XIII. *Observations on the Functions of the Brain.* By Sir Everard Home, *Bart. F. R. S.*

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THE various attempts which have been made to procure accurate information respecting the functions that belong to individual portions of the human brain, having been attended with very little success, it has occurred to me, that were anatomical surgeons to collect in one view all the appearances they had met with, in cases of injury to that organ, and the effects that such injuries produced upon its functions, a body of evidence might be formed, that would materially advance this highly important investigation.

For this purpose, I have brought together the following observations collected in the course of my professional pursuits, stating them, as so many experiments made upon the brain, with the conclusions which tend to elucidate this particular inquiry, referring to the notes, for fuller information.

The materials that can be furnished by an individual, are necessarily very small; they may however be sufficient to shew the advantages to be derived from this mode of investigation, and by that means connect still more closely the pursuits of anatomy with those of philosophy.

SECTION I.

The effects produced by an undue pressure of water upon the Brain.

Before I enter into the particular effects that take place when pressure is made upon the brain by means of water, it is necessary to mention that sudden pressure of any kind upon the cerebrum, takes away all sensibility, whether made upon the external surface through the medium of the dura mater,* or upon the internal parts through the medium of the ventricles, † and sensibility returns as soon as the unusual pressure is removed.

Faintness is the consequence of the pressure, to which the cerebrum has been accustomed, being suddenly taken off. ‡

I am induced to believe that pressure to a certain degree uniformly kept up, is necessary for the performance of the healthy functions of the cerebrum; and any increase or diminution of this pressure puts a stop to them. It is asserted, that in addition to this pressure, the pulsatory motion of the blood in the arteries of the cerebrum is also necessary; but the late JOHN HUNTER, whose accuracy in a point of this kind is not to be doubted, retained his senses although the heart had apparently ceased to act. §

* After the operation for the trepan, before the skull at that part is ossified, pressure upon the brain with the finger produces insensibility.

† This I have seen in cases of spina bifida, by pressing upon the tumour in the back, and forcing the water up into the ventricles.

‡ The removal of a coagulum of blood, half an inch thick, between the skull and dura mater, made the pulse nearly stop, but as soon as he recovered from this faint state, the person was perfectly well.

§ Vide Life of John Hunter prefixed to his work on the Blood, Inflammation, and Gun-shot Wounds. The account is transcribed from his own notes.

Although insensibility is the common effect of undue pressure upon the cerebrum, it appears from what will be stated, that it is not a necessary consequence of undue pressure upon the cerebellum.

The facts which have been stated appear to point out the use of the water in the ventricles of the brain, and they account for the great variety which is met with in the form and extent of the posterior cornua of the lateral ventricles, their size varying according to the quantity of water which is necessary to keep up the pressure required.

The size of the ventricles would appear to be very immaterial, since even when they are increased so as to contain above six ale pints, the functions of the brain are all carried on, and the growth of the body proceeds; but after the skull is completely ossified, an increase of two or three ounces produces insensibility.

That the ventricles should admit of being increased to so great an extent, without any of the senses or faculties of the brain being destroyed, is in itself a curious fact, and of so much importance with respect to the physiology of the brain, that I shall detail the two following cases, which illustrate one another.

In the one, the accumulation of water proceeded, as it will appear, as far as it could go without materially impairing the organ; it then stopt, and the boy grew up, with all his faculties: in the other the water continued to increase, the substance of the cerebrum was absorbed, and the faculties of the brain were destroyed.

A boy at a month old had so rapid an increase of the size of his head, as to evince an accumulation of water in the brain; and when he was five years old, the head was so large that the

parents, judging from recollection, believe that it never after increased. It was so transparent, that when exposed to the sun the rays passed through it as they would through a horn lantern. He was unable to walk. At this age, he caught the natural small-pox, which was so violent as nearly to prove fatal. Upon his recovery, the head shewed no disposition to increase, and the child in all respects began to improve, and for the first time learnt to walk. At fourteen, the skull appeared completely ossified. At nineteen years, the time I saw him, he was five feet six inches high; his head measured in circumference $33\frac{1}{2}$ inches. He had grown in the course of the last year about two inches, which is more than he had usually done in any one year.

All the organs of sense are entire; savoury food is agreeable to his taste, but he is moderate in eating. His sight is good, but looking with attention at objects more than half an hour, appears to strain his eyes. His head is so heavy, that the muscles of the neck are unable to support it for many hours together: when he lies down, the head is supported by another person.

