the lower part with the "substance of the tumor; and therefore, putting "a ligature round the vein, I tied it, and then cut "away the remaining part of the tumor below." The cerebral functions appear to have suffered no disturbance from the ligature of the vein *.

Mr Lardner, after describing a case in which he found the internal jugular obliterated by a tumor in the neck of a woman, remarks, as one of the interesting circumstances of the case, the very slight disturbance of the functions of the brain, notwithstanding so great a derangement of its circulating system had taken place †.

Another case, very like to this, occurred in the practice of Mr Young. "A sailor, about fifty "years of age, had an ulcer in the fauces, which "communicated with a chain of tumors surround-"ing the larynx and pharynx, and affording great "impediments to respiration and deglutition. The "tumors increased during several months, when "the patient died, worn out by the irritation and "pain which they excited. When dissected, these "tumors were found to consist of a soft medullary "matter, contained in a cellular structure. One of "the tumors projected into the fauces, and had "excited ulceration, which extended to the epiglot-"tis. The carotid artery and the external jugular

* Edinburgh Medical Essays, vol. v.

† Edinburgh Medical and Surgical Journal, vol. vii.

"vein were enveloped in these morbid growths. "The cavity of the artery was of its natural size, "and its coats were healthy. The left internal ju- "gular vein, for the extent of two inches, where it "passed through the tumors, was completely obli- "terated *."

We had lately a patient in the Leith Dispensary, a man of the name of Veitch, who died suffocated by the pressure of a large medullary sarcoma, which occupied the whole of the neck, extending from ear to ear, and from the chin to the sternum. Deglutition was impeded, respiration difficult, and the countenance swollen and livid. On dissection, all the vessels of the neck were found involved in this large tumor, whose weight may be fairly estimated at somewhat more than two pounds; and yet, as I am informed by Dr Macaulay, who had the charge of him during the last days of his existence, no symptoms occurred indicative of disturbance of the circulation within the head.

It was long believed, on the authority of Aristotle, that the ligature or compression of both internal jugulars was productive of stupor and insensibility. The experiment, however, repeated by Galen, and since by others, has not been followed by any such remarkable result. There are contradictions, it is true, in the observations of different experimenters; but the general conclusion seems to

* Hodgson's Treatise on the Diseases of the Arteries and Veins.

be, that the ligature of the jugular veins of the lower animals is not necessarily followed by any disturbance of the functions of the brain. Morgagni, however, has, by a critical examination of those experiments, rendered it doubtful what were the veins actually secured in most of them, whether external or internal. He remarks, that the experimenters have not generally been sufficiently explicit in their accounts,—that they have sometimes omitted to name the animals operated on, or to tell in what part of the neck the veins had been tied in the dog, when that animal is distinctly mentioned,—that few had made the necessary examination after putting the animals to death, in order to ascertain whether or not the vessels had been properly tied and had continued obstructed, or had made themselves acquainted with the peculiar distribution and communications of those vessels *.

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* " Sed neque dixit, quo in genere animalium, nec qua in " colli sede, venas constrinxerit. Quorum utrumque eos cogi- " tasse, æquum fuerat, qui ejus vellent experimentum in du- " bium vocare. Nam quod ad primum attinet, recentiores " hæc fere solent in canibus, quos ille vel mortuos quam raro " dissecuerit, neminem fugere potest in ejus lectione versa- " tum : quibus autem vivis animalibus ad experimenta utere- " tur, quod ad nervos quidem attinet, scimus ; quod vero ad " sanguifera vasa, si rectè memini, nescimus : et tamen aliam " in aliis animalium generibus esse posse vasorum dispositio- " nem, aut communicationem, quis neget ? quando haud raro " in eodem genere, imo vel in uno eodemque animali, si quæ " sunt in dextro, et sinistro latere inter se comparemus, varias " illas esse, deprehendimus. Quamobrem et illum alterum

