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A CASE OF RAPID "WASTING PALSY" FROM STRUCTURAL DISEASE OF THE SPINAL CORD.

By J. L. W. THUDICHUM, M.D., Lecturer on Chemistry.

THE INVESTIGATION OF THE NERVOUS CENTRES WITH COMMENTS.

By J. LOCKHART CLARKE, F.R.S., &c.

CASE.—A gentleman, æt. 54, had enjoyed good health during adolescence and early manhood; when at the age of 45, he met with what was then considered a slight accident. In jumping across a flower-bed for a wager, he came down heavily on his heels, and then fell backwards upon his head. He was stunned for a time, but gradually recovered, and after some days' confinement to his bed, appeared to be quite well again.

It was, however, soon perceived that a great change took place in his habits. Having been extremely fond of manly sports and exercises, rowing, cricketing, riding on horseback, dancing, and the like, he discontinued to take part in any of them, although he continued to go every autumn to the Scotch moors for the purpose of shooting grouse.

At the age of 50, while engaged in this latter sport, he perceived that his right leg had lost a part of its usual strength; that although he could perform with it every motion, yet he could not perform it in the manner necessary for the purpose; that he could not put the foot into the exact place where he wanted to put it. The weakness of the limb increased, and the right arm began to show similar symptoms. Under these circumstances, various remedies were tried in vain, until acupuncture and the electrical induction current, effected a speedy recovery.

Four years afterwards, however, the symptoms of weakness in the leg and arm re-appeared, and were not checked by the remedy which apparently had arrested and cured them before. Notwithstanding the treatment of the most celebrated physicians in town and country, the affection terminated in complete motor paralysis of the right leg. Now the left leg began to be effected in the same manner as the right; the arms, though weakened, retaining sufficient power to enable the patient to walk with the assistance of two sticks. While the left leg became quite paralysed, the right arm exhibited the same symptoms of weakness, lost all power in the

most gradual manner, and became ultimately quite paralysed. This was succeeded by gradual paralysis of the left arm. There remained some motility in the toes of both feet, and a slight amount of flexibility in the left index finger, as also slight adducting power in the left thumb. Sensibility was everywhere perfect and nowhere notably increased.

While the limbs thus lost their motor power, they gradually wasted in the most remarkable manner. The calves became two flat planes, what muscular substance remained upon the gastrocnemei being at the side; the thighs shrank very much; the arms and hands were wasted to a very extraordinary degree, the right hand particularly appearing as if crushed, having lost the whole of the projecting mass of the short muscles of the thumb.

In the right hand there had at one time been some involuntary movements, but they had entirely ceased; in the index finger of the left hand, which retained a small amount of voluntary motion, this spasmodic, but painless motion, came at intervals to the last. The hand lying queitly by the side of the patient, the fingers, stretched out, moved up and down, more or less rapidly, like that of a person striking a key of a note on the pianoforte. This was the only spasm of a clonic nature observed throughout the whole illness.

The only places where there was pain, for any length of time, was at the points of insertion of the deltoid muscles. At the insertion of the right deltoid, in particular, a hardness could be felt, which was painful to the touch. Those muscles were much wasted, so that the shoulders were angular, with projecting points of bone, and flat planes corresponding to the places covered by the deltoid muscles.

While this wasting palsy gradually crept over the patient, various modes of treatment were adopted, according to the opinion of the one or the other of the physicians consulted on the case. The ordinary medical attendant prescribed alterative doses of bichloride of mercury, subsequently iodide of potassium; steel medicines, quinine and others were tried in vain; acupuncture and all forms of electricity failed to have any effect. The seventh cervical vertebra was very prominent, and appeared to the touch as if thickened; indeed, so deceptive was the condition of that part of the spine, that several of the gentlemen consulted, had diagnosed a tumour in that region, which was supposed to cause the paralysis, by pressure upon the spinal marrow. Cupping had been repeatedly applied to this prominence, blisters had been raised, and ointments lavished upon it; but neither tumour nor paralysis had been affected thereby. There was no acquired

constitutional taint of any kind that could be ascertained; the surface of the skin was everywhere clear and white.

The senses and all mental functions were perfect; but a state of sleeplessness gradually developed itself, which ultimately constituted the most painful, and least remediable, symptom of the whole disorder. The patient was always very warm, down to the most extreme parts, and could under no circumstances bear to be too warmly covered. He had frequent attacks of what may be called showers of heat, that is, sudden and rapidly passing sensations of heat all over his body; there were no rigors or goose-skin. The pulse was sometimes natural, always full, mostly accelerated to 100, 112, and even more beats per minute.

Gradually the muscles of the trunk participated in the palsy, less in the wasting. The first effect of this extension of the disease, was inability to sit in the erect posture, next came inability to strain at stool or while making water. The contractility of the bladder was unimpaired, and the urine was expelled regularly and completely, when time was given for the operation.

It soon became necessary to assist defæcation by the injection of water and the administration of purgatives. Even then the sphincter, which was not paralysed, but strongly contracted, and contractile at will, would cause retention of the solid part of the faeces, and allow only the water and a small amount of soft matter to escape. This difficulty at first was obviated by artificial compression of the abdomen, by means of an air pad and leather strap, which was tightened as often as the patient strained, and immediately loosened again. Notwithstanding these precautions, an accumulation took place in the greatly dilated rectum. An accumulation of flatus in the large intestine, was relieved by passing a long tube into the bowel; the pain round the rectum persisting, and retention of urine taking place, the rectum was digitally explored, and the accumulation, with a clear passage through its central part was discovered. The faeces were broken down with two fingers, while a current of warm water was passed through the rectum, and by this operation, which was somewhat difficult, the pain, retention of urine, and obstruction of the bowels, were removed. Shortly after, a tetanic spasm of the recti muscles of the abdomen set in, which was painful, and lasted for about 14 hours. It was removed by small doses of prussic acid and morphia, and the application to the abdomen of hot flannels.

The most distressing symptom during the last six weeks of the illness was catarrh of the lungs, which caused a slight

amount of bronchial secretion. The phlegm proceeded to the trachea, and remained there, as the respiratory muscles were paralysed, and coughing was impossible. By slight movements of the diaphragm, which was not paralysed, and was the organ, which in union with the respiratory muscles of the neck, particularly the stero-cleido-mostoidei, performed ordinary respiration ; the lump of phlegm in the trachea could be moved up to the larynx, but it could not be carried through the rima glottidis, and there produced the most anxious sensation of suffocation. When I was first called to the patient about this symptom, he had been struggling with a lump for three hours. I immediately performed a kind of artificial coughing by assisting the patient's feeble efforts with a synchronous pressure of both hands upon the lower part of the thorax, the servant compressing the abdomen steadily with both hands. The phlegm was immediately carried through the larynx, and the patient was relieved. The attendants were taught the manner of practising this operation, and during the last three weeks of the patient's life it had to be frequently performed.

Quinine, morphine, strychnine, iron, phosphoric acid, and a variety of other remedies had no effect upon the disease, which from first to last, within a period of nine months, progressed to a fatal issue, without a halt, change, or hesitation. Morphine produced some sleep, but left an irritability, which caused the patient to wake up in great fright ; sometimes mucus in the throat was the cause of this symptom. The mercurial and iodide remedies had left, if any, no beneficial effects ; and the iodide, which had been continued upon the advice of a physician, with the hope of its reducing the tumor in the back of the neck, had probably had a great share in the production of the condition of the air passages. In the earlier stages the patient had drunk much wine—less latterly; but when faintness came on, after setting up for defaecation, or after shifting from the bed upon his chair, he usually took some. Against brandy and the like he used to protest strongly, as it left him in a state of great heat with excitement of the circulation. Upon my advice he confined himself to claret, and brandy was reserved for those rare occasions, when strong stimulants were medically indicated. He underwent the process of the Turkish bath on repeated occasions, and felt revived by it; but as the only bath at his disposal unfortunately broke down at the time when it might perhaps have been useful, it cannot be said that this agent had any trial in this case. It was perceived that the limbs of the right side, which had been paralysed the longest, and retained the least motility, perspired the most readily.

He died of a very gradual cessation of the respiratory powers. The heat continued strong to the last, and the pulse could yet be felt, after respiration had ceased, and consciousness had fled. During the last hours there had been many attacks of heat showers and copious perspirations.

Post-mortem examination eighteen hours after death.—There was the usual lividity and discoloration of the skin, especially about the legs. The wasting was greater on the right side than upon the left. The right hand was flattened, as if crushed. On the back was seen a prominent tumefaction involving the seventh cervical and two first dorsal vertebræ. The spinal processes were distinguishable, but there was a thickening on either side, so that the finger could not be pressed down there. The third dorsal vertebra was natural. The tumefaction was hard, dense, and could not be compressed. The skin showed numerous scars of cupping wounds, and the puckering and discoloration left by blisters. When the skin was removed the tumour was seen to be a layer of hard fat, of the size of a crown piece, half an inch thick in the middle, and gradually getting thin towards the circumference. The spinous processes, and all tissues around, were found in a perfectly normal condition.

