University of Glasgow.

THESIS FOR THE DEGREE OF M.D.

OBSERVATIONS

ON THE

SPINAL CORD IN THE INSANE.

BY

R. S. STEWART, M.B. AND C.M.

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THESIS.

ATTENTION was directed for the first time in England to the condition of the spinal cord in the insane by Dr. Buckmill in 1851 in the Annual Report of the Devon County Asylum, where, as the result of numerous observations in general paralysis, he expresses the view that the spinal cord presents in that affection a less diameter than ordinary, and that probably atrophy of the cord, in addition to the changes observed in the brain, is peculiar to that disease. As the result of further investigation he describes an apparent induration and atrophy of the white fibrous matter of the cord, a deepening of the colour, and softened consistence of the central grey matter, and an unduly rough and discoloured condition of the spinal membranes, as conditions commonly associated with general paralysis.*

Dr. Boyd, in the *Journal of Mental Science* for 1871, gives the results of his observations on the spinal cord in 161 cases, and of these he found only six in an apparently normal condition. Of the remainder, the cord was either softer than normal, or harder, tougher, and wasted, or the cerebro-spinal fluid was in excess, or contained blood.

Changes are described by Westphal as occurring in the spinal cord of general paralytics, and upon these he bases a classification of the affection into—*1st*, a tabic, and *2nd*, a paralytic form. He summarises the changes as—*1st*, Affections of the posterior columns; *2nd*, Affections of the lateral columns; and *3rd*, Mixed affections of the lateral and posterior columns. He views the spinal affection as occurring independently of the cerebral disorder.†

Reference is made to the condition of the spinal cord in all the standard English works on mental diseases, but generally

* *Psychological Medicine* (4th Edition), p. 602.
† Blandford's *Insanity and its Treatment* (3rd Edition), p. 320.

it applies to that distinct type, general paralysis. Dr. Bucknill * expresses the view that the cerebral and spinal diseases must be regarded as simultaneously existing in general paralysis, in certain respects independently of each other. Sankey † mentions the occurrence of disease of the spinal cord in general paralysis, and section IV of his Lectures is devoted to the consideration of spinal disease with mental symptoms. Here special mention is made of multiple sclerosis and locomotor ataxia, and three cases of general paralysis described by Westphal, where the spinal symptoms preceded the mental alteration. The occurrence in old lunatics of symptoms of lateral sclerosis is likewise noted. Blandford, ‡ speaking of the condition of the spinal cord, instances cases where paraplegic symptoms preceded by some years the symptoms of general paralysis, and he assumes that the grey matter either of the cerebral or spinal centres is the seat of the morbid lesion, the essential nature of which is a slowly progressing degeneration of an inflammatory character. A case of general paralysis supervening on locomotor ataxia of some years is recorded by Clouston, § where disease of the posterior and anterior columns of the spinal cord was found, and in his definition of the disease he says it is characterised by a spreading of the morbid process to the whole of the nerve-tissues in the body.

In Julius Meikle's work ‖ the results arrived at by fourteen different observers as to the condition of the spinal cord in general paralysis is given. Westphal was unable to trace the morbid changes higher than the foot of the cerebral peduncle, but these have been found by Rubenau and Huguenin as high up as the corona radiata. Mickle views the spinal affection as occurring secondary to the cortical brain lesion, or in some cases to a lesion situated lower down in the cerebro-spinal axis. In the *Journal of Mental Science* (April, 1885, p. 53, and April, 1882, p. 65), he describes cases of general paralysis and other forms of insanity (mainly organic) associated with spinal lesions.

The changes in the spinal cord in general paralysis are described by Savage ¶ as of three kinds—*1st*, General wasting; *2nd*, Disease of the posterior columns; and *3rd*, Disease of the

* *Op. cit.*, p. 608.
† *Lectures on Mental Diseases* (2nd Edition), pp. 307 and 364.
‡ *Op. cit.*, p. 320.
§ *Mental Diseases*, p. 364.
‖ *General Paralysis of the Insane*, p. 131.
¶ *Insanity and Allied Neurosis*, pp. 349 and 316.

lateral, or lateral and anterior columns; and cases are instanced of ataxy preceding general paralysis, the simultaneous development of these and of general paralysis, with lateral sclerosis. In the *Journal of Mental Science* for April, 1884, he describes several cases of general paralysis with lateral sclerosis of the spinal cord. Two cases of locomotor ataxia, with mental symptoms simulating those of general paralysis, are described by Bevan Lewis, and Plaxton in the *Jour. Ment. Sc.* for July 1878, p. 274, and in the same Journal for July, 1878, Dr. Gairdner describes three cases resembling general paralysis, but without insanity, associated with symptoms of motor non-co-ordination.

The occurrence of changes in the spinal cord in general paralysis is thus a well attested fact; but my own observations lead me to believe that, constant as these changes are in general paralysis, they are by no means of unfrequent occurrence in other varieties of insanity, at all events when the duration has been of any length.

The cases which are considered in the following pages with a view to the investigation of the condition of the spinal cord, are twenty in number, divisible as follows:—

General paralysis, - - - - - -	5
Dementia, - - - - - - -	6
Melancholia, - - - - - - -	4
Imbecility with epilepsy, - - - -	4
,, without epilipsy, - - -	1

With two exceptions the duration of the mental disorder at death was not under a year. The exceptions are one case of general paralysis where the duration was six months, and one case of melancholia of ten months. An opportunity for investigation of the spinal cord in a very recent case of insanity has not offered itself, so that the description here applies mainly to cases of considerable duration.

CASE I.—Summary—*General paralysis of eighteen months—Irish extraction—history of a "fit"—mental condition, one of advancing dementia—pronounced motor symptoms, facial tremor, and speech hesitancy—exaggeration of deep reflexes—rigidity and contracture of legs and arms—congestive seizures, followed by aggravation of mental and bodily condition—progressive dementia and motor paralysis—muscular hyper-excitability and atrophy—sacral and trochanteric eschars—death.*

Michael H., age 29, was admitted on 17th May, 1884. His parents were Irish, but he himself was born in Wales. No history of neuropathic antecedents could be obtained, and both himself and parents had been of temperate habits. The first alteration observed was his talking foolishly about five months before admission, and four days before admission he is said to have had a "fit," during which he was convulsed. He seems never to have had any grand delusions. His mental condition on admission was one of mild dementia; he was pleasant and good natured, apparently indifferent about coming to the asylum; memory was not much impaired, but there was a considerable degree of confusion of ideas. There was marked facial tremor and speech hesitancy. The legs were slightly rigid; spinal trepidation was easily induced; the patellar reflex was markedly exaggerated on the two sides; tendon reflexes existed at the wrists and elbows; but the superficial reflexes were normal. Seven weeks after admission he had a "congestive seizure" of considerable severity with, for two days, complete loss of consciousness, paralysis of the lower limbs, and occasional nystagmus. This was followed by a marked deterioration both mentally and physically. Six months after admission he had another congestive seizure. The dementia and motor helplessness steadily advanced until, ten months after admission, he was completely confined to bed. At this date there was pronounced rigidity and contracture of the legs, which were so flexed that the heels lay in contact with the buttocks. It was impossible to extend the limbs, and any attempt to do so gave rise to expression of pain. The arms, too, were rigidly flexed and firmly applied to the chest, the hand assuming a posture not unlike that of the "writing hand" of paralysis agitans, the fingers slightly flexed at the metacarpo-phalangeal articulations, and extended at the other joints, the thumb extended and loosely applied to the index. The pupils were equal, of moderate size, and insensitive to light. Slight tremors of the muscles of the arms and legs were noted, and the muscles generally responded with undue readiness to slight mechanical irritation, such as a tap with the finger, while they were markedly wasted. Bedsores developed over both trochanters and over the middle line of the sacrum. These increased until they assumed very grave dimensions, the sacral sore penetrating into the substance of the bone. Two days before death retraction of the head was observed. Death occurred on 28th May, 1885, after a residence of about a year.

The autopsy was performed twenty-four hours after death, and the following changes noted as regards the brain and spinal cord. A large eschar existed over the middle line of the sacrum, exposing the bone which was friable, easily penetrated by the knife, and infiltrated with fœtid pus. Over each trochanter was another, but smaller sore. On opening the spinal canal nothing noteworthy was to be observed until the dural cavity was opened, when a quantity of greyish offensive purulent fluid escaped. On exposing the soft membranes posteriorly, they were found covered with a greyish fibrinous exudation, and bathed with pus. This condition extended over the whole posterior aspect of the cord, and over this area the membranes were pink and injected. On removing the cord and exposing its anterior aspect, the same greyish exudation and purulent secretion were found, both, however, in smaller quantity than osteriorly. The cord itself was soft generally, more so, however, in the lower dorsal third, where it was quite diffluent; the cervical and lumbar enlargements were the firmest parts. The only change apparent on section beyond the generally soft condition was an undue pinkness and vascularity of the central grey matter. The calvarium weighed 14 ounces, and was not unduly adherent or otherwise abnormal. Externally the dural sac appeared normal, but on opening it the same fœtid pus, as was found in the spinal dura, escaped in considerable quantity, and the soft membranes presented the same greyish exudation over their whole extent. In addition, the membranes over the right convexity were stained of a reddish brown colour, apparently the result of an old meningeal hæmorrhage. Over the convexity on both sides small granulation-looking eminences were seen projecting from the soft membranes, and breaking the continuity of the otherwise smooth and glistening surface. There was extensive adhesion of the soft membranes, and on removal of these, decortication of the convolutionary tips over an extensive area, comprising on the left side parts of the bases of the first, second, and third frontal, the lower third of both central convolutions and part of the first temporal, and on the right side, the bases of the second and third frontal, the lower two-thirds of the central convolutions, and part of the supra-marginal gyrus. The grey matter of the cortex and basal ganglia was of a uniform slaty colour, while the medullary substance was very pale. The brain weighed 40 ozs. The ventricles were not dilated; they contained yellow serum, and their liming membrane was smooth

and glistening. Pieces of brain* and spinal cord were immersed in Müller's fluid, but owing, apparently to changes induced by the putrefactive processes, the pieces of nervous tissues did not harden very satisfactorily, and it was only with considerable difficulty that sections could be prepared and mounted for examination. Sections of brain were stained in dilute carmine; and sections of the lumbar enlargement with picro-carmine and with osmic acid.

Brain.—With regard first to the vessels, there is a very notable increase of the vascularity of the cortex, the smaller arteries and capillaries being gorged with blood, and forming a prominent vascular network. In both cortex and medulla the small arteries present considerable thickening of their walls, limited mainly to the middle coat. Numerous deposits of hæmatoidin crystals and granules are seen in the vascular sheaths, in the substance of the arterial walls themselves, and scattered here and there through the tissue independently of the vascular distribution. The large pyramidal cells of the deeper layers of the cortex are notably atrophied and degenerated. Very few are to be seen of the normal size and distinctness; the majority are of a more or less rounded form, with indistinct and withered-looking processes; while the substance of the cell has a yellow granular appearance, the nucleus alone taking on the usual carmine tint. The smaller pyramidal and round cells do not present any material alteration. The pia mater is considerably thickened, and here and there it is covered with an exudation, consisting of round cells and fibrine. The superficial non-cellular layer of the cortex presents a swollen spongy appearance, and its neuroglia cells are numerous, prominent, and very large. The neuroglia of the remainder of the cortex has a rather coarse appearance.

Spinal Cord.—As above mentioned, sections only of the lumbar enlargement were examined. To the naked eye, and more distinctly with a low magnifying power, it is at once apparent that the lateral column on each side is the seat of sclerosis. The area of sclerosis has a triangular outline; anteriorly it reaches as far forward as a line on a level with the junction of the posterior columns and gray commissure;

* Unless it is stated to the contrary, the pieces of brain tissue removed for microscopical purposes were always taken from the upper end of the central convolutions in the neighbourhood of the paracentral lobule. The reasons for this were, that uniformity might be attained, so that sections from different cases might be submitted to comparison; and secondly, because in this region all the structural elements of the cerebral cortex, including the large pyramidal giant cells, are most highly developed.

externally it reaches quite to the periphery; and internally it is separated from the posterior cornu by a narrow strip of comparatively healthy tissue. In this area the customary appearances of sclerosis are noted; an increase in the connective tissue structures, and a diminution in number and size of the nerve tubes. The remaining white columns are normal. In the gray substance there is a decided increase of vascularity, more pronounced in the posterior cornua than elsewhere, and the walls of the small arteries are thickened. With regard to the nerve cells, changes too are very apparent. In the anterior cornua, most of the multipolar ganglion cells show a tendency to rounding off of angles and atrophy of processes, while the whole cell presents a yellow granular appearance. The same condition of nerve cells, though much less pronounced, is found in the posterior cornua. The pia mater is uniformly thickened, spongy-looking, and infiltrated with round cells, while its epithelial cells show a tendency to proliferation. The central canal is obliterated; amyloid bodies in moderate numbers are found scattered the section, and over a few granule cells exist in the areas of degeneration.

According to Westphal's classification, this is a case of general paralysis of the *paralytic* form. The symptoms manifested during life, and the appearances presented on microscopic examination, indicate a diseased condition of the central spinal gray substance, as well as of the lateral columns. The primary spinal affection was probably the sclerosis of the lateral columns, manifesting itself by the contracture, rigidity, and exaggeration of deep reflexes; but the occurrence later on of muscular atrophy, bed-sores, &c., point to an extension of the disease to the central trophic regions of the cord.

CASE II.—Summary—*General paralysis of 4 years and 8 months—initial symptoms, hesitation of speech, followed by loss of memory, impairment of handwriting, and mental failure—symptoms of ataxia, with loss of knee-jerk—hæmatoma auris—ischio-rectal abscess—emaciation—pressure-sores—syncopal apoplectiform seizures—pupillary symptoms rigidity and tremors of arms—rigidity in flexion of both legs.*

John S., a draper, age 42, was admitted on 21st August, 1884. His condition was one of advanced general paralysis, the disease extending over four years. It was attributed to business reverses. The first indication of alteration was a

hesitation in his speech, a halting between the individual syllables of a word. Shortly after, his memory began to fail, and then his writing became impaired. He never had any grandiose delusions. His mental condition on admission was one of deep dementia, with thick and indistinct speech, and with little remaining intelligence. There was inequality of the pupils, with loss of their reaction to light, though not to accommodation. The patellar reflex was entirely absent, and he had great difficulty in maintaining his equilibrium when walking, especially in turning, or when standing with his feet in apposition, the difficulty being much exaggerated by closure of the eyes. There was very considerable motor feebleness generally, without, however, any absolute loss of voluntary motor power, and the muscles were much atrophied.

In January 1885 an ischio-rectal abscess formed, discharged, and healed slowly, and at this time it was noted that he began to lose flesh and strength in a marked manner, and that pressure sores tended to develop.

On 18th March a somewhat sudden change occurred, characterised by collapse, a feeble pulse of 112, and sighing respiration of 32 per minute. There was considerable, though not complete loss of consciousness, and conjugate deviation of the eyes upwards and to the left, with twitching of the left arm and leg. In a few days the immediate effects of this attack passed away. At this date the plantar reflex was found slightly present, the cremasteric and the epigastric absent. Both arms were the seat of considerable rigidity, with fine muscular tremors. No response could be elicited to painful impressions on any part, such as transfixing a fold of skin with a pin. Although very demented, and passing his evacuations in bed, he still understood simple remarks addressed to him. He was able to execute simple movements which he was desired to make, lifting, for example, either leg or arm, showing that there was no absolute motor paralysis.

From March onwards he became gradually more and more demented; his legs assumed a constant position of fixed flexion, and there was much rigidity and emaciation of the muscular masses. The arms, too, were very rigid, the fingers flexed, with the thumb bent underneath them. Loss of consciousness supervened, and he died on 9th April, 8 months after admission.

The autopsy was made 8 hours after death. A much emaciated body with bed-sores on sacrum and both trochanters; extreme rigidity in flexion of knees and hip-joints. The spinal dura mater presented nothing remarkable, but there

was increased vascularity of the soft membranes towards the lumbar region. The cord itself was firm, and on section the only naked-eye changes were an undue pinkness of the central grey matter and a greyish tinging of the posterior white columns in the lumbar region. Its measurements* were as follows:—

	Transverse.	Sagittal.
Cervical, ...	14	9·5
Dorsal, ...	8·5	7·5
Lumbar, . . .	10	9 mm.

These would indicate a slight degree of wasting, more pronounced in the lower regions of the cord. In the brain atrophic changes, evidently of some duration, were found. A soft thin pellucid membrane of a reddish tint, and peeling off easily, was found on the inner surface of the dura, extending mostly over the left convexity. Under the soft meninges over the left half of the pons, there was a recent hæmorrhagic effusion extending superiorly from the upper border of the pons quite into the upper cervical region of the cord. The calvarium weighed 15½ ozs. Thesoft membranes throughout, but more especially over the convexity, were gelatinous and opaque, but nowhere were they adherent to the underlying convolutions, from which they were separated by a considerable quantity of subpial fluid. The brain tissue was soft and œdematous; the cortex in the fronto-parietal regions appeared wasted, and the inner of its three apparent layers presented a pinkish tinge. The central white substance had a brownish tint. The brain weighed 42 ozs. Beyond slight fatty infiltration of the liver, the other organs presented nothing noteworthy.

Microscopic Examination—Brain.—The pia mater appears normal, and attached to the cortex by a few vessels only. Many of the smaller arteries are irregularly dilated and varicose, and deposits of hæmatoidin occur frequently in their sheaths. The large pyramidal cells are shrunken and wasted looking, and almost all of them have a more or less general yellow granular appearance, the nucleus being the only part of the cell which takes on the carmine staining perfectly. Their outlines are ill-defined and their processes shrivelled. *Cord.*—White substance: The supporting connective tissue

* The measurements of the normal cord are—

	Transverse.	Sagittal.
Cervical, ...	13 or 14	10
Dorsal, ...	10	8
Lumbar, ...	12	9 mm.