He sleeps with most ease on the right side, and the left side of the head appears to the eye to be rather the largest. In lying down, there is, what he describes to be, a momentary thrilling heat felt on the upper part of the brain, in the line of the longitudinal sinus. Lying on his back strains his eyes so much, that he cannot continue in that posture; stooping forwards brings an oppression upon his eyes. The least weight in his hand, as a tea cup, makes it tremble: all sudden noises jar his head, and produce giddiness. When he falls down, the jar renders him insensible; at one time this was the case for fifteen minutes, without being attended with any bad consequences.

His head aches when exposed to heat. He has had no illness since the small-pox. His sleep is easily broken: he never dreams. He is fond of reading and writing; has a taste for poetry, and can repeat verses out of COWPER. His memory of common things is very good. He never expressed any attachment or passion for women. He is of a mild disposition; but when irritated, his whole frame is in a state of agitation, which, however, soon goes off.

In another boy, the enlargement of the head was perceived at three months, and increased for three years; and then appeared to be stationary, and the child till that period was sensible. The upper part of the skull from that time began to ossify, and in three years more there was only an irregular space at the fontanelle, and a small space between the two portions of the os frontis remaining open. The child continued sensible till three years old, and then became gradually less so, did not know what it did; heard sounds, but could not see. At six years old he died.

The child was three feet three inches high, the skull twenty seven inches round; the water contained in the two lateral, and third ventricles was six ale pints and a half in quantity. The cerebrum formed a thin case of medullary substance surrounding this cavity. The cerebellum was entire.*

* The lining of the lateral ventricles was tough; the septum lucidum elongated so that the corpus callosum was raised up close to the skull, the falx of the dura mater being nearly obliterated. The water in the third ventricle had split the fornix and septum lucidum into two, and the thin membranes of the septum had holes in them, making a communication between the third and lateral ventricles. The substance of the brain surrounding those cavities, as well as the pia mater covering it, had no convolutions; there was one continued smooth surface. On the right side, upon which the child was usually laid, there were no remains of medullary or

	lb.	oz.	dr.
The weight of the whole brain was - -	2	3	1
The weight of the whole brain of a child between six and seven years - - -	2	12	0

The preceding facts explain satisfactorily that the cerebrum is made up of thin convolutions of medullary and cortical substance surrounding the two lateral ventricles; which are unfolded when the cavities of those ventricles are enlarged, and in this unfolded state the functions belonging to this part of the organ can be carried on.

Although the quantity of water may be so much increased without material injury to the functions of the brain when the skull is not ossified, yet after that period even a few ounces in the lateral ventricles has been known to produce so much undue pressure, as to bring on head-ache, general uneasiness, a sensation as if the head were too large, loss of spirits, convulsions, loss of memory of recent events, idiotism, insensibility, and death.*

cortical substance, and there the pia mater, and dura mater adhered together. There was no remaining brain between the third ventricle and sella turcica. On the left side of the left hemisphere the medullary and cortical substance was only half an inch thick. The corpora striata, and thalami nervorum opticorum were small and tough: the union between the thalami was elongated into a broad flat ligament. The two commissures, and iter ad infundibulum had the natural appearance. The pituitary gland had become flattened. The fourth ventricle, tuberculum annulare, and cerebellum, had nearly the natural appearance. The olfactory nerves were tough and small; the optic nerves had no medullary pulp; the other nerves going out of the skull had undergone no change.

* One ounce and half of water in the lateral ventricles, at $4\frac{1}{2}$ years old, were accompanied by pain in the head, and great general irritability. Five ounces at 7 years by insensibility for 14 days before death. Two ounces and one half at 9 years by violent head-aches, an unwillingness to be moved, and stupor. Three ounces at 11 years were attended with loss of recollection of recent events. This began at the

When the water, instead of being contained in the general cavities of the lateral ventricles, is principally confined to their posterior and anterior cornua, the effects sometimes are occasional constipation, pain in the bowels, and lower part of the belly.* When accumulated in the third ventricle without any increase in the lateral ones, distressing pain in the head, loss of speech, and insensibility have occurred.† When accumulated in the ventricles of the brain, and also under the tuberculum annulare, painful sensations in the stomach, bowels, lower belly, and across the legs have been met with.‡ When not only in the ventricles, but between the tunica arachnoides and pia mater over the hemispheres, and also upon the tubercula quadrigemina, the apparent consequences in one

age of 10. A stupor of 12 days preceded death. Four ounces at 11 years were followed by the sensation of the head being too big, loss of speech, insensibility, convulsions. Eight ounces at 74 years were accompanied by a state of idiotism for ten days, and then death.