The spinal canal was next opened; it was nowhere changed, with the exception of a small place on the fifth dorsal vertebra, where there existed a somewhat varicose vein. The position and appearance of the chord were normal. It was carefully removed and given to Mr. Lockhart Clarke for examination. The brain showed nothing abnormal. On the declivity of the basilar bone, however, immediately behind the back of the Sella Turcica, there were two bony excrescences, covered in by fibrous adhesions of the dura mater, but when isolated, appearing as sharp, spinous projections. The left one was situated somewhat higher, and projected an eighth of an inch from the surface of the bone. The right one was situated a little lower, and was a sharp conical spine, three-eighths of an inch in height. There were irregularities in the basilar bone, resulting in a protrusion of the margin of the foramen magnum upwards, and the narrowing of the apertures for nerves and blood-vessels. But it was difficult to ascribe to these irregularities any particular origin or effect, as they were found in most skulls examined for the purpose of comparison. The spinous excrescences if they affected the brain substance must have irritated the pons Varolii; no permanent impressions could, however, be found on this part. If these excrescences and irregularities could be considered as the effect of injury, it is perhaps right to bring them in connection with the fall ex-

perienced by the patient nine years before his death. The absence of brain symptoms speaks against the hypothesis that these excrescences had anything to do with the disease of the chord of which the patient died.

The chest and abdomen were not opened. The part of the right deltoid muscle, which had been painful during life, was dissected, but no changes were discovered in it. Various parts of muscle were examined and compared. The paralysed muscles remained of a pale rosy hue when exposed to the air, while the muscles which had been contractile became dark red as usual. Examined with the microscope the paralysed muscle exhibited the fibrils in a state of relaxation. While in the healthy muscle the fibrils are closely folded together, so as to produce the tranverse striæ, in the paralysed muscle all tranverse striæ had disappeared, and the fibrils lay in undulating lines. Beyond that, there was no change even in the most wasted muscle. There was no fatty or other deposit of any kind, either in or upon the microscopical elements.

The fatty bolster on the back of the neck consisted of common fat tissue, with very little connective tissue.

INVESTIGATION OF THE NERVOUS CENTRES, WITH COMMENTS.

By J. LOCKHART CLARKE, F.R.S.

(1) THE parts which I received from Dr. Thudichum for examination consisted of the cerebellum and pons varolii, the medulla oblongata, and the whole of the spinal cord. They had been carefully removed soon after death, and were all free from mechanical injury. Upon external examination the cerebellum, pons varolii, and medulla oblongata presented no evidence of disease; but in the white columns of the cord there was observed a variable extent and degree of softening, which was greatest at the upper part of the lumbar and the lower part of the dorsal regions, where it was confined chiefly to the posterior columns, and some parts of the lateral, as will be described in proper order. At these places the cord was divided transversely by a very sharp instrument, and small portions of both the white and grey substances were at once examined under a $\frac{1}{8}$th-inch object-glass, but without detecting, among the confused mass of broken nerve-fibres, granules and nerve-cells, any satisfactory evidence of morbid product.

The mode of preparing these parts for minute examination

was similar to that which I employed for the same purpose on former occasions.*

(2) I began the examination of the cord at its lower end, and shall begin from the same part to describe the extensive and remarkable morbid appearances which render this case so peculiarly interesting and important. The central part, or axis, of the fi l u m t e r m i l e was occupied by a comparatively thick column of dark, morbid substance, which entirely obliterated the canal and replaced the small remnant of grey substance by which, in the normal state, it is here immediately surrounded. In very thin sections—which, however, from the friability of the substance were not easily made—the structure of this morbid material could be ascertained under a high power without disturbance, and by this means was found to consist of a dense aggregation of cell-like bodies, intermixed with corpora amylacea and a few fine fibres. The cell-like bodies, fig. 1, A, Plate II., were more or less globular, and varied from about the 1300th to the 2800th of an inch in diameter. Their outline was delicate, and in many instances resembled that of scaly epithelium, or of certain vegetable cells. I believe, however, that they were not real cells, but consisted partly of, more or less globular portions of the white substance of diseased or degenerate nerve-fibres. At a, fig. 1, the coarsely granular substance was clearly seen, in many instances, to result from the breaking up of these cell-like bodies. Of the epithelium which originally surrounded the canal no traces could be distinguished, except, perhaps, the fine fibres which once proceeded from their tapering ends, and now intersected the mass. The corpora amylacea were not particularly abundant; but in two or three places the dark opaque mass was interspersed with small patches of granular degeneration.

(3) In ascending to the lower part of the conus medullaris, the diameter of this morbid column increased nearly in the same ratio as that of the cord, obliterating the canal and replacing nearly the whole of the grey substance, as represented in a transverse section, fig. 2. To appreciate the exact extent of the morbid changes which were thus induced, it will be necessary to compare this section with one taken from the corresponding part of a healthy cord, as shown in fig. 3. By this comparison it will be seen that the morbid cylinder (a a) encroached forward on the deep central portions of the anterior white columns (e, e), which are consequently shallower than in the healthy section; and that it destroyed and replaced the whole of the grey sub-

* See Beale's Archives of Medicine, No. 9; and British and Foreign Med.-Chirurg. Review, July, 1862.

stance except the superficial part in front and at the side (*d*), and the gelatinous substance behind (*b*); from both of which several slender processes, consisting chiefly of connective tissue, intersected, and divided it into lobes of different sizes.

Through the rest of the conus medullaris the morbid column increased somewhat in thickness, and assumed an oval shape, with its long diameter behind-forward. On comparing a transverse section of the white and grey substance (fig. 4) with a similar section from the corresponding part of a healthy cord (Fig. 5), the difference observed is very striking. The relative quantity of grey substance destroyed is less than in fig. 2; but *t*he morbid column (*a*) has obliterated nearly all of that portion which immediately surrounds the canal, including the inner sides of the posterior cornua, which seem to be tilted backward, as it were, by the forward pressure of the morbid column against the anterior commissure and diminished white columns (*e, e*). The chief portions, however, of the anterior c o r n u a (*d, d*) still remained, and with one exception, to be described in its proper order, were found healthy.

(4) Through the lower part of the lumbar enlargement the morbid column continued to increase somewhat in size, but chiefly in an antero-posterior direction, and the changes which it effected in the f o r m of both the grey and white substances were remarkably curious, as may be seen by comparing together corresponding sections of the diseased and healthy cord (figs. 6 and 7). In fig. 6 the posterior white columns (*c, c*), although scarcely, or not at all, diminished in area, are very much displaced and altered in shape by the presence of the morbid column (*a*), which seems to have been developed between them, from the bottom of the median fissure, to be the result of diseased blood-vessels, as we shall see further on. Thus originating and continuing to increase in size, the morbid mass pressed forward the transverse portion of the grey substance with the central canal, while in the same proportion the anterior white columns (*e, e*) were reduced in depth. As effects of the same cause, the posterior cornua were not only separated from each other to an unnatural extent, but were increased considerably in length; while the anterior cornua (*d, d*), on the contrary, were shortened to corresponding degree.

The central canal was not entirely obliterated, but was less distinct than usual; while in front of it, in the substance of the anterior commissure, was a transparent and elongated patch of granular degeneration (*h*). The roots of the nerves, especially the posterior, were, as in the previous sections, reduced considerably in thickness.

On ascending through the lower half of the lumbar enlargement, the morbid column (*a*) gradually diminished in size, until, a little below the middle, it entirely disappeared. In the process of reduction the mass diminished laterally and from behind-forward, so that its a n t e r i o r portion was the last to disappear in the form of a longitudinal cone or tapering cylinder resting on the posterior commissure between the bases of the horns. In the same region of the cord the proper substance or healthy portion of the posterior columns, especially the deeper parts, was affected with softening, which, however, disappeared gradually towards the middle of the lumbar enlargement, where, for a short distance, it was limited chiefly to the surface. At this point the grey substance was not, either in form or size, appreciably altered from the natural state; and with the exception of a peculiar condition of the nerve-cells, to be noticed hereafter, had nearly a healthy appearance. Above this point, for about half an inch in the m i d d l e of the lumbar enlargement, the area of the softening in the posterior columns again increased—their superficial halves, between and immediately behind the heads of the cornua, being quite pulpy and disorganised. In this destructive process a large proportion of the fibres of the posterior roots of the nerves were of course involved.* On the r i g h t side of the cord the posterior part of the l a t e r a l column, extending from the posterior-lateral fissure to the base of the caput cornu, and comprising a triangular area, was also softened to a very considerable degree.

Through the rest of the m i d d l e of the lumbar enlargement, the softened state of the posterior columns diminished in a r e a, but not in d e g r e e, and was gradually more limited to the surface.