—Erb in Ziemssen's *Cyclopedia of Medicine*, vol. xiii, p. 11.

generally, appears to be much increased. Its septa are both more numerous and much thicker than normal; the nerve fibres are diminished both in number and size, and the glia cells are large and numerous. The walls of the arteries are much thickened and their nuclei increased in number. Granular cells and pigmentary deposits occur frequently in the perivascular sheaths, and here and there are larger collections of hæmatoidin granules and crystals, suggesting previous hœmorrhages. Numerous granule cells occur both in the white and grey substance, often disposed in a linear fashion, as if following the vascular distribution. There is increased vascularity of both grey and white, the vessels standing out dilated and prominent; many of the small vessels are varicose, and the connective tissue surrounding them appears to be in excess. The pia is somewhat thickened, more especially over the posterior columns and the posterior part of the lateral columns. A collection of blood pigment and debris is seen under the pia over the left lateral column of the cervical region, evidently the result of the meningeal hæmorrhage before alluded to. The process of sclerosis of the white substance, while affecting the whole cord and the whole of its transverse section, is not equally distributed. It attains a greater intensity in the posterior columns and in the lumbar region, more so than elsewhere. In this region the columns of Burdach are most deeply tinted with carmine, and here the sclerotic tissue appears in a manner to interrupt the fibres of the internal radicular fasciculus.

The nerve cells of the central grey substance present distinct evidences of degeneration; all of them, while not materially altered in outline or much diminished in size, are of a yellowish colour and granular appearance, only taking on the carmine incompletely. This applies pretty equally to the multipolar corpuscles of the anterior cornua, to the smaller cells of the posterior cornua, and in the dorsal region to the cells of the vesicular columns of Clarke. In all these cells the nucleus is intact and well marked.

This is an instance of the *tabic* form of general paralysis, but here again it is not the posterior columns which are alone affected. The diseased condition is a more widely spread one, and affects the whole transverse area of the cord, both grey and white, always, however, attaining its highest development in the posterior columns. It is hardly possible to determine positively whether the spinal disease preceded the mental; the history would rather indicate that the first manifestations of disease were mental.

CASE III.—Summary—*General paralysis of two years and four months—attributed to sexual excesses—mental symptoms—a degree of dementia, with confusion of ideas, resistiveness and depression—delusions, exalted and melancholic—loss of memory—insomnia—motor symptoms—tremulous and unsteady gait—tremors of muscles of arms—exaggeration of deep reflexes—deficiency of cremasteric reflex—partial analgesia—congestive seizure with clonic spasms of muscles of left side, followed by temporary left hemiplegia. Transient motor excitement—gradual deepening of dementia and advancing paralysis—emaciation; bed-sores—convulsive seizures—coma and death.*

Evan E., 40, a native of Wales, single, a shoemaker, was admitted on 17th January, 1885. He was a man of loose and immoral habits, and much addicted to sexual excesses. An alteration in his manner was observed about two years before admission, a tendency to lying and mischief making developing itself, and he left off work six months before admission. His mental condition on admission was one of mild dementia, with considerable confusion of ideas, and a trace of depression and resistiveness. He had various delusions. He wandered aimlessly about, resisting any interference with his movements, and giving expression to such phrases as "Everybody hates me," "They are killing them; they are all dead, and I'm here all alone." He asserted, too, that his mother had millions of money. Memory for past and recent events was much impaired, and frequently his nights were restless and sleepless. His physical condition was good; he was a well nourished man, inclining to obesity; complexion sallow and pasty; expression dull and stupid looking. His gait was tremulous and unsteady, and the muscles of both arms were the seat of fine tremors. The patellar reflex was exaggerated, equally on the two sides; the plantar reflex was present, but the cremasteric was deficient; sensibility to painful impressions, such as pricking with a pin, was much deadened generally.

March.—He had a convulsive seizure, in which there was almost complete loss of consciousness, twitching of the muscles of the left limbs, and conjugate deviation of the eyes, and rotation of the head to the left. This was succeeded by left hemiplegia, which was recovered from in a few days, and by a permanent aggravation of the mental symptoms.

April.—For a few days there was a considerable degree of motor excitement. He rolled about helplessly on the floor of the padded room, in which he was confined, tumbling his bed-

clothes about. He became gradually more and more paralysed and helpless, so that, by the end of this month, he was entirely confined to bed. The dementia deepened; the features became heavy and relaxed, with a meaningless vacant expression, and he passed his evacuations in bed. He gradually lost both flesh and strength, and his skin became muddy and greasy. A bed-sore developed on the left gluteal region.

May.—On the 15th clonic spasms supervened, affecting chiefly the right side of the mouth and, to a less extent, the right side of the face and right arm. These continued for two days: coma supervened, gradually deepened and ended in death on the 17th.

The autopsy was performed twenty-one hours after death. The spinal dura mater presented nothing noteworthy; the small vessels of the pia were slightly injected throughout, and over the posterior aspect of the lumbar enlargement the veins were gorged with blood. The only noticeable change on section was an increased vascularity of the central grey substance. Its measurements were—

	Transverse.	Sagittal.
Cervical, ...	13	10
Lumbar, ...	10	9 mm.

The calvarium weighed 13½ ozs., and was firmly adherent to the dura, which was otherwise unchanged. The soft membranes were congested and opaque, especially over the convexity, but nowhere were they adherent. The brain tissue was rather soft and œdematous; the inner cortical layer had a pinkish tint, and the central medullary substance was slightly brownish. The puncta were prominent, and the arteries of the basal ganglia much injected. No gross lesion was discovered.

Microscopic Examination.—Sections of *brain* were stained in dilute carmine, and the following appearances noted:—Both the white and grey matter appear unduly vascular; in many of the smaller arteries there is considerable thickening of the walls and narrowing of the lumen, owing, apparently, to hypertrophy of the middle coat; in others, again, there are irregular dilatations, while in many instances the perivascular lymphatic spaces are much distended and occupied by brown pigmentary granules and granular cells. Deiter's cells are large and prominent in the outer non-cellular layer of the cortex. The normally large pyramidal cells are diminished in size, and are badly defined in outline; their processes are wasted, and a degree of granular degeneration exists in all.

In sections stained in one-eighth per cent solution of osmic acid, the only notable appearance is a slight brown staining of the large nerve cells.

Spinal Cord.—With regard to the white substance, changes are noted, both in the posterior and lateral columns, in the cervical and lumbar enlargements. In the *cervical* region the columns of Goll are in carmine tinted sections of a darker shade than the remaining white substance. This is distinctly limited to the postero-internal columns forming a wedge-shaped area, not reaching as far forward as the central grey matter. In the posterior part of each lateral column, likewise, there is an area of deeper staining. These last areas of degeneration are symmetrically disposed ,and are of a triangular outline. Externally each is separated from the periphery by a narrow zone of healthy nerve tissue. Anteriorly its limits are not well defined, as it tends to shade off into the normal tissue, but it reaches as far forward as the level of the central canal. All along its internal margin it is in contact with the grey substance. These areas present all the usual appearances of columnar sclerosis.

In the *lumbar* cord the degeneration of the posterior columns is much more restricted, being here confined to a small narrow strip lying on each side of the posterior median fissure, and not reaching either to the central grey matter anteriorly or posteriorly to the periphery. Here, also, the posterior portion of each lateral column presents the same appearances as in the cervical region. The area of degeneration preserves its triangular outline, but it is much smaller in extent; externally it is in contact with the periphery, but internally it is separated from the posterior cornu by a layer of normal tissue. There is no degeneration of the anterior or postero-external columns.

Even with a low power the yellow granular appearance of the nerve cells of the grey substance is very apparent. This condition applies almost without exception to every individual ganglion cell of the anterior cornua, and to a less degree to the smaller cells of the posterior cornua, both in the cervical and lumbar enlargements. The degeneration is more advanced in some cells than in others. In most instances it appears to begin round the nucleus, which is obscured by the granular clusters surrounding it, but in some instances it originates in one or more of the angular recesses of the cell, or in one or both poles of the bipolar cells. Some of the cells are in process of active disintegration with broken-down processes and ill defined outlines, the whole cell in some instances

presenting little but a mass of granules with an obscured nucleus embedded in it. There is a considerable increase in the vascularity of the central grey matter, and the walls of the arteries are in many instances much thickened.

CASE IV. Summary.—*General paralysis of 6½ months—dementia, with slight excitement and general restlessness, facility, and emotional disposition—tremors of face, lips, arms, and legs—hesitancy of speech—exaggeration of deep reflexes—progressive dementia and failure of voluntary motor power—emaciation—eschars—ischio-rectal abscess—coma—death.*

Isaac G., a German Jew, a picture framer, age 40, was admitted on 12th January, 1885. No hereditary predisposition to insanity, phthisis, or intemperance could be ascertained. For a year his bodily health had been failing, and the mental affection, attributed to business reverses, was of two months' duration on admission. His mental condition on admission was one mainly of mild dementia, with a trace of exaltation. He was emotional and facile, talked constantly in a rambling fashion, said he was strong and happy, and thought he had no tongue. His body, generally, was well nourished, but his face was sunken and aged-looking, and of a dark, muddy-olive tint. The pupils were equal, of moderate size, and responsive both to light and accommodation. There was very pronounced tremor of the facial, labial, and lingual muscles, and speech hesitancy. The arms and legs likewise were the seat of tremulous and jerky movements, of a coarse description, and aggravated by attempts at voluntary movements. His gait was shaky and uncertain, and both patellar reflexes were in excess. Feeding by hand was required almost from his admission, for two reasons—a tendency to hastily bolt his food, and because of the great disability owing to the marked jerkings of the arms on voluntary movement. The mental deterioration and motor helplessness advanced progressively, so that, a month after admission, he appeared to be quite unable to understand anything beyond such simple requests as asking him to put out his tongue. He became defective in habits, and so feeble and shaky that he was hardly able to walk, or even to sit on an ordinary chair, although he was able to spend the greater part of the day in a reclining chair. Four months after admission the helplessness had become so extreme as to require his confinement to bed, and from this onwards he lost flesh and strength until emaciation became extreme. The

face became more muddy and greasy; wrist reflex developed; a large abscess formed in the left ischio-rectal fossa, and a bedsore formed over the sacrum. The muscular tremors, with resistiveness to passive movements, persisted, and the muscles became wasted. Loss of consciousness supervened, gradually deepened into coma, which lasted two days, and terminated in death on 26th May, 1885, his residence being a little over four months.

The autopsy was performed twenty-five hours after death. In addition to extensive atheroma of the aorta, slight congestion of the right pulmonary base, and fatty infiltration of the liver, the following changes were noted:—The calvarium weighed 12½ ozs.; the dura presented nothing remarkable; the soft membranes were gelatinous and opaque generally, but more so over the convexity, while over the inferior surface of the sphenoidal lobes they had a rusty brown tint, the result apparently of an old meningeal hæmorrhage, but they were not anywhere adherent. The cortex was markedly pale, and the central white substance was slightly brownish. Cerebellum and medulla 6½ ozs.

The spinal dura was not altered, but the veins of the pia over the lumbar enlargement were much engorged. The cord itself was firm, and to the naked eye presented little appearance of alteration beyond injection of the central grey substance. Its measurements were:—

	Transverse.	Sagittal.
Cervical, ...	14·5	10
Lumbar, ...	10·5	9 mm.

Microscopic examination of sections of the *brain* reveals changes in the blood-vessels and nerve-cells. Deposits of hæmatoidin particles occur frequently in the perivascular sheaths, more abundantly in connection with the smaller arteries both of the grey and white matter. The large pyramidal cells of the cortex are but slightly diminished in size, but they present a certain indefiniteness of outline and a varying degree of fuscous granular degeneration. In the majority of the cells the nucleus is easily observed, but in some it is completely buried and obscured in the granular mass. Granule cells occur here and there in the central medullary substance.

In the *spinal cord* very apparent alterations are likewise noted, affecting mainly the lateral columns, the posterior columns in the cervical region, and the anterior cornua of grey matter. The lateral columns are the seat of degeneration

throughout their whole extent. In the *cervical* region the cross section of this degenerated tract has a triangular outline; its anterior boundary is not well defined, and is on a level with the central canal; externally, it is separated from the periphery by a narrow strip of comparatively healthy nerve tissue; and, internally, it touches the posterior cornua only near its posterior extremity. In the posterior columns, likewise, in this neighbourhood, an alteration is apparent, the columns of Goll taking on a deeper staining than the external divisions of the columns, evidencing a degree of degeneration. This is strictly confined to the funiculi graciles, and is symmetrically disposed, forming a wedge-shaped area, reaching posteriorly up to the periphery, but, anteriorly, separated from the central grey matter by a tract of healthy tissue.

In the *lumbar* cord the degenerated area in the lateral columns is considerably diminished in size, and is more confined to the posterior extremity of the lateral columns. It extends completely up to the periphery, and nearly to the posterior cornu. In the posterior columns, likewise, the degeneration is much more limited, and occupies only a narrow strip on each side of the posterior median fissure, reaching neither to the periphery, nor to the central grey substance.

The nerve cells of the central grey substance present traces in varying degrees of granular degeneration, without much actual atrophy. The cells are well defined, and their processes intact; but instead of taking on the usual carmine tint, they appear in parts of yellow colour. This varies in degree in different cells; in some it is limited to one, in some to several of the polar recesses, while in others it is more general, obscuring the nucleus, and giving to the cell a uniformly yellow appearance. The smaller arteries and capillaries of the gray appear dilated and prominent. The central canal in this case is double; the two canals lie side by side, and are separated, at least, in the cervical region, by a considerable space which, as well as the space for some distance round each canal, is occupied by densely packed round granular cells.

CASE V.—Summary—*General paralysis of over 2½ years, attributed to overwork—mental exaltation with expansive, delusions, facility, feeling of bien etre—tremor of facial and lingual muscles—hesitancy of speech—inequality of pupils —gradual mental deterioration with variability of moods—transient apoplectiform seizure—transitory paroxysms of mania—gradual failure of bodily health—progressive*

diminution of voluntary motor power—renewed congestive seizure, followed by great helplessness and sacral eschar—temporary improvement—erysipelas of buttocks and abscess of right gluteal region—convulsive seizures—coma—death.

John W., age 35, a native of Glamorgan, a stoker, was admitted on 30th July, 1883. Very little information could be ascertained with regard to his antecedents. The affection had begun six weeks' previously, and was attributed to overwork, but probably alcoholic excesses and domestic unhappiness aided. The mental symptoms on admission were—mild exaltation, expansiveness, facility, and a feeling of well-being and contentment, with delusions of an exalted kind. There was marked tremor of the facial muscles and of the tongue, hesitation of speech, and inequality of pupils.

For eight months after admission, little change beyond slight mental deterioration occurred. There was during this period considerable variability of his mental condition; sometimes he was full of expansive delusions; at other times he recognised their absurdity, and was able to understand that they were deluded ideas.

In March, 1884, the tremor and speech hesitation had become more pronounced, and on the 12th he had a modified apoplectic stroke with transient loss of voluntary power, but with no loss of consciousness. He quickly recovered, and the mental exaltation was retained. His face at this time always wore a happy smiling expression, and there was some fixing of the features, more especially of the upper part of the face, a drawing downwards and inwards of the eyebrows, and longitudinal wrinkling of the brow. In May he became restless and excited, and sleepless at night, and fresh delusions developed. Writing to his wife, he says:—"Give my kind love to all my nabours i will open a scircets (circus) at carphilly castel as son as I get from hear that is a business will get a lot of money . . . i think to travel round the world when I get a little money." This paroxysm of excitement lasted only three days, but it was followed by a noticeable failure of bodily health, his complexion beginning to lose its formerly fresh appearance, and assuming a muddy tint. During the remainder of that year the facial tremor and speech hesitancy became gradually more pronounced, accompanied by corresponding bodily and mental failure.

In March, 1885, in addition to the gradual failure, physically and mentally, it was noted that he was somewhat lop-sided, the left shoulder tending to droop. Muscular power had become much diminished, and more so on the left side. His mental condition betrayed still a trace of his former expansive-

ness, but in this month, what was considered as a suicidal attempt was made. He attempted to cut his throat with a small tooth comb, but the affair was conducted in a most clumsy and indeliberate fashion.

In May, 1885, he had a congestive seizure accompanied by partial loss of consciousness, sickness and vomiting, incomplete loss of voluntary power and involuntary passage of evacuations. On account of the great helplessness he was confined to bed for a few days, and during this period a bed-sore formed over the sacrum, a little to the left of the middle line. Although it did not extend far superficially, it penetrated to a considerable depth, quite an inch, involving in a slough a large piece of loose cellular tissue. This attack was followed by a further aggravation of the mental and bodily symptoms; he became more confused and demented; his habits, previously correct, became defective; he lost very markedly in flesh and strength, and his face wore a pinched look, though still retaining a trace of its happy expression. There was great blunting of sensibility; he suffered no pain, and in fact was quite unaware that he had a bedsore. After a short time he again began to improve, and was able to be out of bed; and by September he was again walking briskly round the airing court; the sacral eschar had quite healed over, and his habits became correct.

In November, a red erysipelatous blush was observed on the right gluteal region, invading also, but in a minor degree, the left side. This gradually extended until it involved the whole gluteal region and back of the thighs. Along with this was a marked aggravation of the mental and paralytic symptoms. He became much more stupid; his habits again became defective; and he became strikingly helpless, and utterly unable to support himself in the erect posture. Ergot and tincture of perchloride of iron were given, and the inflammation gradually subsided; but 18 days afterwards an abscess was found to have developed in the right buttock. After evacuation, healing action set in, and was making rapid progress, when, in December, convulsive seizures supervened. At the onset, these began by twitching of the left side of the mouth, but afterwards involved the left face and arm, and were accompanied by conjugate deviation of the eyes, and rotation of the head to the left. For a considerable time consciousness was not lost, but the clonic seizures became more frequent and more severe, and, limited at first to the left, they afterwards affected only the right face and arm. Consciousness became involved; coma supervened, became gradually more profound, and terminated in death on 20th

December, 1885. The clonic seizures had lasted, in all, 12 days, and little or no effect was produced by chloral hydrate, even in large doses, and administered subcutaneously.