* Five ounces of water contained principally in four small cells, two in the anterior and two in the posterior cornua of the lateral ventricles, at 6 years of age, were the only evident cause of pain in the lower part of the belly, occasional constipation, and violent pain in the bowels.

† Two ounces of water in the third ventricle, enlarged by the layers of the septum lucidum being separated, at 30 years of age, appeared to produce distressing pain in the head, loss of speech, and insensibility. Two drams of water in the third ventricle of an aged dog, were attended for four years by fits like apoplexy, pain in the head only relieved by opium, convulsions, and death.

‡ Two ounces of water in the lateral ventricles, 1½ ounce under the tuberculum annulare between the tunica arachnoides and pia mater, at 5 years of age, were followed by painful sensations in the lower belly, stomach, and bowels.

Two ounces of water in the ventricles one under the tuberculum annulare, at three years appeared to produce not only painful sensations in the lower belly, stomach, and bowels, but pain in the head and pain across the legs, as if they were cut with an instrument.

case were depression of spirits, pain in the back of the head, and mania.* When in the ventricles, and also between the tunica arachnoides and pia mater, and between the dura and pia mater, melancholy, imbecility, apoplexy, and paralysis of one side, have been the accompanying symptoms.† When in the ventricles, where there has been an unusual vascularity of the dura mater, violent affections of the præcordia have occurred in the night during sleep, which have led to suicide.‡ When between the dura and pia mater in considerable quantity, a state of melancholy and imbecility of mind has been met with. §

* Water in the third ventricle in sufficient quantity to separate and keep apart the thalami nervorum opticorum, also between the tunica arachnoides and pia mater, over the hemispheres, and under the tubercula quadrigemina, in an adult, were attended by pain in the back of the head, low spirits, and after drinking wine, very high spirits. This ended in mania, and, after three months, in death.

† Two ounces in the lateral ventricles, one between the dura and pia mater; the space between the tunica arachnoides and pia mater loaded with it, the consequences of attacks of inflammation upon the coverings of the brain in an adult were attended by these symptoms. The paralysis took place after the last apoplectic fit, and death ensued.

‡ Two ounces in the lateral ventricles and a very unusually vascular state of the dura mater in an adult was followed by these effects.

§ A gentleman fell from a horse. From that time he had head-aches, gradually became melancholy and imbecile. He lived three years in that state. Four ounces of water were found between the dura and pia mater, on the right side. There was an exostosis $\frac{1}{8}$th of an inch long from the parietal bone with a sharp point, in contact with that part of the dura mater under which the water lay. There were four ounces in the lateral ventricles, the posterior cornua were very small, there were also three ounces on the basis of the skull.

SECTION II.

The effects produced by concussion of the Brain.

Concussion of the brain produces delirium and coma; these symptoms go off, they sometimes in a few days return and prove fatal.*

In the torpid state commonly attendant upon any violent shake being given to the brain, the senses are so much impaired that little information can be gained respecting the effects produced upon the internal organs. The bowels have been found under such circumstances to be acted on by aperient medicines with great difficulty.†

SECTION III.

The effects produced when the blood vessels of the Brain are preternaturally dilated or diseased.

Sudden dilatation of the blood-vessels of the cerebrum, in consequence of exposure to the sun, is sometimes accompanied by delirium; loss of speech and the power of swallowing.‡

A dilated state of the veins of the cerebrum has been attended

* This happened in two cases, and no appearances of alteration of structure in the brain were met with after death.

† A gentleman fell from his horse, and had a concussion of the brain. While in that state it required 60 grains of jalap and 20 of calomel to procure one evacuation from the bowels.