These objections seemed to Morgagni to be less applicable to the experiments of Lamure and Desnoves, than to those of others. Lamure tied the jugulars of a dog, as the experiment is described, immediately below the bifurcation, without effect; but when he tied the same veins lower down the neck of another, the animal was affected with profound stupor. Desnoves, by his account, tied both the external and internal jugulars in two dogs, and the animals are said only to have become heavy and sad *. Morgagni, therefore, concludes, that Galen might have really tied the internal jugulars without any remarkable occurrence in the subject of experiment, seeing that Desnoves had secured both the external and the internal veins, without

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" spectare decet, id est qua in colli sede ligatæ fuerint venæ " jugulares. Nam inter altiorem, et inferiorem sedem, sive " ob eam quæ modo indicata est, sive ob constantem causam " vel in canibus discrimen esse, conjicias licet ex Cl. Lamurii " experimentis. Hic enim cum aliud inquirens, multorum vi- " ventium canum jugulares internas venas spectaret, hasque " ad breve temporis spatium in duobus obligandas curasset; " in primo quidem postquam vinculum injectum fuerat infra " earum bifurcationes, soporem adnotavit nullum; in altero " autem cum injectum esset, quo ad fieri potuit, proprius tho- " racem, canis, inquit, incidit in profundum soporem."

* " Et sane utrasque olim videtur intellexisse Novesius qui " externis simul internisque vincula injecit. Quod cum in uno, " itemque in altero fecisse cane, animadvertit quidem (id quod " apud Loverum non invenio) signa capitis facti ponderosio- " res, et lacrymas aliquot; sed canibus aliquo post tempore " mortuis, nihil quidquam seri extra aut intra cranium effusi " deprehendit."— *Morgagni*, Lib. ii. Epist. 19. § 32.

any greater disturbances having followed *. There is still something imperfect and unsatisfactory in the account of these experiments; and I have reason to think, that even those of Lamure and Desnoves are open to the doubts which Morgagni has cast on the experiments of their predecessors. In fact, the dog, the common subject of all those experiments, has, in reference to the anatomy of man, no internal jugular.

The common jugular, as I shall call it, is a very large vein situated superficially immediately under the skin of the neck of the dog, which, in its division and distribution, may be very aptly compared to the common carotid, for, like it, the common jugular ascends obliquely from the chest, giving off no remarkable branch but one, the transverse cervical, which supplies the parts about the shoulder, till it reaches a little higher than the upper third of the neck, where it bifurcates at a very acute angle into two principal and equal sized branches, the most external and continuous of which ascends to the head, gives some veins to the occiput, and then, a little before the meatus auditorius externus, it turns under the coronoid process of the jaw-bone, gives off numerous branches to the neighbouring parts, and enters the cranium a small vein, to re-

* "Utcunque id est; certe Novesii observationes ostendunt, potuisse Galenum læsionem adnotatu dignam nullam videre paulo postquam internas adstrinxissit jugulares venas, quando internis simul, externisque constrictis, non plura Novesius animadvertit."—*Morgagni*, Lib. ii. Epist. 19.

ceive the blood from the sinuses of the brain; so that this small branch which perforates the cranium, is the only true internal jugular. The other great bifurcating branch of the common jugular, runs upwards and forwards to the face and throat, —soon divides into two veins of nearly equal size, the one proceeding to the larynx and adjacent parts, while the other, running upwards over the angle of the lower jaw, gives branches to the head and face, —passes under the zygoma to the orbit, and is now the ophthalmic vein, which receives a large portion of the blood of the sinuses of the brain. The branch which I have described passing to the larynx and adjacent parts of the throat, gives off a very slender vein which becomes recurrent, plunges deep into the neck, and running down nearly in contact with, and parallel to the carotid, and between it and the trachea, communicates with the subclavian vein; so that, when I first observed this recurrent branch, slender as it is, I concluded it to be the internal jugular. It is, however, no other than a very small reflected branch from the laryngeal vein.

The veins which have generally been tied in the dog, can, I think, have been no others than the common jugulars; and when these are secured, it is evident that all the blood returned from the brain by the internal branches must be intercepted, were it not for the small recurrent branch, which preserves a communication between the laryngeal vein and the subclavian, and by which some portion

of blood will still be conducted from the head to the heart.