The autopsy was performed 53 hours after death. The dura spinalis was dark and congested, and the cerebro-spinal fluid in considerable excess. The only abnormality apparent to the naked eye was a decidedly pink appearance of the central grey substance, and a slightly brownish tinging of the white columns.

The weight * of the cord, deprived of nerve roots, was 15½ drams avoirdupois, and its measurements were—

	Transverse.	Sagittal.
Cervical, ...	13	9
Dorsal, ...	8·5	7
Lumbar, ...	10	8 mm.

These figures indicate a degree of atrophy of the cord. The calvarium weighed 11 ozs.; the dura and soft membranes were of a dusky colour, and the latter were in addition gelatinous and opaque, but nowhere adherent, being separated from the underlying convolutions by a considerable quantity of subpial fluid. The cortex was of a dark colour and much congested, especially its inner layer. The white substance of the centrum ovale was likewise congested, and the puncta cruenta very pronounced. The ventricles were slightly distended, but their walls were nowhere roughened. The brain weight was 47½ ozs. Beyond congestion of all the solid organs and slight fatty infiltration of the liver, nothing noteworthy was remarked concerning the thoracic and abdominal viscera.

Microscopic examination.—Sections of *brain* were examined, unstained and stained with carmine. There is a decided increase of vascularity both of the cortex and central white matter, the smaller arteries and capillaries standing prominently out. The extra-vascular spaces, too, are considerably enlarged, suggesting that the vessels had been even more engorged at some previous time. Hæmatoidin particles and cells containing hæmatoidin granules are found in the vascular sheaths, and a few granule cells are observed in the medullary substance. The most striking alteration in the cortex is that which affects the larger pyramidal cells which, almost without exception, present traces of degeneration.

* The average weight of the spinal cord in 121 male insane persons dying between the ages of 30 and 40 is given by Boyd (*Table of Average Weights of the Body and Brain*) as 19½ drams.

Quain (*Anatomy*, 8th edition, p. 582) says the cord weighs in the human subject from 16 to 28 drams.

This has in no instance advanced very far; all the cells preserve their usual dimensions, but their outlines are somewhat indistinct, and in many instances there is a tendency to rounding off of angles and wasting of processes. The cells fail in varying degree to take on the carmine staining; some present a generalised yellow granular appearance; in others, again, this is limited to one or more of their processes. The nucleus is not in any instance obscured, but stands out prominently stained in the general yellow ground of the degenerated cell-substance.

Spinal cord—cervical enlargement—white substance.—There is increased vascularity of all the columns, but this is most pronounced in the lateral and posterior columns. The columns of Goll take on a decidedly deeper tint of the carmine, and the same applies to the posterior two thirds of the lateral columns. The degeneration of the posterior columns is well defined, and it affects their inner sections alone, extending from the periphery quite up to the grey commissure. That of the lateral columns is of a somewhat triangular form; its anterior margin, not very distinctly delimited, but shading off into the comparatively normal tissue, is on a level with the middle of the anterior cornu; internally it is in contact with the grey matter of the anterior and posterior cornua, while externally it is separated from the periphery by a zone of normal nerve tissue (Figure 1A). There is no affection of the columns of Türck. With a high power the connective tissue septa are seen to be considerably increased in number and thickness in the deeper stained areas, while the nerve fibres are, on the contrary, diminished both in size and number. The neuroglia cells are numerous, enlarged, and prominent, and granule cells are not infrequent in the degenerated areas, more especially those of the lateral columns.

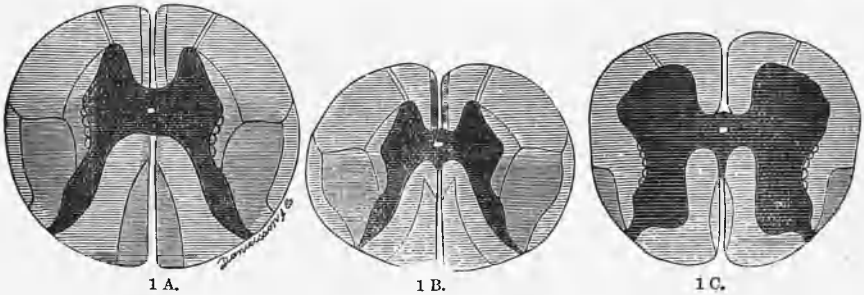
Grey substance.—Changes are here likewise very apparent. There is greatly increased vascularity, and this is most marked in the posterior cornua, where numerous small arteries and capillaries stand prominently out, gorged with blood. Granule cells exist in some number in the posterior cornua. With regard to the nerve cells changes are likewise to be noted; they present changes strikingly similar to those noted in the cerebral cortex, appearances denoting an early stage of degenerative atrophy. The majority of the large multipolar cells preserve their normal outline, but some are assuming a globular form with shrivelled processes. There are varying degrees of the yellow granular degeneration, and in some cells this has proceeded to such an extent as to completely obscure

the nucleus, the whole cell appearing as a mass of yellow granules.

In the *dorsal region* the sclerosis of the columns of Goll has quite disappeared, while that of the lateral columns exists in much the same position as in the cervical region, and is still separated from the periphery by a narrow zone of healthy nerve-tissue.

Similar changes exist in the grey substance here, but in addition the bipolar cells of the vesicular columns of Clarke present, in a very marked manner, evidences of granular degeneration.

Lumbar Enlargement.—The degenerated area of the lateral columns is, in this region, of very limited extent, is placed towards the posterior part of the columns, and reaches completely to the periphery.



1 A. 1 B. 1 C.

FIG. 1.—Spinal cord in a case of general paralysis—(*a*), cervical; (*b*), dorsal; (*c*), lumbar sections. Symmetrical degeneration of the lateral columns exists in all three regions. Degeneration of the postero-internal columns is limited to the cervical region.

In the grey substance the vascular and cell-degenerative changes are very pronounced, and in the posterior cornua of this region the hyper-vascularity reaches its highest development. The above description applies to sections stained in carmine. In unstained sections the vascularity and degeneration of nerve-cells is very apparent, and amyloid bodies occur in some number scattered over the section. In sections stained with osmic acid the granular parts of the degenerated nerve-cells take on a decided dark-brown tint. In these sections granule-cells are demonstrated in the areas of columnar degeneration, more distinctly so in the lateral columns; they take on a darker staining than the myeline sheaths among which they lie. In sections stained by Weigert's hæmatoxylin and prussiate method, the degeneration of the white columns and of the nerve-cells is easily seen, but nothing further is revealed.

The next series of cases comprises six, in which the form of mental disorder was dementia.

CASE VI.—Summary—*Delusions as to identity of persons and places—muttering to self—involuntary and unconscious passage of urine and alvine evacuations—paralysis of left external rectus—inequality of pupils, with loss of response to light and accommodation—absence of patellar reflex—normal superficial reflexes—common sensation not entirely obliterated—tactile sensibility present in some degree—intermittent clonic spasms of right triceps brachii—tremor of muscles of lips, and occasionally of muscles of abdomen and legs—ataxic gait and deficient equilibration increased by closure of the eyes—temporary monoplegia of right arm—arthropathy of right knee—eschars—coma—death.*

Thomas S., a navvy, a native of Wiltshire, age 49, was admitted on 5th May, 1885. With regard to his antecedents very little information could be obtained. He had been in the workhouse for some time, and was on the "imbecile list" for fourteen months before his admission. The evidences of insanity given in his admission order were refusal of food, his saying he was in heaven, and running about naked.

On admission he was a stout well nourished man; height, 5 feet 7½ inches; weight, 11 stones 11 pounds. He was inclined to be communicative, and gave expression to some delusions, but shortly after admission he stubbornly refused to speak. He sat or lay in bed with his hands before his eyes, muttering semi-audibly to himself, and occasionally one could hear him repeat, "Curse me God, curse me God," or "take me up to heaven." He refused his food, giving, as his reasons for so doing, that he was in heaven, that he was "the happy angel," and that God would not allow him to take food. This refusal of food was persisted in, with few exceptions, up till the time of his death, and necessitated the regular administration, by the stomach tube, of food three times a day. There was internal strabismus from paralysis of the left external rectus; the left pupil was larger than the right, and both were irresponsive to light or accommodation. The knee-jerk was completely absent on both sides, but the plantar and other superficial reflexes were normal. There was almost constant dribbling of urine, of which, as well as of the passage of alvine evacuations, he appeared to be quite unconsious. The right arm was the seat of frequent, but not constant, tremor, having a rhythm and extent of movement somewhat similar to those of ankle clonus. This tremor was much intensified

during the process of forcible feeding, and at such times it often extended to the abdominal muscles and legs. The tremor of the arm appeared to be due to clonic contractions of the triceps, and the intensification and radiation of the tremor appeared to be associated with the powerful contractions of the muscles of mastication made in his stubborn endeavours to resist the forcible opening of his jaws by the gag. There were also fine tremors of the muscles of the lips and levator menti. He felt as a painful impression the prick of a pin; he was able to recognise the contact of the head of the pin, to distinguish the head from the point, and to localise the point of contact pretty accurately. His gait was distinctly ataxic; in standing or walking he kept his feet widely apart, and during locomotion the heels were brought down with the characteristic stamp. Equilibration, when the feet were in close apposition, was deficient, and the swaying was decidedly increased on closing the eyes. On 3rd June it was found that the right arm was completely paralysed; the limb hung helplessly by his side, and he was totally unable to execute the slightest movement. In three days there was a slight return of power, but the grasp of that hand continued feeble. On 10th June the right knee, which up till then was perfectly normal, was found in a condition which strongly suggested that it was a case of Charcot's joint affection. The left knee was normal. The right knee was considerably swollen, and presented the features of a hydarthrosis. The patella could be felt floating on the fluid contents of the articular cavity. But, in addition to the signs of articular effusion, there was very noticeable swelling and induration of the limb for some distance above and below the knee, so that there was considerable disparity between the measurements of the two limbs elsewhere than at the knee. This, as well as the variations in the degree of the swelling, is indicated in the accompanying table.

MEASUREMENTS OF LOWER EXTREMITIES.

	June 10th.		June 11th.	June 13th.	June 27th.
	R.	L.	R.	R.	R.
Knee, ...	16⅞	15	17⅜	18¼	17½
4 inches above upper border of patella,	17¼	16	18½	18⅝	18¼
4 inches below do. do., ...	14⅜	13¼	14⅞	15⅛	13¾
8 inches below do. do., ...	14⅛	13⅜	15	15¼	13

The movements of the joint, active and passive, were perfectly unrestricted, but were accompanied by a creaky feeling on placing the hand over the articulation. It appeared to give rise to no painful sensations: in fact, the patient was quite unaware of its existence until it was pointed out. He could move it freely, or allow it to be moved, and often he would walk energetically round the airing court without apparently suffering in the slightest degree. It appears to have been rather sudden in its onset, and no specific history of injury could be found. Two days after its first appearance, a slight ecchymosis was visible over the inner aspect of the head of the tibia, and next day, in addition to a further augmentation of the swelling, and the appearance of œdema of the foot and ankle, the ecchymosis had extended so as to involve the back of the thigh, over an area about the size of the hand, and the posterior and inner aspect of the calf. Two small bed-sores which had formed shortly after admission, one over the sacrum, slightly to the left of the middle line, the other over the right gluteal region, now began to assume serious dimensions. That on the left penetrated as far as the sacrum, and presented a sloughy gangrenous mass of cellular tissue, tending to separate. During the next 14 days the swelling of the knee abated somewhat, but the eschars showed no sign of healing action. On 30th June he became comatose, the coma gradually deepened and ended in death, his residence being in all nearly two months.

At the autopsy the following changes were noted:—On the inner side of and above the knee a collection of sanguineous sero-purulent fluid was found, which was, however, perfectly extra-articular. On opening the joint, evidence of intra-articular changes were also to be noted; there was distinct erosion of the cartilage over the lower end of the femur, over an area about the size of a threepenny piece; the cartilaginous surface of the patella was roughened; there was no pus in the joint, but the synovia was slightly in excess.

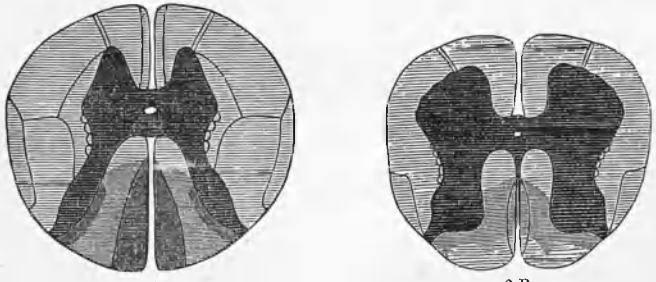
The cerebro-spinal dura presented externally nothing noteworthy, but the soft membranes generally were highly hyperæmic and covered with a glairy purulent exudation. The sacrum was soft, friable, and infiltrated with offensive pus. The cord was rather soft, and, on section, the posterior columns, especially in the lumbar region, had a greyish appearance. Its measurements were—

	Transverse.	Sagittal.
Cervical, ...	13·5	10
Lumbar, ...	10	9 mm.

The brain weighed 43½ oz.; its tissue was soft and œdematous, but no gross lesion was discovered.

Microscopic examination.—The large pyramidal cells of the cerebral cortex are well defined both as regards outline and processes, but in many instances, in the carmine stained sections, they present traces of yellow granular degeneration. The degenerated parts of these cells are stained of a dark brown colour by osmic acid. Several of the arteries of the white matter are considerably distended, but this is by no means general.

Spinal Cord.—Changes are apparent throughout the whole length of the spinal cord, and these are limited almost entirely to two regions of the transverse section, the posterior white columns and the cornua of gray matter. Sections were stained with carmine, osmic acid, and by the hæmatoxylin-prussiate method. In the *cervical* region the degeneration of the posterior columns is rendered apparent in the carmine tinted sections by the deeper colour which they assume. This degeneration exists over almost their whole extent transversely, varying, however, in intensity in different parts. The deeper parts—*i. e.*, those lying next the grey commissure, are comparatively unaffected, while of the remaining parts of the columns, the degeneration is more pronounced in the internal divisions, and at the outer part of the external divisions, in which last position the sclerotic tissue appears to interrupt in some degree the fibres of the internal radicular fasciculus. (Fig. 2*a*.)



2 A 2 B

FIG. 2.—Spinal Cord from a case of dementia, with symptoms of locomotor ataxy. (*a*.) Cervical enlargement. The deeper parts of the posterior columns are unaffected, and the sclerosis is more pronounced in the columns of Goll, and in the outer part of the columns of Burdach. (*b*.) Lumbar enlargement.

In the *lumbar* cord the deeper parts of the posterior columns are again unaffected. In addition, however, the superficial parts of the columns of Goll, and, towards their inner side, of

the columns of Burdach likewise are unaffected. The degenerated area extends transversely over the whole width of the posterior columns in their middle two-fourths, but posteriorly it is limited to the outer parts or the postero-external columns. (Fig. 2*b*.)

Both in the cervical and lumbar region there is a very apparent degeneration of the nerve cells of the central grey matter, and this applies alike to the larger multipolar ganglionic corpuscles of the anterior, and to the lesser cells of bipolar form of the posterior cornua. It exists to a pretty high degree; almost every one of the cells shows, in greater or less degree, evidences of degeneration, and many of them are most extensively degenerated. In a few instances there are, in addition to the degeneration, evidences of atrophy, but this is limited to only a few cells and is by no means very pronounced. The majority of the cells are of normal size, and present well-defined outlines, processes, nuclei and nucleoli. The degenerated condition is remarkably well demonstrated by the use of osmic acid, which stains the granular parts of the cells of a dark brown colour. In the osmic acid stained sections, the degenerated areas of the white columns appear of a relatively pale colour. The nerve fibres of these areas are noticeably diminished both in number and size, while the glia cells are numerous and well developed. Corpora amylacea are not unfrequent over the degenerated areas, but they are also found in small number scattered generally over the section. In sections stained by Weigert's hæmatoxylin-prussiate method the degenerated condition of the nerve cells is well demonstrated, the granular parts appearing of a very dark colour; in the areas of columnar degeneration the connective tissue is stained of a light lavender brown, while the remaining myeline sheaths take on a dark blue colour. In all the sections it is observed that there is a distinct difference in the appearance of the new formation in different parts of the posterior columns; in the outer segments of the columns of Burdach, through which the internal radicular fasciculi pass, it has the character of well formed wavy fibrillar connective tissue, while in the remainder of the degenerated area it consists mainly of a thickening and coarseness of the normally fine connective tissue trabeculæ.

During life, this case presented many of the symptoms of locomotor ataxy, leading one to expect such a diseased condition of the posterior columns as was found on microscopic examination; but there were, in addition, other symptoms only to be explained by supposing an extension of the pathological

process, to the central or trophic parts of the cord. It is in this way that the joint affection and the eschars are to be accounted for. The character of the symptoms manifested during life indicate an "irritative," as contra-distinguished to a "degenerative" lesion of the cerebro-spinal centre. This case affords an illustration of the view held by Erb,* that sclerosis of the posterior columns is in the majority of cases, perhaps, in all, not the only condition found in tabes. The process extends from the posterior columns to the lateral columns, the posterior cornua, and more rarely to the anterior cornua, causing degeneration, sclerosis, and atrophy of the ganglion cells. The extension of the morbid process to the anterior cornua takes place along the fibres of the internal radicular fasciculus, which have been shown by Kölliker to be traceable to the anterior cornua, where they form connections with the ganglion cells. From the fact that the joint affection was on the right side, and that the bedsores attained their greatest development on the left side of the middle line of the sacrum, it is probable that the morbid process in the central gray matter was of relatively greater intensity in the right half of the cord.