‡ In a case of coup de soleil in the West Indies these symptoms were produced, and the person died in two hours. The brain was examined four hours after death. The scalp felt hot, was loaded with blood; the cerebrum was hot to the feel; and a general distention of the blood vessels of the pia mater was the only unusual appearance, except that the substance of the cerebrum was unusually soft.

with head-aches, which are very severe when the body is placed in a horizontal posture.*

When the smaller arteries of the cerebrum are preternaturally enlarged while those of the cerebellum are not, delirium has taken place, followed by a fit resembling apoplexy, and a paralytic affection of one side.†

An obstruction to the passage of the blood through the right internal carotid artery was attended by a succession of slight apoplectic fits, unaccompanied by any paralytic affection.‡

An aneurismal enlargement of both the internal carotid arteries to the size of marbles projecting into the cavernous sinuses, was the only apparent cause of attacks of mania, with consciousness of being insane.§

* In the case of a young lady who had suffered severely from head-aches, which were so violent at night when she lay without a pillow as to produce occasional delirium, after death the veins in the medullary and cortical substance of the brain were found considerably enlarged.

† A man 60 years of age had from anxiety an apoplectic fit which lasted some hours, leaving a paralytic affection. In seven days, under a course of electricity, he recovered the use of the paralytic limbs. In four months, while under very great anxiety of mind, he became delirious, and one side became paralytic, in which state he died. There were no other appearances than those mentioned.

‡ An officer had a succession of apoplectic fits at intervals of one, two, and three months; the first of six days continuance, the second a few hours, the third and fourth shorter; the last terminated in death. On examining the brain, the right internal carotid artery was filled with a solid coagulum of blood which extended some way into the smaller branches.

§ A lady who had unequal spirits, and occasionally double vision, had an attack of giddiness and mania; the eyes were red, the hands benumbed, and death ensued. On examining the brain, the aneurisms were discovered; and the optic nerves were found wasted.

SECTION IV.

The effects produced by extravasated blood.

Blood in the lateral and third ventricles was attended by repeated fits of vomiting and coma.* In the fourth ventricle, a fit which in twenty four hours terminated in death; † under the anterior lobes of the brain by hiccoughs and stupor; ‡ under the cerebellum, by convulsions of the neck and body, with drawing up of the feet without stupor; § in the folds of the pia mater covering one hemisphere, by a paralytic affection of the opposite side, without any other symptom. ||

Blood in the folds of the pia mater over the posterior lobes of the brain, and serum in the cornua of both the lateral ventricles were attended by giddiness, paralysis, straight objects appearing crooked, loss of memory, and at last idiotism.¶ In the right thalamus nervi optici, extending into the lateral ventricles, by paralysis of the left side of the body, both eye-lids closed, the mouth drawn on one side, a perception of light

* A coagulum of blood, the size of a common leech, lying upon the plexus choroides of each lateral ventricle, and two ounces of serum were found in a person who had the symptoms stated.

† Half an ounce of blood was found in the fourth ventricle.

‡ Three ounces of coagulated blood were found upon the basis of the skull, under the anterior lobes.

§ Blood was found coagulated under the cerebellum.

|| The extravasation was in small quantity.

¶ A person 69 years old had a paralytic stroke, from which he recovered; but had giddiness, and straight lines appeared crooked. He had a second, which terminated in idiotism which lasted a year and a half; he then died. It appeared that there had been two distinct extravasations of blood in the pia mater, which had communicated with the cornua of the lateral ventricles, in which were deposited six ounces of serum.

with the right eye, but not with the left, succeeded by coma.* Between the dura mater and skull covering the right hemisphere, by stupor which went off on its removal; but taking off the pressure produced faintness for a few minutes.†

Coagulable lymph spread over the union of the optic nerves, the pineal gland, and tuberculum annulare, was followed by permanent contraction of the muscles between the occiput and vertebræ of the neck, dilatation of the pupils, and a great degree of deafness.‡ Serum under the cerebellum by restlessness, convulsions, incessant talking, at times incoherent, and the eyes became insensible to light §

SECTION V

The Effects produced by the formation of Pus.

Pus in the cornu of the right lateral ventricle was accompanied with delirium and convulsions. Under the tuberculum annulare by vomiting and delirium. Under the dura mater covering the right hemisphere, by delirium succeeded by coma. Under the left parietal bone, by watchfulness, sickness, irregular pulse, clammy sweats, talking incessantly. These effects went off on its removal: the quantity a tea spoonful.

* An ounce of blood was found in the substance of the right thalamus nervi optici extending into the right lateral ventricle; the left lateral ventricle was filled with bloody serum.

† The coagulum was about half an inch thick.

‡ There was a layer of coagulable lymph, extending over the sella turcica to the parts mentioned.

§ The quantity was two ounces.

