DESCRIPTION
OF THE
SPINAL CORD IN A CASE OF
TRAUMATIC TETANUS.

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IN a case of traumatic tetanus which recently proved fatal in St. George's Hospital, the spinal cord presented some striking pathological changes which may interest the Society, more especially as Mr. Lockhart Clarke has in a recent paper ('Medico-Chirurgical Transactions,' vol. 48) drawn attention to alterations of the same nature in several similar instances.

A carman, 25 years of age, was admitted, under the care of Mr. Holmes, on the 14th of last January, with a wound which had been recently inflicted by an iron spike through the palm of the left hand. Both orifices of the wound presented a jagged outline. The metacarpal bones had escaped injury. The wound was dressed with carbolic acid paste, and the patient, who was able to walk about and eat well, went on favorably until the morning of the 22nd. At 4 a.m. on that day he was disturbed by a feeling of pain and stiffness about

the jaws. By 11 he was in a state of decided opisthotonos. The head was thrown back, he was scarcely able to open his mouth; the muscles of the neck, spinal region, and abdomen, were rigid; and he complained of pain down the back. Tetanic spasms now occurred with great frequency, having scarcely any interval between them; and at 10.30 in the evening he died, eighteen and a half hours after the appearance of the first tetanic symptoms. The treatment consisted of the subcutaneous injection of morphia and atropia.

The foregoing history was obtained from notes taken by Mr. Leigh, the surgical registrar.

The post-mortem examination was made by Mr. Pick, who supplied the following details excepting those which relate to the cord and nerves, which are from my own observation.

The examination took place thirty-five hours after death; the weather was cold, and there were no signs of putrefaction about the body.

The wound was in a sloughing condition. It had severed one of the branches of the median nerve. The divided nerve had a pink tinge near the injury, but when subsequently the nerve was examined in section by the same process as was used for the cord no departure from the natural state was detected.

The lungs were congested and friable. The heart was empty, both ventricles being closely contracted. The valves and muscular structure were natural. The liver was congested, but not otherwise altered. The spleen was natural. The kidneys were somewhat rough on their surfaces, their capsules were adherent, and their cortical portions slightly shrunk.

The spinal dura mater was remarkably injected, as also was the pia mater, the cord being covered along its whole length with a network of conspicuous red vessels.

The cord was, in three places, altered in a striking manner in its external configuration. On the right side of the cervical enlargement was an oval swelling about the size and shape of a split bean, which lay between the roots of the nerves, pushing the anterior roots a little forward, the posterior a little back. This protuberance measured about a third of an

inch in the vertical direction, rather less from before backwards, while the eighth of an inch was about the extent of its lateral projection. In colour and external appearance the swelling did not differ from the neighbouring surface.

Opposite the first lumbar vertebra a more extensive change of the same kind was found. The cord was here expanded on its posterior aspect into a flat swelling which nearly doubled its natural width and was obvious by the distension it occasioned, before the dura mater was laid open. The swelling was about an inch in length. It was confined to the posterior aspect of the cord, of which both sides were involved, the left more than the right. The surface of the swelling was somewhat lobulated. In colour it resembled the adjoining part of the cord, excepting that the injected vessels upon it were more closely placed, and that there were many specks of extravasated blood showing through the pia mater.

About half way between this tumefaction and the lower end of the cord was a smaller circumscribed prominence of the same nature, which lay likewise on the posterior aspect of the cord. It was hemispherical, of about the size of half a large pea, and lay close to one of the left posterior roots, between it and the median fissure.

The cord was now subjected to microscopic examination in order to ascertain the minute changes which had led to these remarkable alterations of shape. Various portions were examined in their fresh state and in glycerine, while sections were made at intervals by the method introduced by Mr. Lockhart Clarke.

This method of preparation, better adapted than any other to show minute changes of structure while maintaining the continuity of the tissues, involves soaking in a solution of chromic acid, which not only hardens the nervous matter, but solidifies the contents of the blood-vessels as well as any serous or albuminous effusions which may occur. It was, therefore, easy to note any excess of blood in the tissue, and also to detect fluid exudations which under other circumstances might have escaped notice.