(5) Throughout the u p p e r t h i r d of the lumbar enlargement the whole of the posterior columns was again involved in the softening. In d e g r e e, however, this morbid condition was greatest at their deeper parts (fig. 8 *c'* Plate III), where they rest on the transverse commissure of the grey substance, which in this case, as shown in the figure below *c',* was eroded, as it were, and granular. In some sections as represented in fig. 8, this more particularly softened portion of the posterior columns was separated from that which was firmer and more super-

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* Perhaps it may be well to remind the reader that the posterior roots of the spinal nerves are attached *exclusively* to the *posterior* white columns, and that none of their fibres are, as they were formerly supposed to be, attached immediately to the lateral columns. These facts I first pointed out in 1851. Phil. Trans.

ficial by a process of pia mater or connective tissue, which extended from the posterior vesicular column (*k*) on the left side to caput cornu and posterior column on the right. Fig. 9 represents a transverse section of the grey substance at about the middle of the upper third of the lumbar enlargement.* Here we find that the posterior vesicular columns (*k, k*), although not much reduced in size, are somewhat altered in position and shape. Along the outer side of the right vesicular column was a curved tract of granular degeneration, extending backward to the base of the caput cornu. The anterior cornua, *d, d*, were somewhat reduced in size and un-symmetrical in shape; and the anterior median fissure (*s*), instead of being midway between them, and equally dividing the anterior white columns (*e, e*), extended from the right extremity of the transverse commissure along the side of the corresponding cornu. Within the fissure was an enlarged and apparently unhealthy blood-vessel, reaching backward as far as the commencement of the tract of granular degeneration, of which it seemed to have been the cause. Fig. 10 represents another section from the same region, a little higher up. Here the form of grey substance on both sides is strangely altered. On the right side the posterior vesicular column (*k*) is not greatly reduced in size, although very much modified in shape. On its outer side in the substance of the cervix cornu posterioris, is a pyriform mass of finely-granular degeneration (*m*). This morbid space, as well as that in the previous section, presented, under a high magnifying power, precisely the same appearance as did those which I described in my former cases.† On the left side of the section, the posterior vesicular column had entirely disappeared : not a cell remained; while the cervix cornu, (*n*) in which it should have been enclosed, was extraordinarily narrow, and gave off numerous processes of connective tissue, which, toward the mesial line, interlaced and became continuous across the posterior columns (*c, c*), with similar processes from the opposite side. Fig. 11 represents another curious deviation from the natural form of the grey substance at the upper end of the lumbar enlargement. The abnormal appearance will be at once evident on comparing it with fig. 12, which exhibits the right side and transverse commissure of the grey substance from the corresponding region of a healthy cord. In fig. 11 the posterior vesicular column (*k*), on the left side is partly thrown or drawn

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* Compare this with fig. 13, plate xxi, of my "Researches on the Grey Substance of the Spinal Cord." Phil. Trans., 1859.
    † Beale's Archives, No. 9, 185; and British and Foreign Review, July, 1862.

across the middle line, and united to its fellow on the right side by a broad process of connective tissue which separates the posterior white columns (*c c'*) between them, into two separate ovoid masses; while the transverse commissure (*p*), by an increased development of connective tissue, is much broader than in health. Moreover, the e n t i r e lateral halves of the grey substance have approximated, or been drawn more closely together.

Throughout the whole of this region (the upper third of the lumbar enlargement), a l l the white columns were more or less softened. The degree of softening was greatest in the posterior—particularly on the right side, at their deeper parts, where they rest on the transverse commissure, which, in many sections, was also in the same condition, and more granular than usual. At this latter part of the posterior columns there was generally an oval or circular space in which they were quite pulpy. Next in degree of softening were the a n t e r i o r white columns; and lastly, the l a t e r a l. In this region the cord, although most carefully hardened, was so exceedingly friable through its whole thickness, that the greatest difficulty was found, even with the sharpest instrument, in making sections sufficiently thin and perfect to obtain a correct view of the actual condition of the grey substance. Nevertheless, I may guarantee that a l l the figures that illustrate this case are e x a c t d e l i n e a t i o n s of the morbid appearances in the form in which they really existed.*

(6) At the lowest part of the dorsal region, where it gradually swells into the upper part of the lumbar, all the white columns were somewhat softer and more friable than natural, the p o s- t e r i o r in particular, although they were less so than in the region last described. But the most remarkable and curious feature at this part of the cord was the form of the grey sub- stance. Fig. 14, Plate IV., represents its appearance in a per- fectly healthy cord. Here we find the lateral halves of the grey substance, with their posterior vesicular columns (*k, k*), standing widely apart, and joined only by the narrow transverse com- missure (*p*). But in the morbid section, fig. 13, the two lateral halves are drawn closely together, so that the posterior vesicu- lar columns (*k, k*) are nearly in contact in the middle line; and while the gelatinous substance of the opposite sides is almost continuous behind them, the transverse commissure and space (*p*) around the canal have assumed a triangular form. An

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* Some of these figures with the preparations from which they were drawn were exhibited by Dr. Thudichum at one of the meetings (December 8, 1862) of the Medical Society of London.

approach to this arrangement is seen in fig. 11. Now what renders this form of the grey substance so exceedingly curious, is the fact that it bears a striking resemblance to the natural form of the same substance in the dorsal region of most of the mammalia, as may be seen on comparing my figures in Phil. Trans. 1851 and 1859, and in Beale's Archiv. No. 3, vol. iii. The tractus intermedio-lateralis (*t*) was very distinct and prominent.

Through the upper half of the lower third of the dorsal region, the whole of the posterior columns were very soft. The posterior parts of the lateral columns also were softer than natural, while the grey substance was still much altered in shape. Fig. 15 represents a transverse section of this substance at the upper part of this region. (*c c'*) are two remaining portions of the posterior columns between the lateral halves of the grey substance. Behind (*c*) the posterior cornua are united by a process (*a*) of connective tissue; and between it and the other (*c'*) were several morbid patches (*b, b, b*), which, when seen under a low power by reflected light, appeared nearly black, but by transmitted light, were exceedingly transparent, and under a high power were found to be finely granular degenerations. These patches extended only a short distance upward, for after two or three thin sections, they entirely disappeared. Immediately above this point, that is, at the lower part of the middle third of the dorsal region, the posterior and lateral columns became much firmer, but after a few more sections, their deeper portions between the roots of the posterior cornua were again softened, particularly on the left side. Through the same space and the rest of the middle third of the back, the form of the grey substance was variously abnormal, the two sides being frequently unsymmetrical, while many of its blood-vessels were much enlarged. Fig. 16 represents a transverse section.

(7) At the beginning of the upper third of the dorsal region, the most important morbid condition was found on the right side in the substance of the anterior cornu, and immediately in front and on the outer side of the posterior vesicular column (*k*, fig. 17). This consisted of several clots of blood (*b, b*) effused from an adjacent vessel, which had a somewhat varicose appearance, and seemed partially eroded as if from granular degeneration. In the next section, fig. 18, which is much more highly magnified (60 diameters) a large irregular clot (*b, b, b*) was found in front of the posterior vesicular column (*k*), and therefore in the centre of the grey substance of the right side. Laterally it projected into the tractus intermedio-lateralis (*t*). The posterior white columns, especially

their deeper portions, overlying the transverse commissure, were softened to a considerable degree. These appearances extended for about the third of an inch up the cord, gradually disappearing; but beyond this point, the vessels in the neighbourhood, and frequently in the white columns, were larger than natural, and sometimes irregularly dilated; while the grey substance was curiously altered in shape and symmetry, as shown in fig. 19, Plate V. Here the anterior cornu (*d*) on the left side is smaller than that on the right, and is thrown or drawn backward away from the anterior median fissure (*s*), together with the corresponding t r a c t u s i n t e r m e d i o - l a t e r a l i s (*t*), posterior cornu, and the posterior vesicular column (*k*), which is narrower and longer than its fellow. Within the caput cornu posterioris, or the extremity of the horn, on the left side, the blood-vessels were very much enlarged,—so much so, as to present a very unnatural appearance, even under a low magnifying power. In different parts of the grey substance, also, along this region of the cord, the blood-vessels were not only dilated, but accompanied by either roundish or irregular patches of extravasated blood.

The same condition in a greater or less degree, continued as far as the part where the cord begins to swell into the cervical enlargement. Here, on the left side, several very much dilated blood-vessels were observed. In some sections three, in others four, were found at the base of the t r a c t u s i n t e r-m e d i o - l a t e r a l i s, at its junction with the posterior cornu; and two or three others were seen at the outer part of the a n t e r i o r cornu. Around the larger of those in the former instance, there was, in some sections, a granular transparent space containing many extravasated blood corpuscles more or less altered in appearance. The posterior white columns—particularly their deeper portions—were very soft; and the posterior part of the lateral columns also were softer than natural.