SECTION VI.

The effects produced by depression, and thickening of different portions of the Skull.

Unusual pressure of the skull upon the middle lobe of the brain, was attended with pain in the stomach, torpor of the bowels, nausea, retching, pain between the shoulders, and in the feet.* On the upper part of the hemisphere, want of sleep, head-ache, and stupor. Those effects went off upon its removal.† On both of the anterior lobes of the brain, heaviness, loss of memory, depression of spirits, bordering on idiotism.‡ On the anterior lobes of the brain, accompanied with water between the tunica arachnoides and pia mater covering the superior part of the hemispheres, an apoplectic fit, heaviness, loss of memory, and a second apoplectic fit, which terminated in death.§ On the lower and lateral part of the left posterior lobe of the brain, uneasiness in the skin of the left cheek, extending along the chin, throat, and trachea, hissing noise in the ears, inability to speak the words

* The pressure was continued by a bony tumour in the form of a hemisphere, half an inch in thickness; the broad surface attached to the parietal bone.

† A depression of the under table of the left parietal bone close to the sagittal suture not more than an inch in length, and depressed for about one eighth of an inch.

‡ The frontal bone was increased in thickness to a considerable degree. The person had been many years resident in India.

§ There was a thickening of the os frontis, with small exostoses the size of peas upon its inner surface. The anterior lobe cerebri had a flattened appearance, and the tunica arachnoides was loaded with water.

the person wished to articulate, using others in their place, although conscious of doing so, and unable to correct it. Numbness in the arms and legs. These effects ceased on taking off the pressure.* On the anterior lobes of the brain, both anteriorly and laterally, with thickening of the pia mater, spasms in the lower extremities, and total loss of memory, so that the person did not know what he had done a few hours before: although in other respects in health.† On the lower and lateral portions of the anterior and middle lobes of the brain, head-aches, general wasting, irregularity in the action of the bowels; the feel of inability to swallow, and great distress in the act of swallowing, with great general irritability.‡

* A gentleman fractured his skull, and remained fifteen minutes insensible; became sensible but could not speak for seven days: for twenty eight days could not speak distinctly, and used one word for another. In six weeks he was considered well with a depression of the lower posterior part of the left parietal bone, two and a half inches long, one and a half broad, and three quarters deep, which was removed at the end of three years, the increase of symptoms making it necessary; they all went off.

† The frontal bone and the parietal ones were one third of an inch thick. There was an ossification in the falx of the dura mater near the crista galli, one inch and a half long, three quarters broad; another near the tentorium three quarters of an inch long, half an inch broad, and three quarters thick. The tunica arachnoides and pia mater thicker than the dura mater. The processes of the pia mater firm; the smaller arteries in the medullary substance carried red blood. Two ounces of water in the ventricles. The person had been thirty-five years in India.

‡ On the basis of the skull were numerous small exostoses, particularly from the lower portion of the parietal bones, some longer than others and sharp at the point; the longest, one third of an inch.

SECTION VII.

The effects of pressure from Tumours.

An hydatid imbedded in the substance of the right hemisphere of the brain, was attended with violent head-aches, and occasional fits similar to those of apoplexy.*

A tumour in the substance of the posterior lobe of the brain, was attended with derangement of the functions of the stomach and bowels, double vision, and afterwards loss of sight.† A tumour pressing on the left hemisphere; settled melancholy, drowsiness after dinner, requiring being carried into the air, which took it off, but it returned on coming back to the table.‡ A tumour in the fourth ventricle, epileptic fits, soreness in the throat, and great pain in the act of deglutition.§ A tumour in the tuberculum annulare and water in the ventricles, pain in the head, stumbling in walking, the mouth drawn on one side, loss of sight of one eye, although the pupils were not affected; dullness in hearing, difficulty of swallowing, so as to die starved, with all the mental faculties entire.‖

* It was the size of an orange, had firm coats in which was contained a limpid fluid in the quantity of four ounces. The sides of the lateral ventricles were closely pressed together.

† The tumour was of the steatomatous kind just above the tentorium, of the size of a turkey's egg, so as to raise up the posterior part of the lateral ventricle. The complaint, till just before death, was mistaken for worms.

‡ The tumour was of a soft nature, the size of a filbert, attached to the left side of the falx of the dura mater, a little above the tentorium, pressing upon the left hemisphere of the brain.