The changes about to be detailed are, firstly, a remarkable

injection of the blood-vessels in certain parts of the cord, by which they became replete to distension with their natural contents, while in a few situations blood-corpuscles had escaped from their proper channels and diffused themselves among the nervous elements. Secondly, a structureless transparent material had been poured out in the immediate vicinity of the vessels, not only into such vacant spaces as exist in the fissures of the cord, but forcibly intruded into many parts of the solid structure, tearing up the tissue and displacing the neighbouring parts. Beside these changes, which affected both the white and grey matter, the white columns presented circumscribed alterations, which, in conjunction with the effusion described, caused the swellings which were so conspicuous on the surface of the cord. The changes indicated may now be described more particularly, taking the cord in position from above downwards. It may be stated that the medulla oblongata, which to the naked eye appeared natural, was not preserved for examination.

In the uppermost part of the cervical region many of the blood-vessels were distended to two or three times their proper width, and formed conspicuous objects. This was the case in the anterior fissure and throughout the whole grey matter. The left posterior horn was more injected than any other part, and in this situation there were several spots where blood-corpuscles had escaped from a vessel and spread themselves in its vicinity. Between the more injected posterior horn and the central fissure was a point where the pia mater had given way, forming a small opening through which the nerve-fibres streamed out in a centrifugal direction, forming a small hernial protrusion evident enough under the microscope, though barely visible to the naked eye.

On reaching the cervical enlargement, which was the seat of the external swelling first mentioned, the same distension of the blood-vessels continued, with the addition of a remarkable mass of smooth homogeneous matter in the central part of the right grey crescent. This new formation lay in a torn cavity in the midst of the grey matter, and had displaced its lateral portion outwards in such a manner as to

cause the superficial projection which has been described. The intruded material measured about one eighth of an inch from before backwards, and reached more than twice as far vertically. It consisted of a perfectly structureless and translucent substance, which took a brilliant pink tint, with carmine, distinguishing it from the nerve-matter around it. It was irregular in shape, filling a rent which had several cracks reaching from its corners towards the front, back, and lateral boundary of the grey matter. The lateral portion of the grey matter was pushed outwards, and the central fissure was bent into a curve, with its concavity towards the left side.

At the outer edge of the rent was a small extravasation of blood, which had imparted a rusty stain to the adjoining part of the cord.

Beside the large mass of new material in the right horn, were two or three much smaller patches scattered mostly in the left grey matter in or near the commissure. The exudations generally lay on the outside of a blood-vessel, the tissues of the cord being torn to a greater or less extent, as if fluid had been forcibly impelled into it.

The patches of new material generally imbedded, particularly at their edges, a few globules, threads, or finely granular matter, the *débris* of nerve-structure, while the adjacent tissue often had a frayed look, nerve-fibres hanging with loose ends, as if they had been partially dissolved or corroded by the effusion.

(Plate XII, fig. 1, represents a section through the middle of the swelling described, and shows the exudation in the right side, and consequent distortion of the cord.)

In the lower part of the cervical enlargement the cord again became symmetrical, owing to the absence of the larger mass of adventitious material, though many smaller patches were scattered through the grey matter and fissures.

The state of blood-vessels which has been described in the upper part of the cervical region continued here, and persisted throughout the whole of the cord, the structure

being traversed by swollen and replete vessels, the grey matter being more injected than the white, and the left posterior horn more than any other part. Vessels distended in the same manner also existed generally, in both anterior and posterior fissures.

In the lower part of the cervical region the vessels in the anterior and posterior fissures were in places surrounded by the exudation, which was in some situations sufficiently abundant to fill the entire space between the vessel and the walls of the fissure, and even to encroach here and there upon the nervous matter, which had been disintegrated and frayed out at the point of contact. (See Plate XII, fig. 2.)

Exudation in fissure of the cord in connection with a blood-vessel.