If, in any of those experiments, one only of the great bifurcating branches (mistaken for the internal jugulars) had been tied, blood would still be transmitted from the brain by the other,—by the ophthalmic vein, if the internal,—and by the internal jugular branch, if the facial or external branch had alone been tied.

I have myself tied the common jugulars in dogs, but they suffered not the slightest inconvenience. They never refused their food, and seemed as lively and active as they had ever before been. One dog, on the third day after the experiment, contrived to rid himself of the rope with which he was secured, made his escape, and I am informed, is still living and well.

It is by no means clear what were the veins secured by Desnoves, as internal and external jugulars. If he tied the two great bifurcating branches, he performed a less satisfactory experiment than if he had tied the common jugulars; but if, mistaking the small recurrent veins for the internal jugulars, he tied these and the common trunks, then he must have intercepted all the blood which can directly be returned from the head by the jugular system of vessels. It seemed to me, therefore, desirable, that the result of such an experiment should be fairly ascertained. The common jugulars, accordingly, and the recurrent veins, were all carefully secured by ligature as low in the neck as they could well be

reached. The dog at first seemed to suffer no inconvenience. The two following days, however, he kept himself in the recumbent or crouching posture, was dull, but not stupid, paralytic, or lethargic; took his food regularly, and seemed pleased when caressed. On the fourth day, he regained his spirits, and continued brisk, lively, and so perfectly recovered, that he gnawed asunder his rope, and nearly made his escape. On the seventh day, being to all appearance in perfect health and strength, he was killed in one minute by a dose of prussic acid. Next morning we examined the head and neck. All the veins were found to have been accurately tied, and to have continued perfectly obstructed by the ligature. The vessels of the pia mater and brain were moderately filled, and the sinuses were distended with blood. There was no serous effusion, and the brain had a healthy and natural appearance. The repetition of this experiment was attended with no difference of result worthy of notice. We may rest satisfied, therefore, that the obstruction of the whole jugular system of veins in the dog has no tendency to disturb much the circulation, or to congest the vascular system of the brain. The truth is, that although the direct return of the blood by these veins be very completely intercepted, it may yet find a sufficiently free, though more circuitous passage to the heart, not only by the vertebral sinuses, which appear to me very large in the dog, and which communicate freely with the sinuses of the brain, but also by forcing those anas-

tomoses, which exist between the transverse cervical veins at the lower part of the neck and shoulders, and the branches of the external and internal bifurcations of the jugulars, which descend from the integuments of the head, and from the upper and back part of the neck. And that those anastomoses are very free, is, I think, demonstrated by the observation, that the ligature of the common jugulars did not occasion congestion even of the integuments of the head and other parts above the ligature.

Not only have the carotid arteries and the jugular veins of dogs been secured and obstructed in separate experiments, without stupor and insensibility having been induced, as the ancients had supposed; but both carotids and both jugulars have been tied up in the same animal, without having occasioned the slightest disturbance of the circulation within the head, of which we have an example in the following experiment by the Baron Swieten: "In cane, cui ante octiduum abscideram nervos re- "currentes, ligavi utramque carotidem, nec potui "observare illum aliquid mali inde pati: inveni "enim hoc animal post alios octo dies elapsos vege- "tum et elacre; ligavi tunc venas jugulares sine "ullo observabili malo. Post quatuor dies inveni "canem sanum omnino. Examinans tunc ligatu- "ras carotidibus injectas inveni illas firmissime hæ- "rere, et thrombum valde densum et compactum "hærere inter ligaturam et cor. Aperto cranio in "cerebro nihil mutatum apparebat, imo cerebri vo-

"lumen potius auctum quam minutum appare-
"bat *."

As the common jugulars were, I presume, the only veins tied in this experiment, and as the arteries and veins were obstructed at successive periods of eight days, it seemed necessary to have it repeated. The common jugulars, therefore, were tied at the lower part of the neck; and immediately after the recurrent veins and carotid arteries were secured by ligature, from which the nerves were carefully excluded. For two days after this operation, the dog was dull and somewhat heavy, but afterwards recovered his spirits and activity. He was kept alive till the seventh day, when he was killed by the prussic acid. On dissection, the integuments of the head, and the contents of the cranium, seemed in a perfectly healthy and natural state; the veins of the pia mater were moderately distended, and the sinuses at the basis were well filled; there was no effusion. The veins and arteries which had been tied continued obstructed.