CASE VII.—Summary—*Climacteric dementia of two years and five months' duration—premature senility—spontaneous development of eschars—defective sensibility—defective habits—increasing dementia and helplessness—coma—death.*

Martha C., aged 53, a labourer's wife, a native of Somersetshire, was admitted on 9th March, 1885. The duration of the mental disorder was two years; it was characterised by a decided change of habits and character, delusions and mental failure. Previously a very respectable woman, she had fallen into drinking habits; became childish, silly, and emotional, unreasoning and incoherent. Her appearance was that of a prematurely old woman; she was gray-haired; and her memory, more particularly for recent events, was much impaired. Habits on admission were not defective.

On 27th July (3½ months after admission), while her habits were still perfectly correct, and she was not confined to bed, but sitting or walking about by day, an eschar formed on each trochanteric region. At first this consisted of a slough of skin and cellular tissue about the size of a crown piece. Shortly afterwards she became more feeble and helpless, and more demented; her habits became defective, and she was confined to bed. The eschars became more and more grave,

* Ziemssen's *Cyclopedia of Medicine*, vol. xiii, p. 536.

and another formed over the middle line of the sacrum. The patellar reflexes were noted at this time to be exaggerated. Death occurred on 12th August, about five months after admission, preceded for twenty-four hours by gradually deepening coma, lividity, and weak irregular pulse.

Autopsy.—The cerebro spinal fluid was in considerable excess, and in it floated numerous cholesterine crystals. The brain was fairly firm; the soft membranes were nowhere adherent, but were gelatinous and opaque over the convexity; the central medullary substance presented a yellowish tinge, and the inner layer of the cortex was somewhat redder than normal. Over the pons there was a patch of recent meningeal hæmorrhage, about an inch in size (evidently the immediate cause of death). The basal ganglia were intact. The spinal dura mater presented nothing noteworthy; the soft membranes were injected inferiorly, and the cord itself was firm, and presented to the naked eye little appearance of alteration.

Microscopic examination—Brain.—There is an undue vascularity of the grey cortex, the small capillaries forming a prominent network. Hæmatoidin granules and crystals occur pretty frequently in the vascular sheaths, and here and there round cells are found collected round the vessels, some of them having in their interior pigment particles. As regards the nerve cells, the larger pyramidal cells of the third layer of the cortex appear ill defined. Their outlines are not well pronounced, and their processes are wasted looking. With the exception of the nucleus, they take on the carmine staining very imperfectly, presenting themselves as yellow granular bodies with a carmine tinted nucleus in their interior. The smaller pyramidal cells present traces, though to a much less extent, of the same yellow-granular degenerative appearance.

Spinal Cord.—Sections were made of the cervical and lumbar enlargements, and of the dorsal region. In these regions evidences of gray degeneration of the columns of Goll are found. In the *cervical* region it is most distinct, and here it is strictly limited to the postero-internal columns, which, with the exception of a very small area at their deeper parts, take on with carmine a uniformly deeper tint than the other parts of the white substance. In sections stained by Weigert's hæmatoxylin-prussiate method, and with osmic acid, this area of degeneration appears as a lighter strip on each side of the posterior median fissure (Fig. 3*a*). In the *dorsal* region this degeneration is not so apparent, nor yet so definitely localised. It does, however, exist, affecting mostly

the posterior part of each column, but not extending quite to the periphery (Fig. 3*b*).

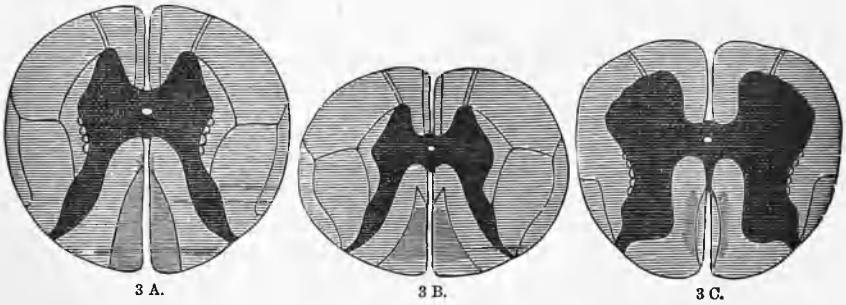


Fig. 3.—Spinal cord from a case of climacteric dementia. Sclerosis of the postero-internal columns—(*a*), cervical ; (*b*), dorsal ; (*c*), lumbar regions.

It is likewise not so apparent in the *lumbar* region, where only a very small area of degeneration is to be observed, and that in an unequal degree on the two sides. It is best demonstrated in sections stained with osmic acid, where the degenerated areas appear as light patches in the midst of the dark normally stained columns. In one column the area of degeneration appears of an elongated oval form, while in the other it takes the form of a narrow strip running alongside the median fissure. In both columns the areas are completely surrounded with normal nerve tissue (Fig. 3*c*).

In this case I devoted considerable time and attention to the investigation of the condition of the nerve cells of the spinal cord and cerebral cortex. Firstly, sections of the lumbar cord (after hardening in the usual manner) were mounted unstained in glycerine. In these the nerve-cells, even with a low power (× 80), stand out prominently as yellow granular bodies in the light-coloured ground of the gray matter. They have somewhat badly defined edges and withered looking processes, and they show a tendency to assume the globular form. With a high power (× 300) it is seen that the majority of the large multipolar ganglion cells present a distinct yellow granular appearance. In some few cells this appearance is not presented, and here, as a rule, the nucleus and nucleolus are quite observable, but these latter, even in some of the apparently healthy cells, are occasionally rather obscured and indistinct. In many cases the granular condition is only partial in its distribution, in every case, however, appearing as a distinct cluster of granules occupying one or other of the angular recesses of the cell, and stretching inwards to the

nucleus which appears at its inner margin. Higher grades of this degeneration are to be found, until finally it seems as if the whole cell were just one mass of granules. In these last cases two varieties are to be observed. All the advanced degenerated cells present this appearance in common, that they are of a distinct yellow colour, but in some it is easily observed that the nucleus is completely obscured, while in others that part is seen without difficulty. In the latter case the cells do not present the marked *granularity* of contents which is exhibited by those cells in which the nucleus is obscured. They appear to have more homogeneous, though still yellowish, contents. In those cells in which the nucleus is completely obscured, the contents are very granular, and the degeneration affects almost the whole cell, leaving often only a remnant of normal parenchyma at the periphery of the cell, or at one or other of their polar prolongations.

In sections soaked in dilute acetic acid, but little change is to be noted as regards those cells which are in a condition of advanced degeneration, and the only effect on the more or less healthy cells is an increased transparency of parenchyma and greater distinctness of the nucleus.

In sections treated with ether, after immersion for some time in alcohol, the following changes are observed:—There is a sensible clearing up of many of the cells, but this is in most cases only partial, while in not a few instances very little change is to be noted. This last remark applies to cells which are extensively degenerated to those—namely, in which the whole cell-substance seems composed of a mass of granules, and in which the nucleus is quite obscured; but even in these there is some slight change in the direction of increased clearness compared with similarly degenerated cells not treated with ether. Examination of sections treated first by acetic acid and then by alcohol and ether gives practically the same results, as in the case of simple treatment by alcohol and ether alone.

In sections stained by osmic acid, the following appearances are noted:—The nerve cells are, almost without exception, stained in varying degrees of a dark brown colour. Even those cells which present no trace, or very little trace of granular appearance, are sensibly stained. It is in those cells which present the most advanced granularity that the stain is deepest, and in these the depth of staining varies in different parts of the cell. In some the granular mass is uniformly affected by the reagent, but in others a particular and often fairly defined part of the granular area is stained of

a much deeper tint than the remainder. This deeper staining is usually of crescentic form, and appears to be related in some fashion with the nucleus.

In sections stained with diluted carmine fluid the nerve cells appear, even under a low power, as partly pink and partly yellow bodies, and under the high power the granular degeneration is very apparent. The degenerated area does not take on the staining, and so, in these cells which are most affected there is little or no appearance of carmine tinting.

In sections of the dorsal cord, the bipolar nerve-cells of the vesicular columns of Clarke are seen sharing in equal degree in the general degenerated condition, and in all the regions of the cord this degeneration affects, though in a less marked manner, the smaller cells of the posterior and anterior cornua, being by no means restricted to the cells of larger size.

The vessels in most of the sections appear to be considerably thickened from hypertrophy of their walls.

The condition of the cerebral cells was investigated in a similar manner to those of the spinal grey substance, with approximately similar results, although, in the case of the former, microscopical investigation is attended with considerably greater difficulties.

In this case the unsoundness of mind is to be looked upon as one, and practically the most prominent, of the symptoms of a wide-spread degenerative affection of the essential nervous elements, not of the higher or cerebral centres alone, but affecting alike the whole cerebro-spinal system. The morbid process, in all probability primarily of a "degenerative" kind, shows later on a tendency to take on an "irritative" character manifesting itself during life by the spontaneous occurrence of cutaneous eschars.

CASE VIII. *Organic dementia—paralytic seizure on three separate occasions—right hemiplegia and aphasia.*

Margaret J., aged 48, was admitted on 13th March, 1883. Four years before admission she had a paralytic stroke, causing right hemiplegia and aphasia. She recovered her speech, and six months prior to admission she had a second attack which did not, however, affect her speech. The third seizure occurred 9 weeks before admission, and again involved speech. This was an ordinary case of right hemiplegia and aphasia, following a gross cerebral lesion, and accompanied by such a degree of mental disorder as required her detention in an asylum. During her residence she was often very restless, noisy, and emotional, frequently tossing about at night, getting

out of bed, screaming and crying. She died on 17th November, 1884.

At the autopsy very pronounced changes were found in the brain and some other organs. The cerebro-spinal fluid was in excess, and inside the cerebral dura mater there was a soft new membrane, apparently the result of chronic hæmorrhagic pachymeningitis. The soft meninges were gelatinous and opaque, and the subpial fluid increased. Two centres of softening were found, one on the left side corresponding to the middle of the ascending parietal convolution, the other on the right side situated about the middle of the external aspect of the occipital lobe. These softened areas extended from the cortex into the medullary centre, but did not reach the central ganglia which were unaffected.

The liver and kidneys were the seat of cystic disease, the latter weighing on the right 21 and on the left 19½ ozs. Nodules were found on the mitral curtains, and the lungs were affected with lobular inflammation and basal congestion. The measuremenns of the cord were—

	Transverse.	Sagittal.
Cervical, ...	13	10
Dorsal, ...	10	8
Lumbar, ...	11	9 mm.

Methylated spirit was the hardening agent used, and sections were stained with carmine. These present the usual appearances of descending degeneration of the pyramidal tract secondary to a lesion in the left half of the brain. In the cervical region the right lateral column and the left column of Türck are stained of a deep colour. In the dorsal region the degeneration of the left anterior column does not exist, while in the lumbar region the degeneration is entirely limited to the crossed pyramidal tract, and here it is placed posteriorly, and reaches the periphery. The outline of the degenerated area in the lateral column throughout the cord is of a rounded form, and it has well defined borders, and is distinctly delimited from the surrounding nervous tissue. In the cervical region it does not reach so far forwards as the level of junction of the posterior columns and grey commissure, while in all three regions it is separated from the posterior cornua by a zone of healthy tissue.

CASE IX.—Summary—*Acute mania—hereditary predisposition—gradual supervention of dementia—phthisis pulmonalis—emaciation and muscular atrophy—death.*

George Henry S., a clerk, aged 27, was admitted on 22nd

September, 1874, suffering from acute mania of three days' duration. No exciting cause could be assigned, but hereditary predisposition existed, his father and a sister having been insane. In the course of a month the excitement gradually abated, but he sank into dementia. This last continued and became deeper, and his habits became defective. Symptoms of phthisis developed, and he became emaciated. General muscular wasting. No bedsores. Death occurred on 19th October, 1885, the duration of the mental disorder being in all over eleven years.

Autopsy.—The spinal meninges were injected inferiorly, and the cord itself was soft and œdematous. Its weight was 19½ drams, and its measurements—

	Transverse.	Sagittal.
Cervical, ...	14	8
Dorsal, ...	9	8
Lumbar, ...	11	10 mm.

The calvarium was thickened over the centre of the occipital bone, and weighed 13 ozs. The cerebral soft membranes were gelatinous and lactescent over the convexity, but nowhere adherent. The brain weighed 56 ozs., and the hemispheres each 24½; it was soft and œdematous, and the arachnoid fluid was in excess. The convolutions and, on section, the cortical grey substance appeared wasted. The lungs were affected with advanced tubercular disease, and the liver was fatty.

Microscopic Examination.—Sections of brain and spinal cord were examined unstained and stained with carmine and osmic acid. The large pyramidal cells of the cortex are everywhere considerably degenerated and atrophied; their outlines are ill defined and irregular; their processes wasted, and the whole cell presents a granular yellow appearance. In the osmic acid stained sections these cells present a dark brown appearance. No very marked changes are to be observed in the blood-vessels. The neuroglia is coarse. In unstained sections of the spinal cord, the cells of the anterior cornua are seen to be in an advanced state of degeneration. They are partially, in a few instances even wholly, occupied by yellow granular contents which, in many cases, quite obscures the nucleus. These cells, with osmic acid, take on a decidedly dark brown tint. There is likewise a degree of atrophy, many of the cells being ill defined, with rounded angles and badly marked processes. A few of the vessels of the grey are unduly dilated, but no alteration of white substance is to be observed.

CASE X.—*Dementia—second attack of insanity—history of apoplectic seizures—hereditary predisposition—habitual alcoholic intemperance—cardiac disease—diminished voluntary motor power—aggravation of cardiac condition—death.*

David M. age 51, a labourer, was admitted on 5th May, 1884, suffering from his second attack of mental disorder of four days duration. He is said to have had a fit twelve months, and a second one shortly, before admission. An aunt and her mother suffered from insanity. His general character and habits were essentially bad; he was a habitual drunkard, and ill-treated his wife. On admission he was a man of medium height, well nourished, with fairish hair, and injected facial capillaries. There was very pronounced cardiac aortic and mitral disease, with hypertrophy and dilatation of the left ventricle. He appeared to be somewhat feeble on his legs, and the patellar reflex was more marked on the right side. There was very noticeable tremor of the head and neck, and enfeebled grasping power.

His mental condition was one of mild dementia; he seemed stupid and quite indifferent about his coming to the asylum, sat spitting about carelessly on the furniture or anyone near, and his appearance generally was untidy. His general condition during his residence was one of drowsy, somnolent stupidity; he was extremely disinclined to do any work; he sat by the fire all day, taking little notice of his surroundings, and often falling asleep. Ten months after admission he had what was described as an "epileptic fit," and 17 months after admission the cardiac condition became aggravated, and he died after a residence of about 18 months.

The autopsy was performed 38 hours after death. In addition to grave changes in the other organs, the following were noted as regards the cerebro-spinal axis. There was considerable excess of cerebro-spinal fluid. The spinal cord weighed 21½ drams; it was soft and œdematous, and its measurements were—

	Transverse.	Sagittal.
Cervical, ...	14	11
Dorsal, ...	10	9
Lumbar, ...	11·5	9·5 mm.

The dura and pia spinalis were injected, especially inferiorly. The calvarium weighed 14½ ozs., and was adherent to the dura. The brain weighed 48 ozs.; the soft membranes were gelatinous and opaque, but not adherent, being separated from the underlying convolutions by a considerable quantity of subpial serosity. The brain tissue was soft and œdematous,

and the central white substance was slightly brownish. The second frontal convolution on the right side was in great part replaced by a brownish gelatinous material extending inwards as far as an inch from the longitudinal sulcus. This was apparently the result of softening from embolism.

Microscopic Examination—Brain.—The larger and medium sized pyramidal nerve cells of the cortex present a degree of yellow granular degeneration, and in addition there is in the former a slight atrophic tendency. In no case, however, does the degeneration or atrophy proceed to such an extent as to obscure the nucleus. The remaining cells present no noticeable change. The cortex is unduly vascular, and the smaller arteries have slightly thickened walls. The neuroglia is cloudy and granular-looking.

In the *spinal cord* changes are apparent in the nerve cells, the blood-vessels, and the neuroglia. The ganglionic corpuscles of the anterior cornua, both in the cervical and lumbar enlargements, present a pronounced degree of degeneration. In unstained sections this degeneration is apparent even with a low power, varying in degree in different cells; in some confined to one or several of the angular recesses, and in others filling more or less the whole cell till, finally, the nucleus is completely hidden. The degenerated parts of the cells are of a granular appearance and yellow colour. With ether this is somewhat cleared up, the whole cell appearing more transparent, without, however, any material change of the colour of the granular parts. In sections stained with osmic acid, the degenerated parts of the cells take on a decidedly deeper tint, in some almost approaching a black colour. In carmine-tinted sections the granular parts of the cells not taking on the staining appear of a bright yellow colour, the remainder of the cell assuming the usual tint. In these last sections the degeneration is most apparent. The smaller arteries of the central grey substance have much thickened walls, and in many instances the perivascular space is distended and occupied by a homogeneous, partly fibrillar material stained very faintly with carmine. This is most apparent in the arteries of the anterior commissure, but it affects the others likewise, though in less degree. The increased thickness appears to depend mainly on a hypertrophy of the circular muscular coat. The neuroglia generally is swollen-looking, clouded and granular, but otherwise no change is to be found in the white substance.

With regard to the etiology of this case, three separate factors are to be recognised—hereditary predisposition, cardiac

disease, and habitual intemperance. These two last, acting upon a brain hereditarily unstable, brought about a condition of degeneration of the essential nervous elements, a condition which manifested itself during life by a general failure of the mental faculties. The degeneration is, however, not confined to the highest nervous centres alone; it affects simultaneously and in almost equal degree the lower division of the nervous axis. The similarity of the pathological alterations, the degenerative atrophy of the larger pyramidal cerebral, and of the multipolar ganglion spinal cells, the vascular changes and alteration of neuroglia in the two divisions of the cerebro-spinal axis, forms a striking feature of this case.