(8) On proceeding f u r t h e r upward through the lower part of the cervical enlargement, three or four dilated blood-vessels made their appearance in the centre of the grey substance around the canal (see fig. 20, *b*, *b*). After a few sections, two or more of these blood-vessels were seen to be surrounded by finely granular and transparent substance (*b*, fig. 21), which gradually increased in area for about half an inch upward, while the blood-vessels themselves were partially destroyed, evidently by granular degeneration. Fig. 22 (*b'*) represents this morbid area.* It will be observed, also, that the two halves of

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* For the economy of space the ends of the posterior horns are not represented in the succeeding figures.

the grey substance are unsymmetrical. The posterior columns generally were much firmer, except at their deeper parts (*c'*) where they were soft and granular, and continuous with the m o r b i d area, (*b'*) so that the transverse commissure was involved in the disease.

This condition of the white and grey substance gradually increased as it ascended the lower half of the cervical enlargement. The softening of the posterior white columns extended toward the surface, until it involved their entire area. Figs. 23 and 24 (*b, b'*), show the transparent areas of granular degeneration in two different sections. At the part from which the lower roots of the third dorsal nerves take their origin, this morbid space diminished, and rather suddenly disappeared, only two or three small transparent spots of degeneration remaining at the bases of the posterior cornua. The posterior white columns were somewhat soft.

Opposite the m i d d l e roots of the third dorsal nerves, the granular degeneration again made its appearance as a large transparent triangular space, which destroyed the whole of the p o s t e r i o r, and nearly all of the a n t e r i o r commissure (see figs. 25 and 26 *b*). In fig. 26 the dark granular mass (*a*) is what remains of the fibres of the anterior commissure. It is separated from the anterior columns (*e, e*) by a layer of the soft and transparent granular substance (*b'*). Through each side of this morbid space, ran a branch of the blood-vessel which enters at the anterior median fissure. These branches at some points were partially involved in the degeneration, or seemed to be irregularly eroded. These morbid states diminished somewhat through the u p p e r parts of the same region, but without entirely disappearing. The form of the grey substance was normal. The posterior columns were less soft, except at their deeper parts, which were quite pulpy.

(9) On a level with the lower roots of the second dorsal nerves, the degeneration again increased in extent, and destroyed the whole of the anterior and posterior commissures; but after extending upward a few lines, once more diminished. Fig. 27 (*b, b'*), Plate VI., represents its exact form and size at the middle of the part from which these nerves arise. At (*b*), the posterior commissure and parts surrounding the canal were quite broken up, consisting of bits of altered nerve-fibres, of granules, and of corpora amylacea in abundance. On the left side, the morbid area (*b'*) was larger than on the right, and completely destroyed the posterior vesicular column, which in this region consists of much smaller cells. Into this part of the morbid space the ends of some blood-vessels, completely thinned away as if

by erosion, were seen to project. The posterior white columns were soft only at their deep parts which overlay the transverse commissure. The other columns were apparently sound. On a level with the u p p e r roots of the same (second pair of dorsal) nerves, the transparent area of degeneration was prolonged backward on the right side, as well as on the left; and for a distance of a few lines up the cord the whole inner portion of each cervix cornu, (or the parts between the transverse commissure and the c a p u t cornu) were destroyed by irregular patches of granular degeneration, of different shapes and sizes, which presented a very striking resemblance to the holes in a moth-eaten cloth, as represented in fig. 28 (*b b′ b″ b‴*), &c. The spaces, however, were not vacant, but filled with a finely granular and transparent substance,—the granules, as I found in former cases, being mostly toward their centres. On the l e f t side these morbid appearances gradually diminished on ascending the cord, and disappeared altogether at the commencement of the first pair of dorsal nerves; while on the r i g h t side they remained nearly similar to those represented on the l e f t side in fig. 28. The same state of degeneration affected the parts surrounding the central canal (*b″* fig. 28), and extended on the right side across the anterior commissure around an enlarged and unhealthy looking blood-vessel entering through the anterior median fissure (*s*).

(10) This condition of the grey substance, with that of the white columns last described, continued upward through the whole of the space from which the first dorsal nerves take their origin; the morbid area around the canal being larger for a few lines, as represented in fig. 29 (*b″*). From this a narrow streak of the same substance (*b′*) was seen to extend backward along the inner side of the base of the horn, on the left side. At the upper roots of the same nerve (first dorsal) this large morbid space almost entirely disappeared, the streak on the left side continuing, with some small patches on the right. Its decrease, however, was only for a few lines; for at the commencement of the eighth cervical nerves, it began again to extend itself, eroding, as it were, and destroying the under surface of the posterior white columns, which were softened to a considerable degree. Some minute spots of degeneration were seen here and there in other parts of the grey substance. These various lesions continued to a greater or less extent through the rest of this region (the eighth cervical), the morbid spaces along the inner edges of the posterior horns increasing and diminishing alternately on the opposite sides, varying in shape in almost every section, and encroaching,

generally, on the under part of the posterior columns, which were, therefore, in these instances, entirely separated from the grey substance. At the level of the seventh pair of cervical nerves, the degeneration diminished in extent, affecting chiefly the under part of the softened posterior columns, which were thus separated from the transverse commissure and inner sides of the bases of the posterior horns, by a transparent, narrow, and irregular streak.

Nearly the same condition of the cord was found through the rest of the cervical enlargement, only small streaks or patches of degeneration occurring here and there in the posterior cornua. On approaching the medulla oblongata, the degree of softening in the posterior columns diminished from within outward. Opposite the third cervical nerves, although all parts of these columns were softer than natural, yet the only portion that was actually pulpy, was that between the bases of the cornua, in the form of a longitudinal cylinder, which, on making a transverse section, completely separated from the rest of the substance, leaving the posterior commissure and inner bases of the posterior horns entirely uncovered. The grey substance was not nearly so much affected as in the lower part of this region; but the posterior commissure contained one or two small patches of degeneration, with a few corpora amylacea; while the anterior commissure was in some sections nearly destroyed by the same kind of lesion, and contained a few of the peculiar cell-like bodies constituting the oval tumour which was found in the posterior columns of the conus medullaris, and represented in fig. 3, Plate II.

(11) But besides the variety of morbid appearances which I have now described in different parts of the cord, one constant condition of the nerve-cells was observed throughout its entire length. Nearly all these bodies, in every section, were reduced to about one-half or two-thirds of their normal size, and were considerably altered in shape. They had also, to a variable degree, undergone certain changes in structure. The first indication of these changes was an unusual accumulation, around the nucleus, of yellow or brown pigment granules which either partially obscured or replaced it. Fig. 31, A, is an exact representation of a cell in this stage of transformation, taken with the others of the same figure, from a little below the middle of the lumbar enlargement. Here we find the nucleus enveloped and almost entirely obscured by a large ovoid mass of pigment granules, around which the remaining contents (a) of the cells have retained their transparent aspect and natural structure. The next step in the process of degeneration is the gradual

disappearance or wasting of these superficial or transparent contents (*a*) of the cell, and the consequent shrinking of the investing membrane or cell-wall, until it closely surrounds the central mass of pigment, as seen in the three cells represented at B. In consequence of this atrophy of the superficial parts of the cell, its processes become gradually thinner, and at length nearly obliterated. This was more or less the case with all the cells of the group, of which the greater number were in the condition represented at B. At C, the accumulation of pigment is at one end, and gradually fades away toward the centre, leaving the rest of the cavity transparent. When the sections were tinted with solution of carmine, only the transparent portions of the cells received the colour, the pigment masses, and consequently the whole of those cells which con-sisted entirely of them, retaining their yellow or brown hue. This alteration in form and structure was not limited to the nerve-cells of the anterior cornua, but was found also in those of the posterior vesicular columns, and of other parts of the grey substance.

(12) Through the lower part of the medulla oblongata, the posterior columns, although nowhere pulpy, were everywhere softer than in health, and contained several large fissures, in which irregularly-dilated blood-vessels were lodged. The grey sub-substance, immediately behind the canal, and which in this region is more than a mere commissure, contained several enlarged blood-vessels, and broke up readily under the most careful section. Through the rest of the medulla oblongata, all the central parts immediately surrounding the canal were involved in the softening process, but to a greater extent in front, and in some sections as far forward as the back of the anterior pyramids.

The olivary bodies were smaller than natural and altered to a certain extent in their elementary structure. Their lower two-thirds formed no projection whatever above the level of the surface. Internally, the grey laminæ presented their usually convoluted form ; but the fibrous substance which they enclose, as well as their cells, was atrophied to a variable degree. In some of the convolutions the cells had almost entirely disap-peared. In many sections, the transverse decussating commis-sure was involved in the softening process, and in others, the blood-vessel which enters between the anterior pyramids, as well as the beautiful series of parallel branches which it gives off to the bundles of this commissure, were here and there either enlarged or atrophied, and appeared sometimes as if artificially injected.