This is given to show the exact position of the portion which is shown enlarged on Plate XII, fig. 2.

Quite at the lower part of the cervical enlargement was a hernial protrusion, in contact with the left posterior horn, a

mass of nerve-tubes streaming out centrifugally through a rent in the pia mater, forming a small abrupt swelling of about an eighth of an inch prominence, immediately in front of the emergence of the nerve.

From the lower end of the cervical enlargement to the beginning of the lumbar the changes were less conspicuous. The blood-vessels were in many places surrounded by such material as has been described, more or less intermixed with broken nerve-tubes. The central part of the dorsal region had undergone most alteration, being irregularly traversed by small fissures, which contained the intruded material.

In the lumbar enlargement the cord presented alterations of such extent as to cause the large external swelling which has been described. On making sections through the swollen part, it was found that both the grey matter and the white had contributed to produce the change of shape.

In the right crescent was a large mass of exudation, such as has been described in the cervical region, while in the left was a smaller blotch of extravasated blood. Each of these intruded materials lay in a torn cavity in the middle and posterior part of the grey matter.

The exudation in the right horn was uniform, translucent, and abruptly circumscribed, like that in the cervical region, which it closely resembled. On the left side the tearing of the cord was extensive and irregular, a rent nearly an eighth of an inch long traversing the grey matter from before backwards. This laceration contained extravasated blood, and blood-corpuscles were also diffused into the surrounding tissue, and blended with the white matter. A large distended vessel, in which, however, no rupture could be detected, lay in the torn cavity described. Beside the extravasated blood, a minute quantity of translucent exudation was here seen.

By the exudation on one side and the extravasation on the other the hinder extremities of the grey matter were displaced, so as to contribute largely to the external swelling. There was, however, a coincident change in the white matter, in the posterior and lateral columns. These, more particularly the left lateral column, were increased in bulk by a

swelling in the nerve-fibres composing them, the outer portions of which were thicker than was the case elsewhere. Beside this, the fibres were separated from each other by an opaque granular material. In one place also, close to the tip of the left posterior horn, was a considerable mass of finely granular substance, which existed to the exclusion of nerve-tubes, and took a pink colour with carmine. One or two smaller patches of the same nature were found in other parts of the posterior columns.

The changes described became less extensive towards the upper and lower limits of the tumefaction, where the cord resumed its natural size; nothing further was noticed than the distension of the vessels which has been so often referred to. The same statement applies to the rest of the cord, with the exception of the small space where the hemispherical protuberance which has been described lay upon the surface of the left posterior column.

This occurred close to the emergence of one of the posterior roots. The drawing (Plate XIII, figs. 1 and 2) represents the state of the cord opposite to the middle of the swelling. The cord is here distorted, the central fissure bent, the grey matter rendered unsymmetrical by an elongation of the left posterior horn, while the corresponding posterior column is swollen so as to elevate the surface and cause the prominence described. The immediate cause of the swelling appeared to be a large exudation of the same translucent, structureless, carmine-absorbing material which has been described in other parts of the cord. This effusion, distinguished in the drawing by its pink colour, lay as a large irregular mass in the centre of the tumefaction, where it existed for a considerable space unmixed with any organized structure. Beside this large pool of exudation, which was visible to the naked eye, were several small patches of the same substance, some of which imbedded globules of disintegrated nerve-fibre; and a similar exudation was also intimately diffused among the nerve-fibres, between which it had insinuated itself. A narrow stream of the same material filled the posterior fissures and imbedded broken-down remains of the nervous

elements. A similar effusion was intimately spread among the fibres of the posterior horn, and a considerable mass of the same nature lay on the outside of the cord, close to the attachment of the posterior root.

Where the nerve-tubes came in contact with the exudation they were mostly changed, as in other parts of the cord, as if by partial solution. In some parts of the swelling they had lost the distinction, ordinarily so clear, between the outer white matter and the axis-cylinder, while there were places where the tubular character of the tissue had almost disappeared, being replaced by a nearly uniform surface, showing but the faintest trace of the original structure.