CASE XI.—*Head injury—epilepsy—paralytic seizure—dementia—urethral stricture and retention—general analgesia—increase of patellar reflex—deficiency of superficial reflexes—uncertainty of gait—transitory attacks of mania—unilateral clonic convulsions—coma—death.*

William D. N., an ironmoulder, aged 38, was admitted on 24th December, 1885, and died on 26th January, 1886. His father was a habitually intemperate man; one sister died of consumption, and a brother of "sunstroke." He himself was always a temperate man. Twenty-five years before admission he sustained a severe injury to his head, and 14 years afterwards "fits" supervened. Nine years before admission he had a "paralytic stroke" which affected his left side, but from which he completely recovered. For two years prior to his admission his mind had been noticeably weakened, and he had not been able to follow his occupation. The fits did not occur very frequently, perhaps to the number of two or three in a year, but they were described as being very severe, especially so during the two years before his admission. The last fit occurred three weeks before admission, and was followed by loss of consciousness which lasted for five days, during which he took no food, while bedsores formed.

Of late a difficulty of swallowing, and a tendency to choke while eating, were observed, and his sleep had become very indifferent.

On admission he was a tall, spare man, with dark hair, sallow anæmic complexion, and blue irides. His bodily condition was much below par—$\frac{\text{height}}{\text{weight}} = \frac{5 \text{ ft. } 9\frac{1}{2} \text{ in.}}{10 \text{ st. } 9 \text{ lbs.}}$ Two eschars, unhealthy looking, with sloughy edges, and no sign of healing action, existed over the gluteal region, that on the right being

the larger. His expression was dull, stupid, and vacant. Tongue clean and moist. Heart's action weak and irregular, both in rhythm and force; no cardiac murmurs. There was a slight urethral stricture, about half an inch, behind the external orifice, and retention of urine dependent partly on the stricture, but in part also on a paralytic condition of the detrusor, rendering catheterism necessary. The pupils were equal and contracted, dilating only very slightly on the withdrawal of light. There was complete analgesia of the trunk, limbs, and head. No pain was experienced when a fold of skin was transfixed, the sensation being merely one of touch. The sense of contact, localisation, and the distinction of objects, such as the head from the point of a pin, were retained in some degree. The patellar reflex was in slight excess, more so on the left side. The plantar reflex was normal, but the other superficial reflexes were in abeyance. There was slight rigidity of both legs; his gait was uncertain and unsteady, without any real loss of equilibration, even when the eyes were closed, and grasping power was decidedly impaired.

His mental condition was one of considerable hebetude; he was stupid and obtuse, and manifested great confusion of ideas as to time, places, the value of pieces of money, &c. His memory was much impaired both for recent and past events.

During the first week of his residence catheterism was repeatedly required. There was obstinate constipation, and his habits were defective. During the succeeding week transient attacks of mania occurred, and twenty-six days after admission clonic convulsions supervened. At first these were limited to the left side, affecting the arm, leg, and face, with conjugate deviation of the eyes, and rotation of the head to the left. On the first day only three occurred, but gradually they became more frequent and more severe, so that on the third day consciousness was completely abolished in the intervals. During the intervals the head and eyes were turned to the right, and the left limbs were rigid. The knee jerk became more exaggerated on both sides, and clonus could be induced with facility by downward pressure of the patella. There was no ankle clonus, and the superficial reflexes remained as before. The clonic seizures lasted in all eight days, the number being 441. Although at first limited to, and always commencing in, the left side, latterly they showed a tendency to invade the right side. During the last three days of his life the average daily temperature was 101° F.; pulse, 130; respiration, 36 per minute. Treatment was by chloral and bromide of potassium, nutritive enemata, and

evaporating lotion to the head. The obliteration of consciousness became more and more pronounced, passing into coma, which gradually deepened, and ended in death.

The autopsy was performed thirty-three hours after death. The cerebro-spinal fluid was in excess. The spinal dura presented nothing noteworthy; the soft membranes were congested; the cord weighed 19 drams, and its measurements were—

	Transverse.	Sagittal.
Cervical, ...	14	9
Dorsal, ...	8·5	8
Lumbar, ...	11	9 mm.

On section the changes apparent to the naked eye were increased vascularity of the central grey substance, and, probably a slight greyish discoloration of the left lateral column in the cervical region. The calvarium weighed 14 ozs.; the dura presented no alteration; the brain weighed 47½ ozs.; the right hemisphere 18; the left 19½; cerebellum and medulla 6½. The soft membranes generally were congested, and in addition were, over the convexity, slightly opaque and gelatinous. The congestion was distinctly more marked over the right hemisphere. The basal arteries were normal. The orbital surface of both frontal lobes had a shrivelled, wasted appearance and rusty brown colour, while the olfactory bulbs were extremely atrophied. There was adhesion of the soft membranes and decortication of the tips of the underlying convolutions over an area on the right side, corresponding to the upper 1½ inches of the ascending parietal convolution, and over the anterior part of the superior parietal lobule for about a superficial inch.

Elsewhere they were not adherent, not even over the orbital surface, where the soft membranes were separated from the cortex by a small quantity of brownish fluid. The brain tissue generally was soft and œdematous; on section the cortex appeared extremely congested, more so on the right side; the puncta cruenta were well marked; the ventricular fluid was in considerable excess, and the lining membrane of the lateral and fourth ventricles presented numerous granulations. The cortex over the area of meningeal adhesion was relatively atrophied, while that of the orbital convolutions was considerably disorganised. Elsewhere it was not notably atrophied, only of a dark purple colour. Basal ganglia congested, more so on the right; otherwise unchanged.

Pieces of the right cortex, the right crus, medulla oblongata, and cervical and lumbar cord were hardened in Erlicky's

fluid.* The left cortex, and crus, and pieces of cord were hardened in the usual manner in Müller's fluid. Sections were examined unstained, stained in Müller's fluid, with carmine and osmic acid, and with these two last combined.

In sections of the convolutions of the right side, taken from the seat of meningeal adhesion, the following appearances are noted;—There is very intense vascularity of both grey and white substance, most pronounced in the deeper layers of the cortex; the capillaries and small arteries are gorged with blood and stand out prominently. In places the arterial walls are somewhat thickened, and hæmatoidin deposits occur with some frequency in the perivascular lymphatic sheaths. With a view to examine for granule cells,† sections were immersed for some time in Müller's fluid and others were stained with osmic acid. These granule cells are exceptional in their occurrence, only a very few being observed in the medullary centre of the convolution. In carmine tinted sections the larger pyramidal cells of the third layer of the cortex are observed to be degenerated and atrophied, presenting themselves as partly yellow and partly pink bodies with indistinct outlines, and a tendency to wasting of processes. The superficial cortical layer, that devoid, or nearly so, of nerve-cells is spongy and swollen-looking, and has numerous prominent neuroglia cells. In the sections of the corresponding convolution (ascending parietal) of the left side, there are two apparent differences. The large pyramidal cells, though presenting a degree of granular degeneration, do not show much change in the direction of atrophy. They are large and well-formed, with distinct outlines and well-marked processes. The increased vascularity is noticeably less than on the right side.

Crura Cerebri.—Sections were examined unstained and

* This hardening agent is composed of sulphate of copper, 0·5 grams; bichromate of potassium, 2·5 grams; water, 100 grams (*Archives de Neurologie*, vol. x, p. 52). It hardens the tissues very rapidly; but, unless considerable care is taken, there is great risk of their being rendered brittle. In this case the solution was changed on the first and third day and at the end of the first week. The tissues were removed in a fortnight, and even then they were if anything rather brittle.

† The methods used by Charcot (*Archives de Neur.*, x, 31) for the investigation of granule cells are as follows:—Sections are made at the autopsy and immersed in Müller's fluid, examined immediately or after remaining for some hours or days in the liquid. Where tissues have been hardened in Müller's fluid, sections are submitted to the action of osmic acid, which stains the granule cells of a much deeper black than the myeline sheaths among which they lie. Weigert's hæmatoxylin-prussiate method does not give such good results.

stained, with osmic acid, picro-carmine, and carmine. There is no material difference in the crura of the two sides; both are unduly vascular, and the nerve cells of the locus niger are in equal degree affected with granular degeneration. Only exceptionally do granule cells occur, and there is no appreciable appearance of a process of sclerosis either in the region of the pyramidal tract, or elsewhere; certainly none at all comparable to that which will afterwards be described in the case of the spinal cord.

Medulla Oblongata.—Sections were stained as in the case of the crura, and here again no process of sclerosis is to be detected either in the anterior pyramids, or elsewhere. The only apparent alterations are the increased vascularity, and the degeneration of the nerve cells of the gray substance.

Spinal Cord.—With regard to the white substance, changes are apparent even to the naked eye. In carmine stained sections areas of deeper staining, indicating a process of degeneration, are observed in the lateral columns and the inner divisions of the posterior columns. In the case of the lateral columns, the degenerative process appears to be more

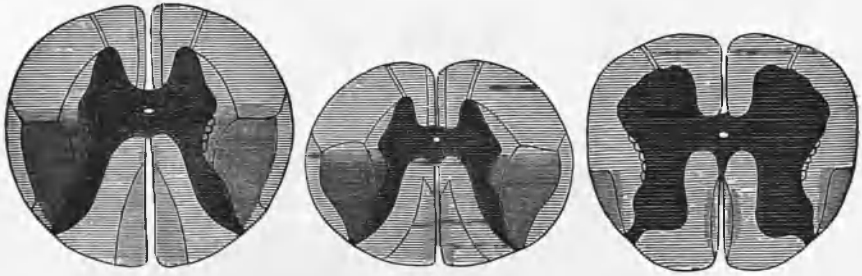


Fig 4.—Spinal cord in a case of dementia with epilepsy—degeneration of lateral columns and of postero-internal columns. (*a.*) Cervical. (*b.*) Dorsal. (*c.*) Lumbar regions.

intense on the left side, as indicated by a deeper staining. In the cervical region the degenerated area is of a triangular form; its anterior margin, rather indistinct, and shading off into the normal tissue in front, is on a level with the central canal; internally, it is in contact with the posterior cornu; and externally, it is separated from the periphery by a narrow zone of normal tissue. In the dorsal region this area is smaller, but occupies much the same position, while in the lumbar region its size is much diminished, and here it is placed more posteriorly; is in contact with the pia mater, and is separated from the posterior cornu by a strip of normal tissue.

The degeneration of the posterior columns is not so pronounced as in the case of the lateral columns, and it is strictly confined to their inner division. In the cervical region it forms a wedge shaped area, reaching from the periphery nearly to the central grey matter; in the dorsal region it has diminished to a small strip on each side of the posterior median fissure, while in the lumbar enlargement it forms a small oval area lying embedded within normal tissue.

These areas present all the characters of sclerosis, increase of the supporting connective tissue elements, diminution in number and size of the nerve tubes, increased vascularity, and thickening of the arterial walls.

In sections stained with carmine and osmic acid a few granule cells are observed in the degenerated areas, and these last are very definitely mapped out by this combined staining, appearing as lighter pink tinted areas in the midst of the dark osmic-acid-stained medullary tissue. There is a very noticeable increase of vascularity of the whole transverse section, both white and grey, but it is most pronounced in the area of degeneration of the lateral columns.

The nerve cells of the central grey substance do not appear to be much atrophied; they have well defined edges and processes, but they present in varying degrees traces of yellow granular degeneration. This is very apparent even in unstained sections, but is admirably demonstrated in the sections stained with osmic acid and carmine. In these the cells appear as partly pink and partly dark brown bodies, the degenerated part being stained with the osmic acid, the remainder taking on the usual carmine tint. This applies most to the multipolar cells of the anterior cornua, but it likewise exists, though in minor degree, in the smaller cells of the posterior cornua and those of the vesicular columns of Clarke.

The central canal is obliterated.

The starting point of the pathological alteration, in all probability, is the disorganisation of the cortex of the orbital convolutions, a condition probably induced by the head injury which occurred twenty-five years before the death of the patient. This determines a morbid process, of an irritative type, which shows a tendency to extend in a progressive, though unequal fashion, being more intense in some parts than others. Epilepsy and dementia are secondarily induced. The morbid process attaining a greater intensity, as evidenced by the meningeal adhesions, in the region of the ascending parietal convolution and superior parietal lobule of the right

side, determines a transient paralysis of the left side, and, the irritative quality of the lesion becoming pronounced, the unilateral clonic spasms which were ultimately the immediate cause of death. The majority of the symptoms are indicative of a diseased condition of the higher division of the nervous axis, but there are others which point to an implication of the lower or spinal division, such as the increase of the patellar reflex, the rigidity of the lower limbs, the bedsores, and the paralysis of the detrusor urinæ.

The next series of cases comprises four, in which the form of mental disorder on admission was melancholia.

CASE XII.—*Melancholia—attributed to syphilis—greatly impaired physical condition—delusions as to identity of self and in reference to his body—refusal of food—forced alimentation—amaurosis—absence of patellar reflex—increasing emaciation and weakness—death.*

Alfred S., 37, was admitted on 12th March, 1885, suffering from melancholia, attributed to syphilis, and of about 12 months duration. On admission he was a sallow anæmic man, poorly nourished, with a foul smelling breath, and evidently in an extremely feeble condition. His mental condition was characterised mainly by delusions having reference to his body and identity. He would sit with closed eyes making sucking noises with his mouth, saying, "I'm gone down to a baby now." At other times he would assert that his body was constructed of iron bolts and clips, that his eyes were balls of iron, and that he was not Stone, but the devil. He refused food under the influence of various delusions—*e.g.* that his mouth was clipped, that the devil was in his throat, and that iron bodies did not require food.

He was completely blind. The patellar reflex was absent on both sides; the planter and other superficial reflexes were normal, and there was loss of equilibration on standing. Constipation was obstinate, and required the diligent use of enemeta. Urine, specific gravity 1023; contained copious urates, but no albumen. The refusal of food was persistent, and in spite of liberal artificial alimentation, he became more emaciated, and died on 6th April, 25 days after admission.

At the autopsy performed 11 hours after death, the following appearances were noted:—The calvarium weighed 16 ozs., and was unduly adherent to the dura, but the latter otherwise was unaltered. The soft meninges were uniformly injected with a degree of opalescence and gelatinisation over the convexity. The basal arteries were normal, and the optic

nerves appeared shruken, gray and translucent. The brain weight was 43 ozs.; its tissue soft and œdematous. The inner of the three apparent cortical layers presented a distinctly reddish tint, and the white substance of the centrum ovale was slightly brownish. No gross lesion. The optic thalami and corpora quadrigemina presented no abnormality.

The spinal dura was normal; the vessels of the soft meninges considerably injected especially over the lumbar enlargement. On section, the central grey matter appeared unduly red and its vessels prominent, while in the lumbar region the posterior columns presented a greyish tinge. The measurements were as follows:—

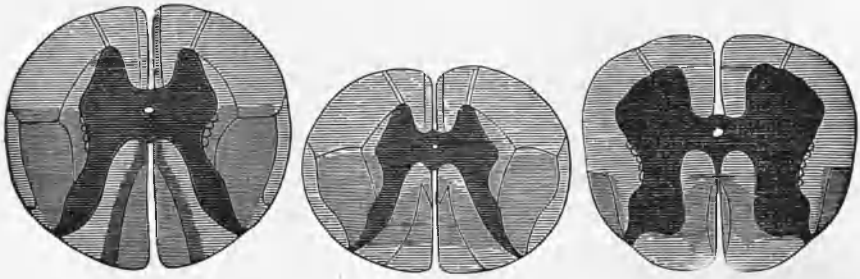
	Transverse.	Sagittal.
Cervical,	12	9
Dorsal,	8·5	7·5
Lumbar,	10	9 mm.

These indicate a degree of general atrophy.

Microscopic examination—Brain.—The most prominent morbid appearance is a great increase of vascularity; the smaller arteries of the central medullary substance and those passing through the grey matter stand out prominently, while the deeper layers of the cortex present a highly vascular network of dilated capillaries. Many of the vessels are irregularly dilated. In the carmine stained sections there are observed scattered here and there, both in the grey and white, small distinct points, consisting of a central deeply stained area surrounded by an unstained and highly refractive ring. These vary in size both as regards the central area and surrounding circle. In sections stained with methyl-violet, the centre is of a dark blue tint while the peripheral ring is again unstained, and nowhere is a trace of pink colouring to be seen. These appearances are in all probability due to long-standing syphilitic disease of the arterial walls. With regard to the cellular elements, most of the large pyramidal cells are atrophied and affected with fuscous granular degeneration. Their outlines are ill-defined; their processes wasted looking, and they present a nearly generalised yellow granular appearance, the nucleus being the only part that takes on the carmine.

Spinal Cord.—On examining with the naked eye or with the aid of a simple lens, carmine stained sections of the cervical, dorsal and lumbar regions, evidences of grey degeneration are found, limited in all three regions to the posterior and lateral columns. In the cervical region the area of degeneration in the lateral columns is of somewhat triangular form; its anterior edge is rather indefinite, but it extends as far

forward as the level of the central canal; it is separated from the periphery by a narrow zone of normal tissue and internally it touches the posterior cornu. In the dorsal region it retains the same outline and position, but here it is much smaller. In the lumbar region it is much reduced in size; it is in contact with the periphery and separated from the grey substance by a considerable tract of normal tissue.



5 A. 5 B. 5 C.

Fig. 5.—Spinal cord in a case of melancholia with tabetic symptoms—symmetrical degeneration of the lateral columns; and of the external and internal divisions of the posterior columns. (*a.*) Cervical. (*b.*) Dorsal. (*c.*) Lumbar.