In the pons varolii, all the central parts were somewhat softer and more vascular than in health, and had very much the same general appearances as the corresponding parts of the medulla oblongata.

The cerebellum and its peduncles were of average size, and presented no deviation from their normal aspect and structure.

The fibres of the anterior nerve-roots, w i t h i n t h e c o r d were evidently reduced below their usual diameter, in consequence of atrophy of the axis-cylinders; but o u t s i d e t h e c o r d, the nerve-roots were apparently of their average size. This difference was probably due to the quantity of neurilemma surrounding the fibres external to the cord, as well as to their larger share of white substance, which perhaps is not affected by atrophy so readily as the axis-cylinders.

(13) It may be well to state, that all these morbid and abnormal conditions of the nervous centres were not only ascertained, but described and sketched before I knew anything of the history of the case, beyond the general fact that it was a case of muscular atrophy, accompanied by paralysis.

Now when we come to compare together the two series of facts it is gratifying to find that the symptoms which were manifested during life, are in almost every instance explained in a remarkable manner by the lesions of structure that were found after death. From the history of the symptoms we learn that both the lower extremities, and subsequently the abdominal muscles, became completely affected by motor paralysis. On examination after death we find that the whole of that region of the cord from which these parts derive their nerves was injured by disease. Thus to sum up, in a general way, the prominent lesions: in the c o n u s m e d u l l a r i s nearly the whole of the grey substance and part of the posterior columns were replaced by a morbid and cylindrical mass. T h r o u g h t h e l o w e r p o r t i o n a n d m i d d l e o f t h e l u m b a r e n l a r g e m e n t only part of the posterior columns were replaced by the morbid cylinder, the rest being unnaturally soft. A large proportion of the p o s t e r i o r r o o t s were also involved in the softening, as was also the posterior part of the lateral column on the right side. The cells of anterior grey substance, and of posterior vesicular columns were more or less atrophied, and wholly or partially filled with pigment granules. In t h e u p p e r t h i r d o f t h e l u m b a r e n l a r g e m e n t there was a variable degree of softening of all the w h i t e columns, but particularly of the posterior on right side, with softening and injury of the posterior commissure, from which they were separated. The posterior vesicular column on the

r i g h t side contained tracts or patches of granular degenera-
tion; that on the left entirely disappearing in some sections.
The form and symmetry of the grey substance was strangely
altered in some sections. The anterior cornua were somewhat
reduced in size; and their cells, more or less, were loaded
with pigment granules.

We are informed that the paralysis of the lower extremities
was followed by almost total loss of power in the arms. On ex-
amining the brachial enlargement there were found several
dilated, and more or less degenerate, blood-vessels on each side
of the canal, surrounded by transparent patches of granular
degeneration, which involved the posterior commissure, and in
some places the anterior. In certain parts of the brachial en-
largement the patches of degeneration extended along the whole
inner side of each cervix cornu. The posterior columns were
more or less softened, particularly their deeper portions which
rested on the posterior commissure. The cells of the anterior
cornua were somewhat atrophied and loaded with pigment
granules.

After paralysis of the lower and upper extremities came that
of the muscles of the trunk. The first effect of this extension
of the disease, we are told, was inability to sit in the erect
posture, and then inability to strain at stool, or while passing
water, and loss of power over the expiratory muscles, which
rendered coughing impossible. In accordance with these
symptoms we found that in the upper part of the lumbar
region, whence the musculo-cutaneous nerve, which supplies
the expiratory muscles of the abdomen, takes its origin, the
grey substance was curiously altered in form and structure,
while all the white columns, but particularly the posterior,
were in a softened condition. Moreover, through the lower
two-thirds of the dorsal region of the cord, which supplies
nerves for some of the abdominal muscles, for the inter-
costal muscles and those of the back concerned in maintain-
ing the erect posture, there were changes in the form and
structure of the grey substance, enlargement of the blood-
vessels, and softening of the posterior columns; while in
the upper third of the same region several clots of extravasated
blood were found in the substance of the anterior cornu, and
extending into the corresponding t r a c t u s   i n t e r m e d i o-
l a t e r a l i s. The grey substance was also curiously altered
in shape and symmetry; the anterior cornu on the left side
was smaller than on the right; the blood-vessels were fre-
quently, but irregularly dilated; and the posterior white columns
were unnaturally soft.

The last of the parts that became paralysed were the diaphragm and the respiratory muscles of the neck; and the patient died of very gradual cessation of the respiratory powers. On examination it was found that those portions of the cord which give origin to the phrenic nerves, the lower roots of the spinal-accessory, and the cervical plexus, were more or less injured by disease. They were less affected, however, than the parts immediately below. Now this is precisely what might have been expected from the previous paralysis of all the other respiratory muscles; for since the respiratory movements were now entirely dependent on these nerves, which, however, were barely competent alone to maintain them with sufficient activity to support life, death would necessarily ensue before any great amount of destruction could invade the grey substance from which they were derived.

But although, as we have seen, there is a striking general correspondence between the symptoms of the case and the lesions of structure in the nervous centres, there is one fact that does not appear to be easily reconcileable with the morbid anatomy. We read in the history that "sensibility was e v e r y w h e r e perfect." Now I have shown that in the middle of the lumbar enlargement the superficial halves of the posterior white columns, between and immediately behind the heads of the cornua, were quite pulpy, and that in this softened mass a large proportion of the posterior roots of the nerves were, of course, included. How can we account for the apparent discrepancy between these facts? We can only have recourse to one or the other of the following suppositions: 1st. That there must have been some failing sensibility in the lower extremities that remained unobserved. 2ndly. That the nerve-roots which traversed the softened columns did not participate in the injury. 3rdly. That the roots which enter through the posterior lateral fissure, and not through the white columns, are the only fibres engaged in transmitting impressions that excite sensation. In whatever way the difficulty may be explained, the retention, generally, of unimpaired sensibility, with general softening of the posterior white columns, goes to support the physiological conclusion, that these columns, if at·all, cannot be the only channels for the transmission of sensitive impressions. This conclusion I arrived at in 1853 (Phil. Trans.) on anatomical grounds—from my own investigations into the course taken by the posterior roots of the nerves within the substance of the cord. Two years later the same conclusion was drawn by Dr. Brown-Séquard from his experiments on animals (Gazette Medicale and Comptes Rendus, 1855).

(14) With regard to the c a u s e of the muscular atrophy in this case, it must of course be referred to the lesions of the spinal cord, for its appearance was subsequent to the paralysis. Moreover, there is good reason to believe that the wasting of the muscular tissue was not a remote or i n d i r e c t, but an immediate or d i r e c t effect of those lesions, since it followed the paralysis too rapidly to be accounted for by m e r e i n a c t i v i t y of the paralysed muscles. In certain cases mechanical injury, exhaustive exercise of the muscular tissue, or an attack of fever, may be the exciting cause of the atrophy ; and these facts, together with the supposed absence of disease of the spinal cord, have led to the general belief that muscular atrophy is not dependent upon lesions of the nervous centres. But even in such cases it is probable that the failure of nutritive reparation is due not to injury or exhaustion of the m u s c u l a r tissue a l o n e, but to injury of its n e r v e s, or exhaustion of their supply of nerve-force, and the consequent disease or atrophy of that part of the spinal cord from which they are derived ; or in cases occurring after fever, it may be due to injuries which the nervous centres have sustained during that disease. It is true that there is no apparent reason why atrophy of muscle should not be as independent a disease, as atrophy of nerve-tissue ; but then it is a significant fact, that in every case of this malady in which the spinal cord has been p r o p e r l y examined, this centre has exhibited the most unequivocal evidence of disease. The first two were examined by myself according to the method which I then recommended. In one of them* there was no decided or complete motor paralysis, but only muscular weakness, which p r e c e d e d the wasting. In those regions of the spinal cord which supplied the wasted muscles, I found in the grey substance, and generally around or in the vicinity of blood-vessels, numerous patches of transparent granular-degeneration of precisely the same nature as those which were found in the present case. Moreover, the nerve-cells contained an unusual number of coarse pigment granules, and corpora amylacea were abundant around the canal.

In the second case† the lateral halves of the grey substance were frequently unsymmetrical or mis-shapen, and contained numerous patches of granular degeneration ; while the nerve-cells of the anterior cornua were nearly all atrophied or shrunk ot one-fourth or one-fifth of their original size.

The third case was treated and examined by Dr. Gull, and

* Beale's Archives, No. 9, vol. iii.
† British and Foreign Med.-Chirurg. Review, July, 1862.

described in Guy's Hospital Reports, vol. viii. 1862. There was progressive paralysis and flexion of several fingers of both hands, with s u b s e q u e n t wasting of their muscles. At this stage of the disease the patient sickened with typhus fever and died. On examination after death there was found in the cervical enlargement of the spinal cord considerable distention of the central canal, from accumulation of fluid within it, with consequent atrophy of the grey substance. In certain parts of this region there appears to have been absorption of nearly the whole of the posterior portions of the grey substance, only a certain extent of the anterior cornua remaining.