I know of no example in which both internal jugulars have been obliterated or obstructed in man; but there is a case related by Dr William Hunter, the consequence of which to the circulation within the head, must have been equivalent to the obstruction of both these veins. The case was one of aneurism of the aorta, in which the vena cava superior, and the common trunk of the left subclavian and jugular vein, were so much compressed by

* Commentaria in Aphorismos Boerhaavii, tom. i. 173.

the aneurismal tumor, as hardly to have any thing left of their natural capacity and appearance. The account of the appearances observed in the dissection of this case, is preceded by a very full history of the symptoms and sufferings of the unfortunate individual; but amongst these I do not find one of functional derangement of the brain *.

As to tumors and enlargements within the abdominal cavity interrupting or rendering difficult the passage of the blood through the aorta or cava,—the effects of these appear also more than doubtful when we know, that the channels of these large vessels have been entirely intercepted in cases where no symptom of disturbed circulation within the head had been observed.

Of the obliteration of the aorta within the thorax, I have already produced Dr Graham's case as an example; another instance of the same kind occurred to M. Paris of Paris; and a third is referred to by Sir Astley Cooper,—in none of which was plethora or congestion of the brain indicated by the symptoms.

In dogs, Sir Astley Cooper tied the abdominal aorta; and, without any dread of thereby forcing too much blood within the vessels of the brain, he afterwards, in a desperate case of aneurism, ventured to secure by ligature the same vessel within the abdomen of a man who survived the operation forty hours. The day after the operation, the patient complained of pain all over his body, more particu-

* Medical Observations and Inquiries, vol. i. p. 323.

larly in the head; and in the same report, it is observed, that the carotids beat with considerable force, but no symptoms of congested brain seem to have followed *.

The descending cava has frequently been found obstructed, and even altogether obliterated, within the cavity of the abdomen, by the pressure of tumors and other causes, of which we have examples recorded by Dr Baillie, Mr Wilson, Mr Cline, Mr Hodgson †, and others; but I do not find that any apoplectic disease has been remarked as a consequence of such obstruction. And yet, in the case of obstructed cava by Mr Wilson, the venous system of the brain must have been exposed to more than usual hazard of congestion; for, amongst other anastomosing channels through which the blood was forced to seek its course to the heart, were the veins coming from the sinuses of the dura mater in the theca vertebralis and the sinuses themselves, which, together with the veins entering them, it is observed by Mr Wilson, were much enlarged; and the communications between them and the sacral and lumbar veins were, he assures us, rendered very apparent by the blood contained in them.

I have thus passed in rapid review the most im-

* Surgical Essays by A. Cooper and B. Travers, Esq. London, 1818.

† Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge, vol. i. and iii.; and Hodgson's Diseases of Arteries and Veins,

portant of those circumstances, which, from the earliest era of medicine, have been presumed to have a powerful and undoubted tendency to force blood into, or to confine it within, the vessels of the brain, and so to produce a dangerous morbid congestion of that viscus,—circumstances which accordingly have very generally been enumerated by systematic physicians as the principal exciting causes of comatose diseases; and though I am aware of many objections,—though I know but too well the unlucky *pour* and *contre* which embarrass us in almost every subject of medical inquiry, I think a case has been fairly made out, proving that the agency of such causes has been greatly overrated;—that nature has guarded, with peculiar care, the brain and its vessels against such accidents from repletion and depletion, as they must otherwise have been constantly exposed to;—and that while the structure of this organ remains *healthy* and *unchanged*, and *its vessels sound*, those causes are little capable of occasioning plethora, congestion, effusions, or comatose diseases.

The real causes of apoplexy are changes which take place in the brain itself,—disorganisations and structural alterations of its own texture, and of its vessels and membranes. There are other points, however, connected with the pathology of the brain, and with the causes of the comata which still remain to be scrutinized, and especially the effects of those agents which have a direct and immediate influence on the cerebral functions, such as alcohol, the narcotic poisons, and cold; but the consideration of these is necessarily deferred to some future occasion.