With regard to the degeneration of the posterior columns, in the cervical region, it affects the inner margin of the columns of Burdach, and, in a lesser degree, the columns of Goll, in their whole extent. In the dorsal region it affects the whole extent of the posterior columns transversely, not reaching, however, either to the periphery, or the central grey substance. In the lumbar region it is limited to the middle two-fourths of both divisions of the columns, presenting a somewhat irregular posterior margin. (Fig. 5, *a*, *b*, *c*.)

On examining the affected areas with a high power, they are found to present all the characters of sclerosis; increase of the number and thickness of the connective tissue trabeculæ, increase of the blood-vessels, and diminution in the size and number of nerve fibres. The smaller arteries, more so in the lumbar region, are unduly dilated and prominent, while in all three regions of the cord the finer capillaries of the central grey substance are decidedly enlarged.

In sections treated with methyl-violet appearances similar to those described in the case of the brain are found, suggesting the occurrence here likewise of a syphilitic disease of the vascular walls.

The nerve cells of the grey matter show, in varying proportion, traces of degeneration. Without being much, if at

all, diminished in size, and still preserving a normal distinctness of outline and processes, almost all the cells are of a more or less yellow and granular appearance. In many instances only a small part of the cell, besides the nucleus, takes on the staining. This applies to the large multipolar ganglion corpuscles, and also, though in less degree, to the smaller cells of the posterior cornua; and in the dorsal region, to the cells of the vesicular columns of Clarke.

In this case the virus of syphilis has affected brain and spinal cord alike, giving rise, on the one hand, to mental disorder, and on the other, to symptoms of ataxia. In all probability it does so in two ways—first, by the direct irritation of the nervous tissues from the syphilitic poison circulating in the blood; and, secondly, by inducing changes in the walls of the supply arteries, leading secondarily to gradual starvation and degeneration of the essential nervous elements.

CASE XIII.—Summary—*Stupor with melancholia—cause, overlactation—feebleness of circulation—gluteal eschars—deficiency of patellar reflex—strychnine—slight improvement of mental condition and of circulation—exaggeration of patellar reflex—acute pulmonary phthisis—exaggeration of superficial and deep reflexes—death.*

Pamela P., age 28, a native of Gloucester, was admitted on 12th July, 1884, suffering from her first attack of mental disorder. Duration, two weeks. Hereditary predisposition to insanity existed, an uncle being insane; but the exciting cause appears to have been overlactation. During the five years of her married life she had three children, one still-born. Her first child she nursed for thirty months, and her last, twelve months old, she was nursing up till within a short time of her admission. She had been in weak health for some time, and two weeks before admission she became depressed and reserved. On admission, she was in a weak and feeble condition; she walked in a shaky and weakly fashion, but the thoracic and abdominal organs were normal. Her mental condition was a combination of stupor and depression. Her face wore a distressed, and pained, and somewhat vacant expression; she had occasional outbursts of passionate weeping, and there was much confusion of ideas as to times, places, and persons, while memory, especially for recent events, was much impaired. There was dilatation of the left pupil, and injection of the left conjunctiva. Two months after admission the stupor had become more profound; she mani-

fested little or no initiative; would stand silent for hours in one position; required to be led to and from the table at meal times; never volunteered a remark; would keep her mouth closed, so that the saliva collected and became fœtid; and when asked a simple question, she took a considerable time to frame and return an answer. Feeding by hand was necessary, but there was no active resistance to the taking of food. Her expression at this time was one mainly of vacancy, with a tinge of melancholy. The circulation was extremely languid; her hands and feet, even in the warm weather of summer, were cold, puffy, and purple-coloured.

On 17th September, an eschar was observed over the sacrum, rather to the left of the middle line. This appeared as a necrotic patch of dry black skin, which in two days separated, bearing an indolent raw surface of the size of half-a-crown. Up to this time her habits had been perfectly correct, and she had not been confined to bed. The sore healed in about four weeks. The patellar reflex at this date was rather deficient on both sides.

In October, the only apparent change was a slight deepening of the stupor; it was with considerable difficulty that she could be induced to answer any questions at all. The patellar reflex is noted as being almost quite gone. The administration of strychnine was begun at this date.

In November, her habits, hitherto correct, became very defective; she passed urine and alvine evacuations in her dress, or in bed. From October to December the strychnine was gradually increased from $\frac{1}{24}$ to $\frac{1}{6}$ grain doses thrice daily; and at the latter date a slight improvement was noted, both mentally and physically; she became a little more intelligent, and the circulation was sensibly more active.

In January, 1885, there were no symptoms of the physiological action of the drug, with the exception that the patellar reflex, previously deficient, was noted to be distinctly exaggerated, equally so on the two sides. The mental improvement was still sustained.

February.—The improvement above mentioned was not sustained; she had become at this date more confused and stupid. Strychnine, increased to $\frac{1}{4}$ grain doses thrice daily, was continued without apparent physiological result, with the exception of the exaggerated knee-jerk. From this date, until June, no further improvement was to be noted, and the strychnine was discontinued. With the exception above mentioned, no symptoms of the physiological action of this drug were manifested at any time; the only complaint on the

part of the patient, was that it was bitter, and went to her head. Signs of rapidly advancing phthisis now developed, with rapid emaciation, high evening temperatures, and occasional diarrhœa, but without cough or expectoration. The patellar reflex became more energetic (strychnine had been discontinued for quite a month); ankle clonus was easily elicited, and tendon reflexes existed at the wrists, while the plantar and other superficial reflexes were also exaggerated. She died on 12th August, 1885, thirteen months after admission.

The *post-mortem* examination made eight hours after death revealed extensive tubercular consolidation and excavation of both lungs, miliary tubercles on the peritoneum, caseous tubercles in the spleen, and caseation of the mesenteric glands. The calvarium was dense and unduly adherent to the dura. The brain weighed 48 oz.; the cerebro-spinal fluid was in considerable excess; the soft membranes over the convexity slightly gelatinous and opaque, and the brain tissue generally presented an anæmic appearance. The spinal soft membranes were anæmic; the cord itself was firm, and in the cervical region it presented a very pronounced flattening from before backwards. The white substance was very pale, the central grey substance relatively injected. Its measurements were—

	Transverse.	Sagittal.
Cervical, ...	14·5	7·5
Dorsal, ...	9	6·5
Lumbar, ...	10	8 mm.

Microscopic Examination.—Sections of *brain* were stained with carmine, and by Weigert's hæmatoxylin method. The whole convolution appears very anæmic; the blood-vessels, especially in the cortex, are not at all prominent, but appear shrunken and empty. Here and there in the vascular sheaths are found granular cells and small particles. The large pyramidal cells appear shrunken and ill-defined, and their processes withered looking. There is, however, no great amount of granular appearance; in many cells there is a small collection of yellowish particles, but nowhere is the nucleus or nucleolus in the least degree obscured. The other and smaller cells of the cortex are of normal appearance. In the medullary centre there is a number of granule cells more apparent in the Weigert-stained than carmine-tinted sections.

Spinal Cord.—Sections were examined unstained and stained with osmic acid, carmine, with these two combined, with picro-

carmine, and by Weigert's hæmatoxylin prussiate method. In the anterior, and, to a lesser extent, in the posterior cornua, the capillaries stand out with undue prominence, and here and there, especially in the neighbourhood of cellular groups, there are small collections of blood corpuscles infiltrated into the nervous tissue, and apparently the result of capillary leakage. The nerve cells of the central grey substance present evidences of changes throughout the whole height of the cord. Although not appreciably atrophied, the great majority of them present traces of fuscous-granular degeneration. This is apparent even in unstained sections, and is rendered more obvious by the use of osmic acid, and in those sections stained with carmine and osmic acid. In these last sections the part of the cell which in sections simply stained with carmine is of a yellow colour, appears of a dark brown colour, the remainder of the cell taking on the usual pink tint. Their processes are well marked, and their outlines well defined. This description applies mainly to the large cells of the anterior cornua, but the same degenerative appearances, though much less pronounced, are to be noted in the smaller cells both of the anterior and posterior cornua, and in those of the vesicular columns of Clarke. The neuroglia is not apparently altered. The central canal in the cervical region is of a rather unusual shape, presenting a sinuous outline of a quadrilateral form.

With regard to the white substance, it is only in the cervical region that any alteration is apparent. Here the columns of Goll are affected with a slight degree of grey degeneration. It is strictly limited to these columns, and is quite apparent to the naked eye in stained sections forming a wedge-shaped area reaching from the periphery to within a short distance of the grey commissure. In the dorsal and lumbar regions there is no trace of degeneration in this region. The degenerated area presents the usual features of sclerosis; a thickening of the supporting connective tissue trabeculæ, numerous large spider cells, and some granule cells, the last being also occasionally found in the postero-external columns, though in much smaller number. Amyloid bodies are of occasional occurrence in the whole transverse section, being, however, more numerous over the degenerated area.

Some of the features of this case would lead one to refer it rather to the class of "stupor with dementia" of Blandford.* The age, 28, is that of stupor with dementia, rather than of stupor with melancholia, which affects mainly persons about

* *Insanity and its Treatment* (3rd edition), p. 230.

50, but there was in this case a distinct element of depression, as manifested in the expression and the emotional outbursts which approximates it rather to the latter.

With regard to the prognosis, hopes were at one time entertained of recovery. The age and ætiological conditions were not unfavourable elements in the case, and the slight glimpses of improvement encouraged one to look for a favourable issue. But this view could not be longer entertained after the development of the phthisis which finally carried off the patient. Whether recovery would or would not have ensued had not the pulmonary intercurrent malady developed, is a question which, considering the duration of the mental affection, and other circumstances, could probably only have been answered in the negative.

With regard to the probable pathology of this case, many of the features would indicate that there was, at least in the earlier stages, an arrest or suspension merely, rather than a real and irrevocable damage of the functions of the central nervous system, spinal as well as cerebral. The etiological conditions and the atrophied state of the nerve cells found after death, point to a condition of starvation and mal-nutrition, a condition which is quite recoverable, but which, in this particular instance, appears to have been indelibly imprinted on the essential nervous structures, so much so, as to preclude the possibility, under the circumstances, of a return to the normal state.

CASE XIV.—*Intense melancholia, with motor excitement and resistiveness—emaciation and muscular atrophy—harshness of skin.*

Mary N., 60, an Irishwoman, was admitted on 25th May, 1884. Only a very meagre history could be obtained, but it was supposed that the disorder was brought on by the desertion of her husband three weeks before admission. This was a case of most intense melancholia, with motor restlessness and resistiveness. She was extremely depressed and apprehensive, sobbing and moaning, beseeching that nothing might be done to her, and lamenting that she, "a well bred and well brought up woman," should have the misfortune to go out of her mind. It was next to impossible to carry out any physical examination, owing to her excitement and active resistance. Her face, typically Irish, was a most woe-begone one, and expressed the utmost misery and wretchedness, the corners of the mouth depending in most doleful fashion. She wandered aimlessly about all day wringing her hands,

groaning and wailing "God Almighty! what'll I do; what'll I do? Oh, God!" etc. When addressed, or even looked at, she rushed off and attempted to secrete herself, resisting most violently any attempt to bring her forward. This condition of wretchedness was almost continuous by day, while her nights were very indifferent. On admission she was in a poor physical condition, thin and emaciated, with a harsh, dry, and sallow skin. Morphia, to the extent of ½ grain doses thrice daily, had not the slighest effect. The depression and restlessness continued during her whole residence of ten months, and her bodily health gradually failed until the emaciation and muscular atrophy became extreme. Death occurred on 14th September, 1885.

Autopsy performed 41 hours after death. The cerebro-spinal fluid was not in excess. The spinal cord, a large and voluminous one weighing 24 drams, presented to the naked eye nothing noteworthy beyond an increased vascularity of the grey substance, and a slight brownish tinging of the medullary substance.

The calvarium weighed 12 ozs., the brain 44½. The soft membranes were much congested, and over the convexity very gelatinous, though not opaque; they were nowhere adherent. The basal arteries, especially the middle cerebrals, were atheromatous. The brain tissue generally was soft; the central medullary substance had a brownish tint, and the inner of the three apparent cortical layers was unduly vascular.

Beyond the occurrence of patches of aortic atheroma, and slight fatty infiltration of the liver, the other organs presented nothing of note.

Microscopical Examination.—The large pyramidal nerve-cells of the cerebral cortex are in an advanced stage of degeneration. As a rule they are not much diminished in size, but almost all of them have a yellow granular appearance. In some few cells the outlines show a tendency to breaking down. In no instance has the degeneration proceeded to such an extent as to lead to obscuration of the nucleus, which stands out prominently stained in the yellow unstained ground of the altered cell-substance. The pyramidal cells of smaller size present traces of the same degeneration, but the smaller round cells are unaltered.

The deeper cortical layers are somewhat vascular, and here and there hæmatoidin granules are to be seen in the vascular sheaths. Amyloid bodies and granule-cells are found scattered over the section, though in very inconsiderable quantity. The

changes noted as regards the *spinal cord* have reference mainly to the central grey matter, and the most noticeable of these is a degeneration and atrophy of the ganglionic cells of the anterior cornua. These have, in many instances, lost their processes and angular outlines, tending to assume a rounded or pyriform shape. Each cell is more or less filled with brownish particles, which in almost every case obscure the nucleus. With osmic acid nearly the whole of the cell-substance is stained of a dark-brown colour, only a little of the normal cell parenchyma remaining at the periphery. The smaller cells, both of the anterior and posterior cornua, and of Clarke's columns, are affected with a similar, though less advanced, degeneration.

Beyond slight increase of the vascularity there is nothing of note as regards the vessels. There is no alteration of the white substance.

The mental depression and motor excitement of this case depend probably on an irritative affection of the nerve-cells of the higher centres; but the alteration is a widespread one, and not by any means confined to these centres. It affects the nerve-cells of the spinal segment of the nervous axis as well as the encephalic, and some of the symptoms noted during life, the muscular atrophy, the emaciation, and the condition of the skin, probably depend on an affection of the trophic spinal centres.

CASE XV.—*Climacteric melancholia—history of a "stroke" —delusions of suspicion—tedium vitæ—somnolence—slowness of gait and movements—gradual intellectual enfeeblement—cerebral hæmorrhage—death 3¼ years from onset of mental disorder.*

William D. C., age 63, a mason, was admitted on 28th July, 1883, suffering from melancholia of two years' duration. No known cause could be ascertained, and nothing of note as regards antecedents. His mental condition was one of mild depression, with delusions of a suspicious variety. He accused his fellow-patients of "making dumb motions" at him, and he often expressed himself as tired of his life. His mind became gradually more enfeebled; his memory, more especially for recent events, became impaired, and he became drowsy and somnolent, often falling asleep by day. His gait and movements generally were heavy and slow.

Fifteen months after admission he was seized with an apopletic stroke, with symptoms pointing to a subsequent irruption of blood, first into the right, and afterwards into

both lateral ventricles. The paralysis affected first the left limbs, and at first consciousness was not completely lost, but shortly afterwards voluntary power was completely lost on both sides; coma supervened; the legs became rigidly fixed in extension, and death occurred nineteen hours from the onset of the hæmorrhage.

Autopsy twenty-four hours after death:—A tall and well-nourished body, with well-developed muscles and abundance of fat; no bed-sores. The spinal fluid appeared in excess, and the soft membranes generally were much injected. The cord was firm, and when deprived of nerve-roots weighed 17 drams. Its measurements were:—

	Transverse.	Sagittal.
Cervical, ...	14	10
Dorsal, ...	9	9
Lumbar, ...	11·5	10 mm.

On section it presented to the naked eye little appearance of alteration beyond slight yellowish tinging of the white substance, and increased vascularity of the central grey substance.

The head was of ample dimensions, especially anteriorly, and the calvarium weighed 17 ozs. The soft membranes were much congested, not adherent, and only slightly opalescent over the convexity. Both lateral ventricles were distended with fluid and clotted blood, and the hæmorrhage appeared to have originated in the neighbourhood of the lenticulo-striate arteries of the right side, the lenticular nucleus being so much disorganised as to be scarcely recognisable. The lenticular nucleus and parts of the caudate nucleus, optic thalamus, and internal capsule were broken up, ragged, and softened, and easily washed away with a stream of water. The whole encephalon, as removed, weighed 68 ozs.; the hemispheres each 28; and the cerebellum and medulla 5 ozs., leaving a residue of 5 ozs., representing the amount of blood effused.* The central white substance had a brownish tinge, and the cortex was pale, but not atrophied.

There was hypertrophy of the left ventricle of the heart, which weighed 17 ozs.; the mitral curtains were slightly thickened; the bases of both lungs were congested and œdematous; the solid organs, with the exception of slight fatty infiltration of the liver, were normal.

* T. W. M'Dowal (*Journal of Mental Science*, January, 1886, p. 498), records a case of general paralysis where the calculated brain weight was 66½ ozs. In this case the actual weight of brain substance was 63 ozs. (probably a little more). Average male weight (Quain), 46 to 53 ozs. Maximum (Thiedemann), 65 ozs.

Microscopical examination of sections of the *brain* reveals changes affecting mainly the nerve-cells and blood-vessels. The cellular changes are of a degenerative kind, without much actual atrophy. There are frequent large pyramidal cells, some even extremely large, and the majority of these present fairly well marked outlines and processes. Many of the larger and medium-sized pyramidal cells show evident traces of degeneration; in carmine-tinted sections they appear as partly pink stained and partly yellow granular bodies, but nowhere is the nucleus completely obscured. The finer capillaries of the deeper layers of the cortex are somewhat prominent, and the small arteries are considerably thickened, this depending mainly on hypertrophy of the middle coat.

In sections of the *medulla oblongata*, at the level of the olivary nuclei, the degeneration of nerve-cells is more apparent than in the brain, and here it affects alike the cells of the grey matter of the olivary nuclei and those of the grey masses situated posteriorly. In this situation, too, the vascular changes are more pronounced; the arterial walls are much thickened and their lumen encroached upon, while hæmatoidin particles occur occasionally in the perivascular sheaths.