The fourth case is that which forms the subject of my present communication.

It is worthy of note that in the second case the symptoms began soon after a sun-stroke received in Australia. On examining the brain (which before I received it was reported as healthy) I found one portion of the marginal convolution of the longitudinal fissure to be much softer than the rest, and closely adherent to the membranes. In the present case also it has been seen that the symptoms made their appearance soon after a severe fall and blow on the back of the head, which rendered the patient unconscious for some time. It is not improbable that in both cases the shock to the cerebral centre may have been the exciting cause of the morbid changes which were found in the medulla oblongata and spinal cord. However this may be, it would be well in all future cases to note any accidental shock which the brain may have received, and examine this organ carefully after death. In cases also, occurring after fever, it might be important to inquire whether the attack was accompanied with severe cerebral, or other nervous symptoms. Indeed, in taking clinical notes, and making out the history of the disease, we should be careful to observe every circumstance that can possibly affect the case ; for it is only by this close and minute investigation during life, with an equally searching and complete examination after death, that we can hope to arrive at definite and exact conclusions in both a pathological and physiological point of view.
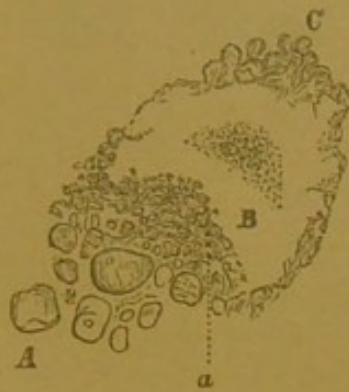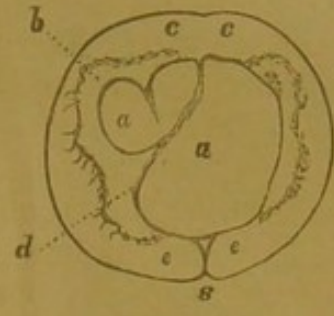
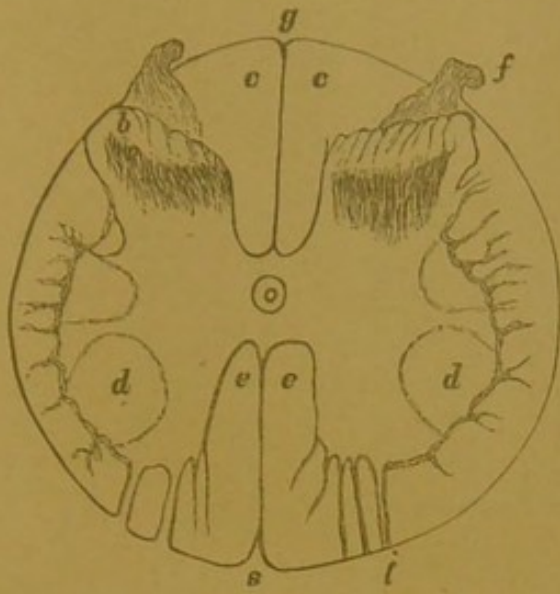PLATE II.

Fig. 1.
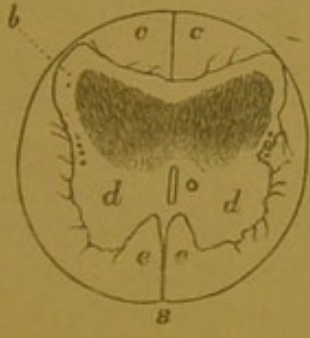
Fig. 2.

Fig. 3.

Fig. 4.
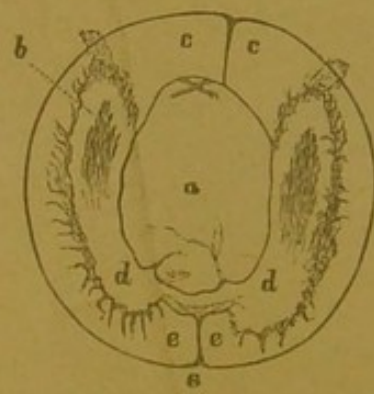
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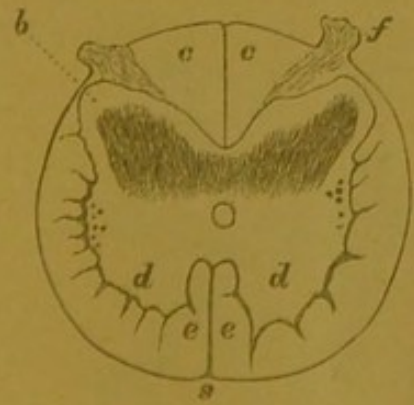
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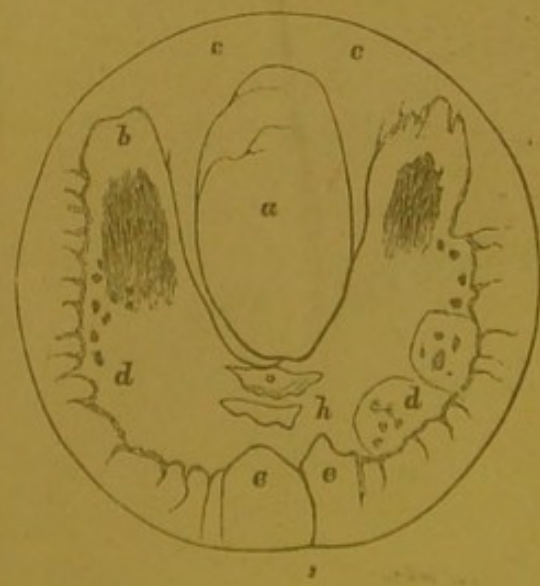
PLATE III.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

PLATE IV.