Below the lowest tumefaction no morbid changes were detected, save the distension of the blood-vessels.

Without presuming that we have found the first disturbance of the nervous system which leads to the development of tetanus, we have recognised very definite lesions which are associated with it. The changes observed in this instance were probably of very unusual extent, since the swellings upon the cord were too conspicuous to have remained unseen, were they frequent in such cases.

The microscopic appearances are very suggestive. The blood-vessels appear to be, if not the first, at least an early seat of change. Distended with blood, not only to the uttermost of their natural capacity, but dilated to many times their proper width, and crammed with blood-corpuscles so as to look like solid cylinders, their condition gave evidence of an altogether abnormal relation between the pressure of the blood and the resistance of the walls. Either blood had been propelled into them with supernatural force, or, what is more likely, the tension of their coats had been lessened by a change in their innervation. The overcharge of the vessels led to the escape of their contents. In some places blood-corpuscles were extruded. More often only the fluid portions of the blood traversed the wall, to appear as the translucent structureless material which played so prominent a part in the destruction of the cord. That this translucent material was an

exudation from the vessels, and not a product of disintegration of tissue, is evident from the following facts. It constantly lay in contact with the vessels, and often surrounded them. It held the most changeable relations to the nervous matter, lying in the grey matter, in the white, abundantly in the fissures, and occasionally outside the cord altogether. It was the source of increase of bulk, of laceration, and of displacement, such as to suggest that it was an addition to the structure, and had been forcibly driven into it.

At the same time a certain amount of disintegration of the nervous elements had taken place, where the exudation came into contact with them, such as might result if, as suggested by Mr. Lockhart Clarke, the exudation had a solvent action upon the tissue.

It is probable that the tendency to disintegration in the nervous matter may have been enhanced by the unnatural state of the blood-vessels, and the consequent imperfect nutrition of the cord.

There are certain points of interest connected with the situation of the various lesions. The irritation from the left hand, conveyed, as we must suppose, by certain of the left posterior roots, occasioned especial congestion of the left posterior horn, and further changes in the white matter in contact with it—that is, in the left posterior and lateral columns. The central and anterior parts of the grey matter were most extensively affected on the side opposite to that of the injury, as might have been anticipated from the decussation in the cord of the sensory fibres. The irritation, having reached any column or segment of the cord, appeared to diffuse itself throughout its whole length with undiminished intensity. Although the cervical region must have been the first recipient of the morbid influence, the lumbar part of the cord, both in the white and grey matter, was at least as severely affected.

POSTSCRIPT.—It may be well to state that the distension and repletion of the blood-vessels throughout the cord involved both arteries and veins, and, in a less degree, the capillaries.

The arteries, in their swollen state, varied up to $\frac{1}{2.30}$ th of an inch in diameter, the veins up to $\frac{1}{1.50}$ th. Both arteries and veins in this state were found in the fissures, as well as in the substance of the cord. Capillaries similarly packed with blood-corpuscles, measuring about $\frac{1}{30.00}$ th of an inch in diameter, occurred here and there in the grey and white matter. The measurements, given since they were obtained from portions of cord which had been subjected to the action of chromic acid and turpentine, are probably short of the real dimensions of the vessels. The process used commonly produces more or less contraction in the tissues subjected to it.

The exudation which has been spoken of was in most frequent connection with the arteries; there was found, indeed, only one clear instance of that formation in connection with a vein.

DESCRIPTION OF PLATES XII AND XIII.

PLATE XII.

Fig. 1 represents exudation in the grey matter of the cord in a case of tetanus (cervical region), $\times 7$.

Fig. 2. Exudation in fissure of cord, in connection with a blood-vessel. (The pink tint shows the effect of carmine on the exudation-matter.)

PLATE XIII.

Fig. 1. Section through the swelling described in lumbar region, $\times 7$.

Fig. 2. A small portion of fig. 1 more magnified, $\times 50$.

The pink tint shows the effect of carmine on the exudation-matter.

Fig 1.

Fig 2.