In the *spinal cord* cellular and vascular changes are likewise apparent. Even in unstained sections the nerve-cells of the anterior cornua appear degenerated and slightly atrophied, but this varies considerably in different cells. Some appear as a mere mass of granules, in which neither nucleus nor nucleolus are apparent; others show a tendency to breaking down at the edges and rounding off of angles; while in other cells the degeneration is not so advanced, the granular appearance being limited to one or other angular recess, or surrounding the nucleus without actually obscuring it. This condition of the nerve-cells is rendered much more apparent by the use of osmic acid, while in carmine-tinted sections the cells appear as more or less pink-stained bodies, the amount of staining being in inverse proportion to the degree of degeneration. The multipolar ganglion cells of the anterior cornua are most affected, but the smaller cells of the anterior and posterior cornua and in the dorsal region, those of the vesicular columns of Clarke, show slight traces of a similar degeneration.

The arteries of the grey and, to a less extent, those of the white substance are considerably thickened from hypertrophy of the muscular coat, and their calibre is somewhat contracted. Granule cells, taking on a deep colour with osmic acid, and

hæmatoidin granules, occur occasionally in the vascular sheaths. The central grey matter, as a whole, appears unduly vascular. In the dorsal region the central canal is double, the smaller one being placed to the right of the larger; elsewhere it presents the usual appearance. There is no degeneration of the white columns.

The primary pathological alteration in this case is in all probability the change in the structure of the walls of the arteries, an alteration not of uncommon occurrence at the period of the grand climacteric, and characterised mainly by hypertrophy of the muscular coat, and a tendency to narrowing of the lumen. This by-and-bye induced a deficiency of blood supply to, and consequent mal-nutrition of, the tissues of the whole cerebro-spinal axis, manifesting itself during life by a depressed mental condition, gradual intellectual failure, and slowness and heaviness of voluntary movement. The fatal complication, cerebral hæmorrhage, is to be referred to the same source—namely, the hypertrophy of the arterial coats and its consequences, cardiac hypertrophy, and increased arterial tension.

The fourth and last series comprises five cases, in four of which the mental condition was one of imbecility with epilepsy, the remaining one being a case of imbecility not associated with epilepsy.

CASE XVI.—Summary—*Epilepsy from 9 months of age—dementia—suicidal and dangerously violent impulses—deepening of dementia—increasing severity of fits—general emaciation and muscular atrophy—phthisis pulmonalis—death at 28.*

John J., age 15, was admitted in 1872 and died in 1885 He had suffered from epileptic fits from the age of 9 months the fits being attributed to teething, and latterly he had developed suicidal and other dangerous propensities, attempting to hang himself, and attacking children with knives.

His mental condition was one of mild dementia with irritability and sulkiness after fits. The fits occurred frequently both by day and night, and tended to become gradually more severe. In 1883 the dementia had become more profound, and his general health so weak as to necessitate confinement to bed. He became stupid, lost, and confused; his habits were defective and he chewed and destroyed his bed-clothes. He became emaciated; his muscles very soft and atrophied, and the patellar reflex exaggerated. He died from phthisis.

At the autopsy, in addition to the tubercular pulmonary disease, the following changes were noted as regards the central nervous system. The calvarium weighed 18½ ozs., and was generally dense, but not unduly adherent. The cerebro-spinal fluid was much increased; the soft membranes throughout gelatinous and opaque, more so, however, over the convexity. There were no adhesions of the soft membranes, but on stripping them off, the tips of the lower two-thirds of the central convolutions and of parts of the supra-marginal and angular gyri of the left side were found distinctly roughened. The brain weighed 47½ ozs.; its tissue was soft and œdematous; the cortex generally was somewhat wasted, and its inner layer unduly vascular, while the central medullary substance had a brownish tinge.

The spinal dura mater presented externally nothing remarkable, but on laying it open two small bony-looking plates were found lying on the arachnoid. These were situated, one about the middle of the dorsal region, the other 1¼ inch below it, while both were placed posteriorly to the ligamentum denticulation. The upper one lay partly in front of the posterior roots; the lower was placed entirely posteriorly to them, while both were to the left of the posterior median fissure. They were about equal in size, measuring ⅜ of an inch long and half that in breadth, the long axis corresponding to the long axis of the cord. They were loosely adherent to the dura, but appeared to be developed in the substance of the arachnoid, which merged with them all round their edges. Both plates were smooth externally, but their inner surface presented numerous little jaggy eminences, imparting to it a distinctly rough feeling. The membranes of the cord in their neighbourhood were not in any way altered. The soft membranes of the lumbar enlargement were somewhat injected, the cord itself was firm, the central grey matter slightly injected, and the posterior columns in the cervical region had a slight gray tint.

Microscopic Examination.—Brain.—The nerve-cells of the large pyramidal type present appearances of atrophy and slight degeneration; they are smaller in size than usual, and are in part yellow and granular. The smaller cells are not altered. The vessels here and there, especially the smaller arteries, both of the grey and white, are somewhat irregular and twisted and their walls thickened, while the perivascular spaces frequently contain hæmatoidin particles.

Spinal Cord.—Sections were examined unstained and stained with carmine and picrocarmine. With regard to the

white substanoe, the only change observed is a slight degeneration of the columns of Goll in the cervical region. It is strictly confined to these columns, forming a wedge-shaped area occupying the posterior two-thirds of the columns. In the grey substance the changes noted affect the vessels and nerve-cells. Even in unstained sections the nerve-cells present an appreciable degree of fuscous degeneration and atrophy. Their outlines are not very definite, and there is a distinct tendency to rounding off of angles and wasting of processes. In many instances there is manifest diminution of the size of the cells, many lying shrunken in spaces much larger than themselves. Almost all the cells have a granular appearance, varying considerably in different cells, and in addition the non-granular part of the cell does not seem to be quite normal, appearing in carmine tinted sections much paler than normal and vitreous-looking.

The small arteries of the grey are very decidedly dilated and tortuous, and this reaches its highest development in the anterior cornua.

The plates in the soft membranes present a homogeneous, and in parts finely fibrillated matrix, with a few large oval cells embedded in it, but nothing approaching the structure of true bone.

The alteration of the spinal nerve-cells in this case is apparently not a simple one, but a combination of fuscous-granular and vitreous degeneration. It is in part, though not probably entirely, but one of the manifestations of the wide-spread atrophic changes associated with the pulmonary affection.

CASE XVII. — *Congenital imbecility — hydrocephalus — epileptiform seizures—gradual paralysis of motor voluntary power—rigidity of limbs—muscular tremors and jerking movements—exaggeration of patellar reflex—abolition of plantar reflex—asymmetry of skull.*

Timothy J., was admitted at the age of 30, on 20th January, 1869, and died on 11th April, 1885. A congenital imbecile, with large hydrocephalic head,* and badly developed body; height, 4 feet, 11 inches; unable to read or write, with slow, and hesitating speech, and very limited vocabulary. His habits were defective, and his gait awkward and ungainly. He became gradually more helpless, and unable to stand or

* Circumference, ... 24¾ inches.
From ear to ear, ... 13 „
From root of nose to occipital protuberance, . . 15 „

walk. His muscles generally became soft and wasted. There was much feebleness and rigidity of the legs, which were contractured in a position of rigid flexion, so that when sitting in a chair his feet were kept constantly drawn up, and never came in contact with the ground. Both patellar reflexes were exaggerated, and there were fine tremors of the muscles of the left arm, and jerking coarse movements of those of the right. Latterly, the arms also became rigidly fixed in adduction and flexion. The plantar reflex was absent. No fits occurred till 1883, in December of which year he had five; in June of 1884 he had a series of epileptiform convulsions; in April of 1885 these recurred, affecting mainly the right side, and he became comatose and died.

The following are the notes of the autopsy made nineteen hours after death. Spinal curvature backwards and to the left in lower dorsal and upper lumbar regions; great rigidity of knees and hip-joints; old pleural adhesions; gall-stones.

The spinal dura mater was congested generally, and in the cervical region slightly thickened, while the soft membranes were markedly injected over the lower dorsal and upper lumbar regions. The cord itself was rather soft, and the only change noticeable to the naked eye on section was a slight grey tinging of the posterior part of each lateral column. Apart from the curvature no evidence of disease of the spinal column could be found.

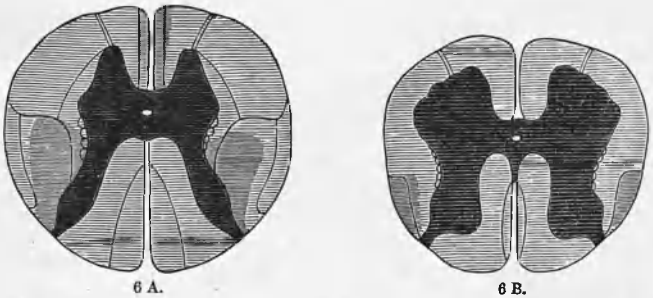
The scalp was much thickened generally, and the calvarium, weighing 19 ozs., was likewise thickened, though in an unequal manner, the greatest thickness, quite half an inch, being in the occipital region. There was well marked asymmetry of the skull, the left side being fuller, and bulging more in the neighbourhood of the parietal eminence. The skull-cap separated readily, and the underlying dura appeared normal. The brain, on being exposed, presented a very remarkable and unusual appearance, dependent, as was afterwards found, on extreme dilatation of the general ventricular cavity. Some of the fluid had escaped during removal of the cord, and the hemispheres had collapsed, so that the upper surface of the brain, as it lay in the cavity of the skull, presented, instead of the usual convex appearance, a deeply concave surface, more apparent on the right. The longitudinal sulcus was displaced to the left. The soft membranes were much congested, especially over the left side, but there was no marked opacity. The brain drained of fluid weighed 40 ozs., and its tissue generally was soft and œdematous. A few scattered meningeal hæmorrhages existed, one over the middle of the upper right frontal

convolution, another over the posterior part of the same, and another over the left superior parietal lobule. The interior of the brain formed one large sac, filled with clear limpid fluid, and the distension had proceeded to such a degree as to cause such thinning that in places the proper nervous structures had entirely disappeared. The corpus callosum, in its middle third, was entirely absent, so that the general ventricular cavity appeared here directly under the soft membranes. The remaining parts of the corpus callosum were much wasted. The soft membranes were nowhere adherent, and the underlying convolutions were flattened and wasted. On making sections of the brain the ventricles were found enormously distended, and in many places the containing nerve-substance measured not more than ¼ of an inch in thickness. The ependemary lining membrane was quite smooth and glistening. No trace of white medullary substance was to be found in the usual position of the formix or septum lucidum, the latter being represented by a thin diaphanous, and in parts fenestrated, membrane stretched vertically between the lateral ventricle of each side. The grey cortex was extremely thin and wasted, equally so on the two sides, and so likewise was the medullary substance. The cortex was relatively more congested on the left side, its colour being of a dark purple tint. The basal ganglia were somewhat softened, but not otherwise altered, and the same applies to the medulla and cerebellum.

Microscopic Examination—Brain.—The cerebral cortex is atrophied, and there is little appearance of the characteristic arrangement of nerve-cells. Both grey and white are very vascular, and the perivascular sheaths are here and there much distended, and occupied by a homogeneous material and hæmatoidin particles. The nerve-cells are almost entirely of the embryonic or undeveloped type, small rounded cells, possessing only a very few processes, or none at all. Only here and there a larger cell occurs, but even these are ill-formed and badly defined, with stunted processes. The majority of the cells present a trace of fuscous degeneration. The neuroglia is in excess, and of a coarsely fibrillated appearance.

Spinal Cord.—With the naked eye, and more distinctly with the aid of a simple lens, various areas of degeneration are apparent in the transverse section. These sections are stained with carmine, and in the cervical region three separate areas of degeneration are visible, one in the region of each crossed pyramidal tract, and another in that of the right direct pyramidal tract. With a low power the degenerated area in

the left lateral column is seen to be of larger dimensions than that of the right. In the cervical region it extends posteriorly quite to the periphery, but its outer edge, in passing forwards, gradually recedes from the outer margin of the cord. The anterior limit of this area is almost on a level with the posterior grey commissure, and by its inner margin it is in contact with the posterior cornu. The degenerated area of the right lateral column is not so extensive as on the left side; it is not in contact with the periphery to so great an extent, nor does it pass so far forward. In both instances the areas are of somewhat rounded form and well defined from the neighbouring tissue. In the right anterior column, the column of Türck is observed to be completely degenerated, while on the left side there is, what is not apparent to the naked eye, a minor degree of degeneration affecting here likewise the direct pyramidal tract.



6 A. 6 B.

Fig. 6.—Spinal Cord from a case of imbecility with chronic hydrocephalus. Degeneration of both lateral columns, and of both columns of Türck. (*a*) Cervical. (*b*) Lumbar.

The left anterior cornu appears smaller than the right, and this appears to depend more on a wasting in the region of the antero-lateral group of cells. In this group the number of nerve cells is much diminished compared with the corresponding group of the opposite side, and in this neighbourhood there are likewise evidences of vascular changes. The supply artery of the group, the antero-lateral artery of Ross and Young, is dilated and engorged; its anterior and posterior branches are distended with blood, while in the neighbourhood of its median branch there is a collection of blood corpuscles, apparently the result of leakage.

With a low power the cells of the anterior cornua present the usual features of fuscous-granular degeneration. The central canal is obliterated.

With a high power the degenerated areas of the white columns present the usual appearances of sclerosis; an increase

of the connective tissue trabeculæ, a diminution in number and in size of the nerve tubes, with here and there large dilated vessels. With regard to the nerve cells of the central grey matter, in almost all of them traces of degeneration exist in greater or less degree. In individual cells this is variable both as to position and degree; in some the degeneration is in the form of collections of granules round the nucleus in the centre of the cell; in others the collections occur at the periphery, often occupying one or other of the polar recesses and sometimes displacing the nucleus to one side. Apart from the degeneration, there is little apparent alteration in the cells; they are only very slightly atrophied; they are well formed and have well defined outlines and processes. This applies mainly to the larger cells of the anterior cornua, but also, though in a minor degree, to the smaller cells both of the anterior and posterior cornua.

In the lumbar cord the area of degeneration of each crossed pyramidal tract is much diminished in size, that on the left, however, still remaining the larger, while the degeneration of the anterior columns no longer exists. The degenerated tracts still retain their more or less rounded form and well defined outlines. They are placed more to the posterior end of the columns, are quite in contact with the pia mater and separated from the posterior cornu by a considerable interval.

In this region, as in the cervical, the degeneration of nerve cells is very apparent and quite as pronounced.

The measurements of the cord were.—

	Transverse.	Sagittal.
Cervical, ...	11·5	8·5
Lumbar, ...	9	8· mm.

Case XVIII.—Summary—*Congenital imbecility—epilepsy from 10—dementia with irritability—violent propensities and defective habits—progressive mental and physical degeneration—death at 48.*

Mary F., an imbecile from birth, and an epileptic from the age of 10, was admitted in 1869 and died in 1885. Her condition on admission was one of very pronounced dementia; she was unable to understand even the simplest questions; she could not read or write, and her habits were defective. The fits were of frequent occurrence, equally frequent by day and by night, and she was liable to outbursts of irritability and violence. She became gradually more and more demented, her physiognomy becoming very depraved and brutish, and she often made hideous animal-like noises. The further

progress of the case was marked by progressive deterioration mentally and physically. She became helpless, feeble, and emaciated; she was latterly quite unable to stand; she made little use of her hands, and the power of swallowing became impaired. For 3 months before death she was confined to bed, and during that period, she suffered from œdema of the legs, occasionally passing into low erysipelatous inflammation. The circulation was at all times very feeble, but bed-sores never developed.

The autopsy was performed 25 hours after death. The spinal cord appeared atrophied in a general fashion; its weight was only 15½ drams; and its measurements—

	Transverse.	Sagittal.
Cervical, ...	11	7
Dorsal, ...	6	6
Lumbar, ...	9	7 mm.

The cerebro-spinal fluid was in excess, and contained numerous cholesterine crystals. The spinal membranes presented nothing noteworthy, and no change was apparent to the naked eye on section beyond the general smallness and a slight brownish tinging of the white substance.

The calvarium weighed 14 ozs. The soft membranes were highly gelatinous and slightly opaque, but not adherent. The subpial fluid was in excess, and convolutions appeared wasted and separated by wide fissures. The brain weighed 37½ ozs.; its tissue was firm and compact, but very œdematous; the cortex generally was wasted and the medullary centre of a brownish colour. Basal arteries and ganglia were not altered.

The only points of note as regards the remaining organs were slight consolidation of both pulmonary bases, cystic disease of the kidneys, fatty infiltration and congestion of the liver, and a single calculus in the gall bladder.

Microscopic Examination—Brain.—An increase of vascularity is apparent both in the grey and white; hæmatoidin deposits occur here and there in the perivascular sheaths, and the walls of the arteries are thickened.

With regard to the nerve cells, the most noticeable appearance is the absence of any well-formed cells of the larger pyramidal type. There are pyramidal cells of small size, but these are badly defined and there angles are rounded off, while they present a degree of fuscous degeneration. The neuroglia appears to be in excess and coarser in texture than normal, and Deiter's cells are numerous and prominent.

Cervical Cord.—To the naked eye, the most striking feature

is the unusually small size of the transverse section. This is most obvious when corresponding sections of this and a cord of normal size are submitted to comparison; when this is done the atrophy is at once apparent. This atrophic condition appears to depend on a wasting both of grey and white substance, but more so of the latter. With regard to the white substance, the supporting connective tissue appears with a low power to be unusually coarse in texture, and with the exceptions to be mentioned, this applies generally to the whole transverse area of the white columns. There is a decided increase in the amount of the connective tissue and the individual septa are thickened. The spider cells are unusually numerous and large and well defined, while the blood-vessels are increased in number and their walls thickened. The exceptions mentioned apply to the posterior parts of the lateral, and to the internal segments of the posterior columns. In the former, the increase of connective tissue becomes more pronounced, forming an area which takes on a deeper staining. This area in each lateral column is somewhat triangular in outline; its anterior margin, not well defined, but shading off gradually, is on a level with the central canal; internally it is in contact with the posterior cornu, and externally it is separated from the periphery by a narrow zone in which the sclerosis is not so intense. In the posterior columns, the deeper staining is entirely confined to their inner segments, forming a wedge-shaped area which extends from the periphery for about two-thirds of the depth of the columns.