§ The tumour was of a soft steatomatous structure, the size of a walnut, but adapted in its shape to the form of the ventricle.

‖ The tumour was of the size of a walnut, composed of a suety matter, four ounces of water were found in the ventricles, and the tunica arachnoides was unusually dry.

SECTION VIII.

Effects of injury to the substance of the Brain.

A deep wound into the right anterior lobe of the brain, attended with inflammation and suppuration, produced no sensation whatever; the senses remained entire, and the person did not know that the head was injured.*

The brain shooting out in the form of fungus, after the dura mater is wounded, has no effect upon any of the nerves, nor is it attended with sensation;† but the inflamed pia mater gives great pain.

Loss of a portion of the medullary substance of the anterior lobe of the cerebrum, produced no symptoms.‡ Loss of a portion of one of the hemispheres was attended with difficulty of swallowing for twenty-four hours, and slight delirium of short duration.§ Ulceration of the anterior lobe of the brain, as low as the anterior cornu of the lateral ventricle, but not communicating with it, paralysis of both arms.‖

* From an explosion of gun-powder, a piece of copper three inches long was forced through the eye into the brain; but the arm being also wounded, the person never knew the eye to be injured. When suppuration came on he became insensible, and in a few hours died.

† A fungus from the brain shot out through the dura mater after the operation of the trepan, upon the left parietal bone. The pia mater surrounding it was so sensible, that when touched, the pain was excruciating.

‡ A boy five years of age, fractured his skull, and wounded the brain, half an ounce came away. When he grew up he was more acute, and had a better memory than his brother.

§ A fracture of the parietal bone, and wound of the dura mater, produced the injury to the brain.

‖ The ulceration took place in consequence of the trepan wounding the dura and pia mater.

In a case of a penetrating wound into the right hemisphere of the brain with bone forced into its substance, while there was an opening for the discharge of matter, no effects were produced, except when the circulation was much increased, and then only head-ache and numbness in the left side.*

SECTION IX.

Effects of alteration of structure in the Brain.

In a case in which the tuberculum annulare had undergone a change in its texture, and become so hard as with difficulty to be cut with a knife, a considerable quantity of earthy particles being intermixed with the medullary substance of the crura, and other parts of the cerebellum, and the cerebrum and upper part of the cerebellum unusually soft; the effects were, the boy had been an idiot from his birth, never walked, spoke, or understood what was said. Went often three days without food. At sixteen, when he died, was no bigger than a child three years old, except the head, which was as large as it is usually at twelve.†

SECTION. X.

Effects of injury to the Medulla Spinalis.

Pressure upon the medulla spinalis in the neck by coagulated blood produced paralytic affections of the arms and legs, all

* A musket-ball fractured and depressed a portion of the superior and posterior part of the parietal bone, but did not penetrate: an abscess formed in the substance of the brain in which the broken portions of bone were lodged. In this state the person was capable of doing his duty as a naval officer from China to England, but died in consequence of an attempt to extract the depressed bone.

† The cranium was not completely ossified, the fontanelle being still of a large size. This case was examined by Mr. Brodie.

the functions of the internal organs were carried on for thirty-five days, but the urine and stools passed involuntarily.*

Blood extravasated in the central part of the medulla in the neck, was attended with paralytic affection of the legs, but not of the arms.†

In a case where the substance of the medulla was lacerated in the neck, there was paralysis in all the parts below the laceration; the lining of the œsophagus was so sensible, that solids could not be swallowed, on account of the pain they occasioned.‡

Where the medulla in the back was completely divided, there was momentary loss of sight, loss of memory for fifteen minutes, and permanent insensibility in all the lower parts of the body. The skin above the division of the spinal marrow perspired, that below did not. The wounded spinal marrow appeared to be extremely sensible.§

* A coagulum of blood, the thickness of a crown piece, was found lying upon the external surface of the dura-matral covering of the medulla spinalis, extending from the fourth vertebra colli, to the second vertebra dorsi. The medulla spinalis itself was uninjured.

† The sixth and seventh vertebræ colli were dislocated; the medulla spinalis externally was uninjured; but in the centre of its substance, just at that part, there was a coagulum of blood nearly two inches in length.

‡ The seventh vertebra colli was fractured, and the medulla spinalis passing through it, was lacerated and compressed.

§ The spinal marrow within the canal of the sixth vertebra dorsi was completely destroyed by a musket ball. The person lived four days.