Fig. 13.
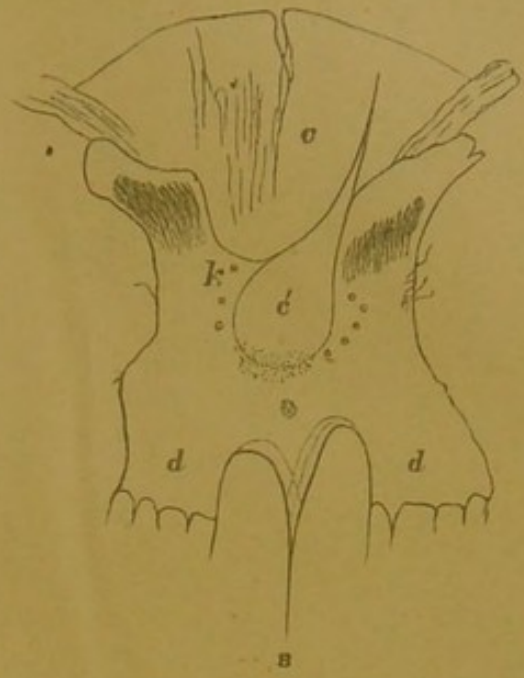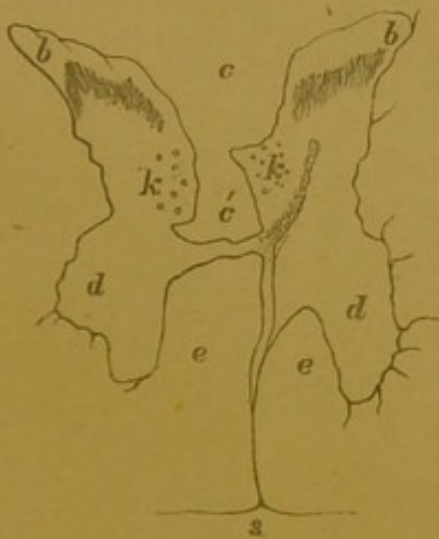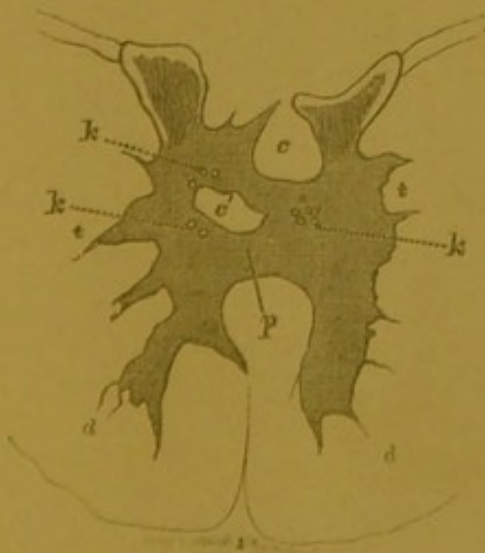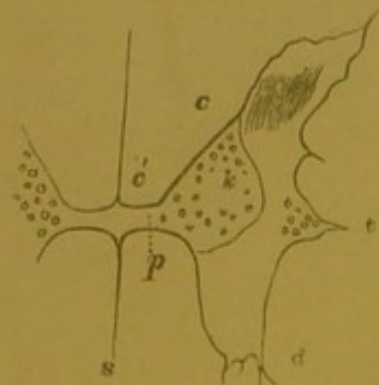
Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18.
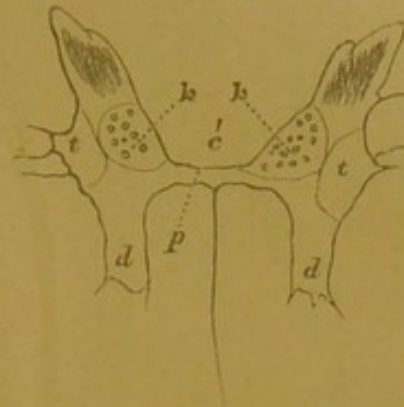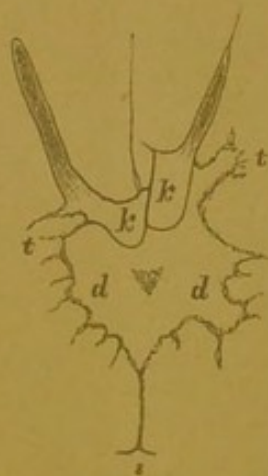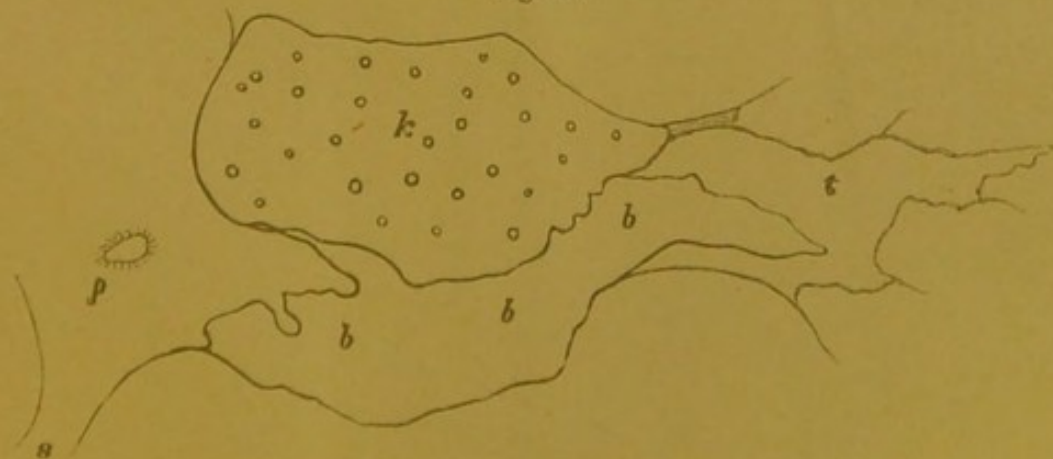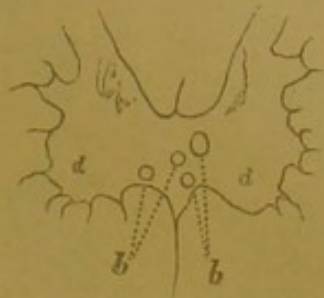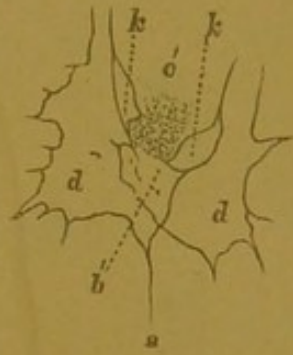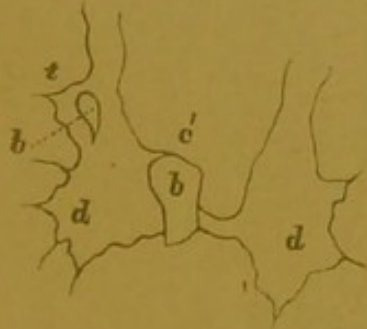
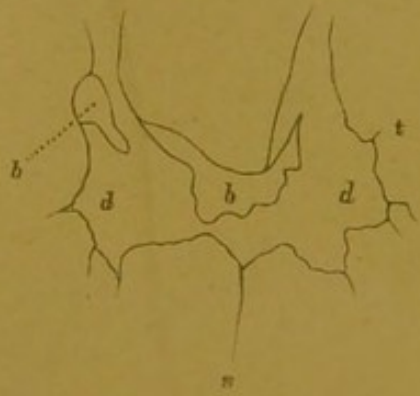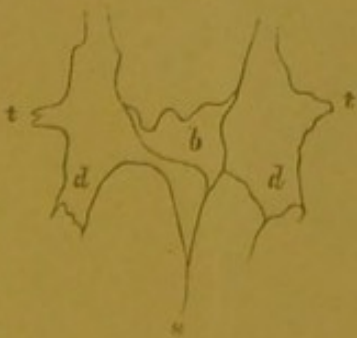PLATE V.

Fig. 19.

Fig. 20.

Fig. 21.
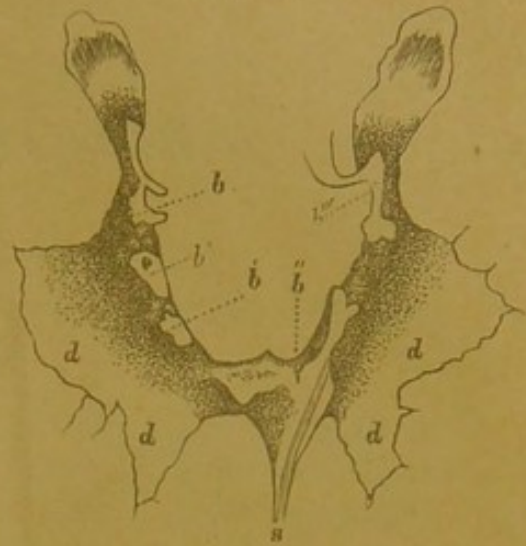
Fig. 22.

Fig. 23.

Fig. 24.

Fig. 25.

Fig. 26.

PLATE VI.

Fig. 27.

Fig. 28.

Fig. 29.
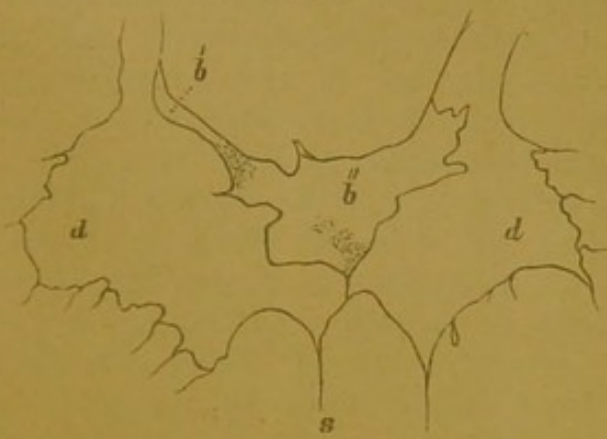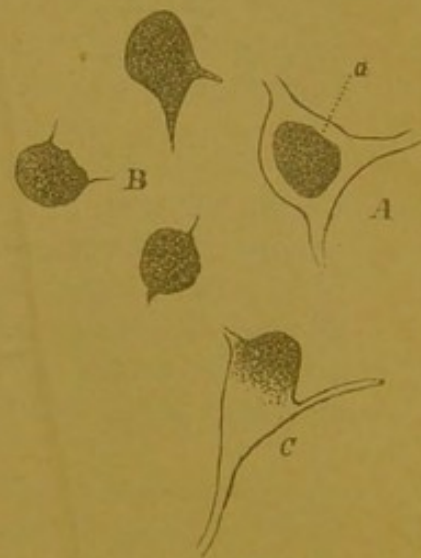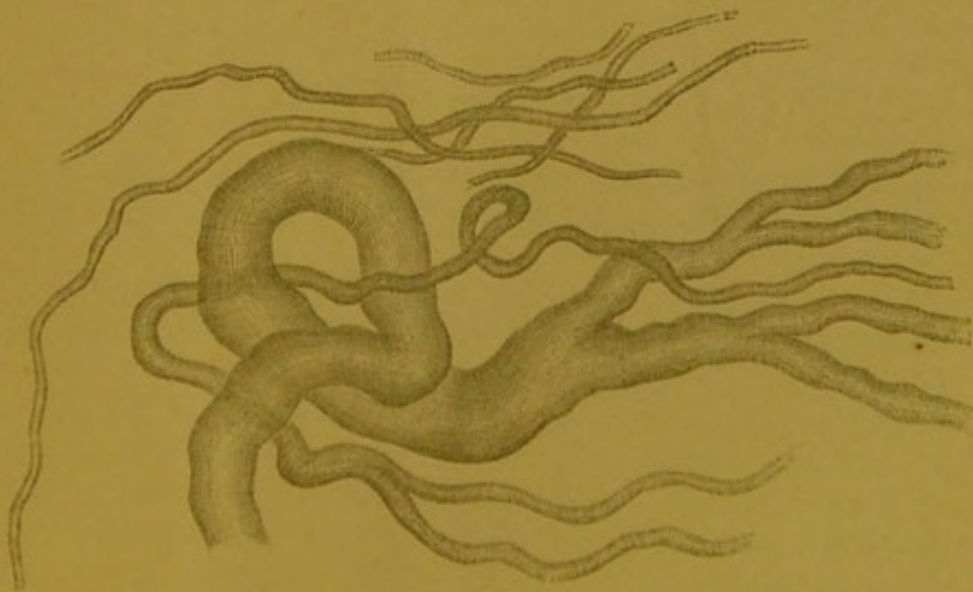
Fig. 30.

J. L. C. del.

Fig. 31.

× 150

EXPLANATION OF THE PLATES.

PLATE I.

*To illustrate Dr. Beale's observations on very fine Nerve Fibres,
&c., page 19.*

THE drawing represents a large plexus composed entirely of very fine fibres (under 1-60·000th of an inch in diamenter) from the bladder of the common frog. The trunks which enter into its formation are also composed of very fine fibres alone. Bundles of fibres are seen to cross from one side of the plexus towards the opposite. Indeed, the general arrangement of the very fine fibres composing this plexus is much the same as that observed in the case of the bundles of large nerve fibres which enter into the formation of the ordinary plexuses.

Nuclei are seen in connection with some of the fibres. To the left, a compound fibre consisting of eight or nine fine fibres is seen to pass off. Some of the fibres entering into the formation of this branch are derived from the upper, and others from the lower, part of the plexus. A similar arrangement is noticed in the case of all the other trunks. Indeed, all nerve trunks are composed of fibres which have proceeded from opposite directions.

The plexus delineated was not visible in the recent specimen, but after the prolonged action of dilute acetic acid, it, with many fibres composed of similar fine fibres, became perfectly distinct. Magnified 700 diameters.

PLATE II.

To illustrate Mr. Lockhart Clarke's observations on the Structure of the Spinal Cord in a Case of Wasting Palsy, page 3.

Fig. 1.—Patch of degeneration from the lower part of the conus medullaris of the spinal cord. A portion of degenerate nerve fibres; *a*, the same becoming broken up or granular toward the edge of a transparent area B, in the centre of which is a group of the finest granules. C, degenerate nerve fibres at the opposite edge of the transparent area. × 420 (see § 1).

Fig. 2.—Transverse section of the lower part of the conus medullaris. *c, c,* posterior white columns; *e e,* anterior, white

columns; *b,* posterior grey substance; *d,* anterior grey substance; *a, a,* morbid mass obliterating all the central parts of the grey substance, and containing small transparent patches represented at B, Fig 1; *s,* anterior median fissure. (See § 2.)

Fig. 3.—A transverse section from the same region of a healthy cord, showing the normal quantity and shape of the grey substance.

Fig. 4.—A transverse section through a higher part of the conus medullaris of the diseased cord. *b,* the transparent gelatinous substance; *a,* the morbid mass, replacing all the central parts of the grey substance, as seen on comparing it with.

Fig. 5.—Which represents a similar section (see § 3) of a healthy cord.

Fig. 6.—Transverse section of the diseased cord through the lower part of lumbar enlargement. (See § 4.)

Plate III.

To illustrate Mr. Lockhart's Clarke's observations on the Structure of the Spinal Cord in a Case of Wasting Palsy, page 31.

Fig. 7.—A transverse section of a healthy cord from the same as Fig. 6. *g,* posterior median fissure; *i,* anterior nerve roots; *f,* posterior nerve roots.

Fig. 8.—Transverse section through the upper third of the lumbar enlargement of the diseased cord. *c,* superficial portion of the white posterior columns, very much softened on the opposite side; *c′,* deeper portion of the same columns, affected by granular degeneration at the point where they rest on the transverse commissure of the grey substance; *k,* remains of the posterior vesicular column, from which a process of connective tissue separates the posterior white columns into two parts, *c, c′.* (See § 5.)

Fig. 9.—Transverse section of the grey substance of diseased cord at about the middle of the upper third of the lumbar enlargement. *c, c′,* posterior white columns; *k, k,* posterior vesicular columns; *e, e,* anterior white columns. (See § 5.)

Fig. 10.—Represents another section from the same cord, a little higher up. The form of the grey substance on each side is considerably altered. *m,* a pyriform patch of finely-granular degeneration, in the substance of the cervix cornu, on the outer side of posterior vesicular column *k.* On the opposite side of the cervix cornu, *n,* is exceedingly narrow, and contains

no traces of posterior vesicular column, but is joined to its fellow on the right side by processes of connective tissue, which divide the posterior white columns *c c′* into several irregular parts.   (See § 5.)

Fig. 11.—A transverse section of the grey substance at the upper end of the lumbar enlargement, showing a curious deviation from the normal shape, as may be seen by comparing it with Fig. 12.   (See § 5.)

Fig. 12.—Represents a corresponding section of one side, and part of the other from a healthy cord.

PLATE IV.

To illustrate Mr. Lockhart Clarke's observations on the Structure of the Cord in a case of Wasting Palsy, page 36.

Fig. 13.—Transverse section of the grey substance of the diseased cord at the lowest part of the dorsal region.   (See § 6).

Fig. 14.—A corresponding section from a healthy cord. Here the lateral halves, with their posterior vesicular columns, *k, k*, stand widely apart, and are joined only by the posterior transverse commissure.   In the diseased section, fig. 13, *k k* are brought closely together; the form of the entire grey substance resembles that of the higher mammalia.

Fig. 15.—A transverse section of the grey substance of the diseased cord at the upper part of the lower third of the dorsal region.   Behind *c* the posterior cornua are united by a process *a* of connective tissue; and between *c* and *c′*, the two remaining portions of the posterior white columns in the central line, were several morbid patches, *b, b, b*, of transparent granular degeneration.   The whole form of the grey substance is strangely altered.   (See § 6).

Fig. 16.—A transverse section of the grey substance of the diseased cord at the lower part of the middle third of the dorsal region.   Its two lateral halves are unsymmetrical.   Compare *d, d, k, k*, and *t, t*.   (See § 6).

Fig. 17.—A transverse section of the grey substance of the diseased cord at the lower part of the upper third of the dorsal region.   *k, k*, Posterior vesicular columns; *t, t*, tractus intermedio-laterales; *b, b*, several clots of blood, effused from a varicose and degenerate vessel, in the centre of the right lateral half of the grey substance.   (See § 7).

Fig. 18.—Part of a similar section about two lines higher up, magnified 60 diameters.   *p*, The central canal of the cord,

surrounded by epithelium; *s*, the anterior median fissure; *k*, the posterior vesicular column of the right side; *t*, the tractus-intermedio-lateralis of the same side. Immediately in front of *k*, and extending into *t*, was a large irregular clot of blood, *b, b, b,* imbedded, as in fig. 17, in the central portion of the right lateral half of the grey substance. (See § 7.)

PLATE V.

To illustrate Mr. Lockhart Clarke's observations on the Structure of the Cord in a case of Wasting Palsy, page 37.

Fig. 19.—A transverse section of the entire grey substance of the diseased cord, near the middle of the dorsal region. The anterior cornu, *d*, on the left side, is much smaller than on the right, and is thrown or drawn backward away from the anterior median fissure, *s*, together with the corresponding t r a c t u s i n t e r m e d i o - l a t e r a l i s, *t*, the posterior cornu, and its posterior vesicular column, *k*. (See § 7.)

Fig. 20.—A transverse section of the grey substance of the diseased cord at the lower part of the cervical enlargement. Posterior horns cut off for economy of space. *b, b,* Four dilated blood-vessels cut more or less transversely, in the centre of the grey substance around the canal. (See § 8.)

Fig. 21.—A similar section a few lines higher up. In the centre of the grey substance, the cut ends of two dilated blood-vessels are seen to be surrounded by a finely granular area of degeneration, *b*, which destroyed the posterior commissure. (See § 8.)

Fig. 22.—A similar section about half an inch higher up. The morbid area, *b*, triangular in form, has increased in extent, and encroached backward on the under part of the posterior columns, *c'*, which, at this spot, are also affected by granular degeneration. (See § 8.)

Figs. 23 & 24.—Two similar sections nearer the middle of the cervical enlargement. *b, b,* Show the form and extent of the morbid area. (See § 8.)

Fig. 25.—A similar section at the middle roots of the third dorsal nerves. (See § 8.)

Fig. 26.—Another section a few lines higher up. *a*, Granular remains of the anterior commissure, surrounded by *b, b'*, a transparent area of degeneration. (See § 8.)