There is a diminution in the number and size of the nerve fibres of the white columns, and this is most marked in the areas of greater sclerosis. Compared with sections of normal cord, the fibres seem distinctly fewer in number, and with regard to size the appearance is best described by saying that the larger fibres are few, while the majority of the fibres are of the smaller variety. The pia mater is thicker than normal.

Grey Substance.—The whole of the central grey matter appears unduly vascular: the smaller arteries and capillaries are gorged with blood, and the walls of the former are thickened. The nerve cells, varying considerably in size, present in almost every instance a degree of that yellow and granular appearance, with changes in size and outline, which are characteristic of an early stage of degenerative atrophy. Some of the cells, but here it is the exception, retain their multipolar appearance, with well marked processes and angular outlines.

The majority of the cells tend to be rounded off at the angles, and to assume a globular or pear shaped form, while

their processes and edges are ill-defined. The yellow granular appearance is present in varying degree; in some cells it is present in only one of the angular recesses; in others it occupies, in part or wholly, the body of the cell, and obscures the nucleus. This applies mainly to the multipolar ganglion cells of the anterior cornua, but even in these, that part of the cell which is not invaded by the yellow granules, does not appear normal; it is not so deeply stained as usual, and it presents a vitreous opaque appearance. The central canal is obliterated, and replaced by a dense mass of round deeply stained cells.

Dorsal Cord.—The description given above applies pretty much to the white column in this region, except that the sclerosis of Goll's columns is not so well defined, and that it is smaller in area, being limited to a small tract on each side of the posterior median fissure. The nerve cells of the vesicular column of Clarke partake in the degenerative condition equally with those of the other parts of the grey substance. A small hæmorrhage exists in the substance of the posterior grey commissure immediately behind and to the right of, the obliterated central canal.

Lumbar Cord.—Here, as elsewhere, there is a general sclerosis of the white columns, not more pronounced in the posterior columns than elsewhere, but still existing in higher degree in the posterior segment of each lateral column. The area of degeneration in this latter region is much reduced in size, and it reaches quite to the periphery, but not to the posterior cornu. The nerve cells here are larger and better defined, but they still present evidences of yellow granular and vitreous degeneration.

The vascularity is more pronounced in the anterior cornua of this region, and in the left one there are two small leakages of blood into the nervous tissue. The central canal, is here, as elsewhere, obliterated, but, in addition to the round cells, numerous spindle cells and wavy connective tissue are found, giving to the centre of the cord a very dense appearance.

The alteration of spinal nerve cells is, in this as in Case XVI, a combination of yellow granular and vitreous degeneration. The most striking feature is the unusually small size of the cord, associated with a corresponding condition of the brain. The weight of the normal cord varies from 16 to 28 drams avoirdupois, while the average weight of the female brain, between the ages of 40 and 50, is 42·81 ozs. (Quain). These contrast with the corresponding weights in this case—viz., 15½ drams for the cord, and 37½ ozs. for the brain. This deficiency

in size and weight of the great nervous centre is, in all probability the result of arrested development. Imbecility, like other forms of insanity, is not always a purely mental disorder or defect; it is as often as not a deseased condition, or arrested development of the whole nervous centre, of the symptomatology of which the mental manifestations form only a part.

CASE XIX.—*Imbecility—epilepsy—awkwardness of gait.*

Kate S. was admitted at the age of 19, on 4th December, 1883, and died on 26th November, 1884. The history obtained from the parents was that she was quite well up till the age of three; that at that age she sustained an injury of the spine, after which she began to suffer from fits, that her mind afterwards was always feeble, and that latterly she had developed violent and dangerous propensities. Her condition on admission was one of imbecility; she was unable to read or write, and she could say only a very limited number of words; her habits were defective, and occasioually she was wayward and violent. There was great deficiency of walking power; her gait was extremely awkward, and she was almost unable to walk unless assisted by some one. The muscles generally were well nourished, and there was a great abundance of subcutaneous adipose tissue.

The following notes, with reference to the nervous centre, were taken at the autopsy. The brain weighed 35 ozs., its tissue was dense and firm, but not œdematous. The cerebro-spinal fluid was not in excess, and the membranes were nowhere adherent. The cortex generally was thin, but not otherwise altered.

The most noticeable feature regarding the spinal cord was its small size, more apparent in the lumbar and dorsal regions than in the cervical. Its measurements were:—

	Transverse.	Sagittal.
Cervical, ...	13	9
Dorsal, ...	7·5	7
Lumbar, ...	8	8 mm.

Microscopic examination—Brain.—The neuroglia appears to be increased in quantity, and of a dense and coarse texture. With regard to the nerve cells, only a very few of the large pyramidal variety are to be observed, and these few are atrophied and degenerated, presenting themselves as ill-defined bodies with rounded angles and of a yellow-granular appearance. The nerve cells are mostly of the embryonic variety, of medium size and rounded form. The structure of the

cortex and underlying white substance appears unduly open with numerous rounded and oval perforations.* There is increased vascularity of the grey cortex, and the nuclei of the vessel walls are increased in number.

Spinal Cord.—With regard to the white substance, there appears to be a generalised increase of the connective tissue in all the columns, not more pronounced in the lateral columns than elsewhere. The posterior columns, however, present, in addition, an unusual appearance. Scattered irregularly through their transverse section there are numerous small cicatricial looking patches of somewhat irregular and angular outline. These do not take on the carmine staining, but appear, some as colourless, others as light yellowish areas, which, under a high power, are seen to be composed of a finely fibrillar and molecular structure, embedded in a homogeneous plasm. This appears to correspond closely with what is described by Batty Tuke† under the term, Disseminated Sclerosis, and it is most apparent iu the lumbar region.

The multipolar nerve-cells of the anterior cornua, and in a less degree, the smaller cells of the posterior cornua, present traces of degeneration and atrophy; they are smaller than usual; their angles rounded, and processes shrunken, while in many the whole body of the cell is filled with yellow granules, so that it does not take on any of the carmine staining, and the nucleus is obscured. The grey matter, as a whole, appears unduly vascular.

CASE XX.—Summary—*Congenital imbecility without epilepsy—development of dangerous and violent propensities—defective articulation and voluntary motor power—death from acute pulmonary phthisis.*

Margaret L., age 44, was admitted on 19th April, 1884. She was a congenital imbecile who was cared for at home without trouble until shortly before her admission, when she developed dangerous propensities, trying to drown one child and throwing a knife at another. This was an ordinary case of genetous idiocy. She answered simple questions, but she had no idea where she was, and, although she had been at school for ten years, she could neither read nor write. Her expression was stupid and unintelligent; articulation thick

* The pieces of brain in this case were hardened in methylated spirit alone, and this open condition of the nervous tissue not found at all or only exceptionally, where the hardening agent used has been one of the chromates, I am inclined to attribute to the method of preparation.

† *Psychological Medicine*, Bucknill & Tuke (4th Edition), p. 625.

and indistinct. She walked feebly, and limped with the right leg; grasping power was decidedly feeble on both sides. Her habits were correct. After admission she learned to do some simple household work, but fifteen months after admission symptoms of acute pulmonary phthisis developed, and she died on 19th August, 1885.

Autopsy.—The skin generally was of a dusky earthy colour, being especially browned over the face and neck. The cerebro-spinal fluid was rather in excess, and blood-stained, but the spinal dura was unaltered. The vessels of the soft membranes were injected over the lumbar enlargement. The spinal cord itself was fairly firm, and presented on section nothing beyond a slightly increased vascularity of the grey matter. Its measurements were:—

	Transverse.	Sagittal.
Cervical, ...	13·5	8
Lumbar, ...	11	9·5 mm.

The calvarium weighed 13½ ozs.; the brain, 35½ ozs. There was considerable asymmetry of the hemispheres, the right weighing 16½ ozs., and the left 14 ozs. The dura was normal, but the pia was gelatinous and opaque over the convexity, though nowhere adherent. The brain-tissue generally was firm; the cortex thin, and its inner layer of a reddish colour; while the medullary centre had a brownish tinge. The changes noted as regards the other organs were:—Hypertrophy of the wall of the left ventricle of the heart; grey tubercles in both lungs; small caseous nodules in spleen, kidneys, and liver, the latter being also highly fatty.

Microscopic Examination.—Sections of the *brain* were stained with carmine and osmic acid, and by Weigert's hæmatoxylin-prussiate method. No well formed cells of the large pyramidal type are to be observed. The cells which are most numerous are small and rounded, and take on the carmine staining well. There are a few nerve-cells of pyramidal form, but they are small and ill defined, their processes are wasted-looking, and their interior is more or less occupied by yellowish granules. The vessels here and there are somewhat irregular in calibre and outline, but hæmatoidin deposits are very exceptional.

In the *spinal cord* there is no appreciable alteration of the tissue of the white columns in any part, but in the grey substance changes are noted with regard to the nerve cells and the vessels. Even in unstained sections, and with a low power, cellular degenerative changes are easily appreciable.

Some of the cells retain definite outlines, angles, and processes, and are of fairly normal size, but others again are wasted, and tending to the rounded form. All the cells, both those of apparently normal size, and those affected with a degree of atrophy, present, in varying proportion, evidence of degeneration. This reaches its highest development in the atrophied cells, but in all the degeneration has advanced very considerably. It is most apparent in sections stained by carmine and osmic acid. There is increased vascularity of the whole grey centre, and many of the arteries are thickened, and their calibre diminished.

In every one of the cases described in the preceding pages, without exception, changes in the spinal cord existed along with changes in the higher nervous centres.

The *macroscopic appearances* noted at the autopsies refer mainly to changes in the vascularity either of the soft membranes or of the central grey substance, or both together; appearances suggesting the existence of sclerosis of the white columns, and qualitative and quantitative changes in the cerebro-spinal fluid.

Beyond slight congestion in one case, and thickening in another, the *dura mater* presented little appearance of alteration.

With regard to the *soft membranes*, in twelve cases there was increased vascularity, more pronounced over the lumbar enlargement, and, as a rule, more so posteriorly than anteriorly. In one case they were anæmic, and in two cases suppurative meningitis existed, while in one other case two osteoid plates were found.

The *cerebro-spinal fluid* was in fourteen instances in excess; in two cases it contained crystals of cholesterine, and in one case it was sanguinolent.

The following remarks apply mainly to the *microscopic appearances*. In four out of the five cases of general paralysis described, changes affecting the lateral columns, in every instance bilaterally, were observed. In no instance were the anterior columns affected. In only one case (II) were the external divisions of the posterior columns affected in such a manner as to give rise during life to symptoms of ataxia. In four instances, including the latter, the columns of Goll were more or less affected. In one case (V), there was distinct atrophy of the cord as a whole, as indicated by the weight;

while in one other case (II) the cord was affected by a process of general sclerosis, in addition to other changes.

With regard to the white substance of the remaining 15 cases, in five instances no alteration was to be observed. Degeneration of Goll's columns alone existed in one case of melancholia (XIII), in one case of dementia (VII), and in one case of imbecility with epilepsy (XVI). Degeneration of both divisions of the posterior columns was present in one case of dementia (VI), associated with symmetrical lateral sclerosis in one case of melancholia (XI), and, in the form of disseminated sclerosis (of Batty Tuke), in one case of epileptic imbecility (XIX). Combined degeneration of the lateral and postero-internal columns existed in one case of dementia with epilepsy (XV), and in one case of imbecility with epilepsy (XVIII). In an instance of organic dementia (VIII) there was degeneration of the crossed pyramidal tract of one side, and of the direct pyramidal tract of the other. In the case of hydrocephalous imbecility (XVII), there was bilateral degeneration of the lateral columns, associated with bilateral degeneration of the columns of Türck. In the case of two epileptic imbeciles (XVIII, XIX), generalised atrophy was present, associated with general sclerosis.

Vascular changes (hyperæmia, hæmorrhages, and alterations of arterial walls) were noted in the grey matter in 16 of the 20 cases.

The most constant alteration in the spinal cord was the degenerative atrophy of the nerve cells of the central grey substance. According to Charcot* the changes to which the nerve cells of the anterior cornua are liable are of five kinds:—

1. Hypertrophy, occurring in certain cases of myelitis.
2. Multiplication of nuclei, a condition which is sometimes found in normal cords.
3. Vacuolation of the cell, of which he says, "I am not yet convinced that this alteration is not *un produit de l'art.*"
4. Pigmentary degeneration or that condition associated with atrophy, pigmentary atrophy.
5. Sclerosis or sclerous atrophy, in which the wasting is associated with an opaque and brilliant aspect of the cell substance.

Of the above, I have not in my investigations met with either of the first three, hypertrophy, multiplication of nuclei, or vacuolation, In only two instances (XVI, XVIII) have I found a condition approximating to the last, and in these the

* *Leçons sur les Maladies du Système Nerveux* (Fourth Edition), p. 203, vol. ii.

sclerous atrophy was associated with a degree of pigmentary degeneration. With these two exceptions, the alteration of the nerve cells corresponded very closely with that described as pigmentary degeneration and atrophy, and this alteration, varying considerably in different sections, and even in different cells of the same section, formed a very striking feature in, without exception, all the sections of cord which I had prepared and examined.

At an early stage of my investigations it occured to me that possibly the yellow granular appearance might in some way depend on the hardening agent, bichromate of potassium, but that this is not so is evidenced by the fact that a similar alteration exists in sections which had been hardened entirely in spirit and had never come in contact with chromate.

This alteration of spinal nerve cells appears to me to be a combination in varying proportions of three separtate elements:—1. Atrophy; 2. pigmentary degeneration; and, 3. fatty degeneration. So far as I can find, but little reference is made to the last of the three, the fatty degeneration, at least so far as regards the nerve cells of the spinal cord. Under the term *miliary sclerosis*, Bramwell * describes and figures a condition of nerve cells, in which fatty degeneration is a prominent feature, and Charcot, † in an article on lateral amyotrophic sclerosis, describes a similar condition of nerve cells in the optic thalamus. The fatty nature of the degeneration of the nerve cells has been noted by several observers in treating of the cerebral cortex in general paralysis ‡ (Meschede, Voisin, Bonnet, and Poincaré, Hitzig) and in senile atrophy. §

This alteration of spinal nerve cells exists in many forms of spinal disease, amyotrophic lateral sclerosis, glosso-laryngeal paralysis, protopathic muscular atrophy, infantile paralysis, and sometimes locomotor ataxia, and it is divided by Charcot ‖ into three stages. Normal cells present the following features:—They are provided with long and slender processes, which, as well as the cell itself, are coloured sharply and uniformly by carmine; the nucleus and nucleolus are very distinct; the small quantity of pigment which they contain has made no encroachment.

The first degree of alteration is characterised by the very intense ochrey colour which the cells present in the greatest

* *Diseases of the Spinal Cord*, (2nd edition), p. 241 and fig. 141.
† *Archives de Neurologie*, vol. x, p. 169.
‡ Mickle's *General Paralysis of the Insane*, p. 126.
§ Kostjurin, *Weiner Medic. Jahrbücher* (*Brain*, April 1886).
‖ *Leçons sur les mal. du Syst. Nerv.* (4th edition), vol. ii, p. 469.

part of their extent. This colouration results from the presence of pigmentary granules collected into a mass, and not acted upon by carmine. The parts of the cell which have not been invaded by this pigment are stained, on the contrary, almost as in the normal condition. The nucleus and nucleolus are yet distinctly visible and stained, but the prolongations are in general very short, and as it were shrivelled, or sometimes they have entirely disappeared. At the same time the cell diminishes in volume, it tends to lose its angular outlines, and acquire a globular form.

In a more advanced degree of the morbid process (second stage) the cell diminishes still in all its dimensions, is absolutely deprived of processes, and is now represented only by a small mass of yellow granules. The nucleus and nucleolus have, in general, entirely disappeared. There are cases, however, where this last still persists, and it is then the only part of the cell which has preserved the property of becoming coloured by carmine. Finally (third stage), one finds here and there, at the points formerly occupied by a cell, discrete yellow granulations scattered about. This is, without doubt, the last term of the alteration. In such a case one finds no longer the least trace of nucleus or nucleolus. With regard to measurement, the cells which have preserved the property of being stained by carmime in all their extent (healthy cells), have the same dimensions as the cells of a normal preparation. All the cells which have lost their processes are atrophied.

This degenerative-atrophy of the nerve cells of the grey substance of the spinal cord is, I am inclined to think, a constant feature in almost all, if not all, cases of insanity which are of some duration. The atrophy is marked by a diminution in volume of the affected cell, by a tendency to rounding off of angles, and wasting of processes, and a breaking down of edges, and indefiniteness of outline.

The degeneration is characterised by the existence, within the interior of the cell, of substances not found, or only found in minute quantity, in the healthy normal cell. The morbid products within the cell appear to be not alone of a pigmentary kind; the degeneration is a combined pigmentary and fatty one. As already mentioned, this degeneration is quite apparent, even in unstained sections. It exists in varying degree in different cells of the same section, and it is characterised by the aggregation of numerous minute particles of yellow or brownish colour. It is interesting to note the behaviour of these cells when submitted to the action of osmic

acid. In such sections, the part of the cell, which in unstained sections appears of a yellow colour, now takes on a decided brownish-black tint, most intense, as a rule, toward the centre of the granular mass, and often quite as dark as the stained myeline sheaths of the medullary substance. This is sufficient evidence of the (in part) fatty nature of the degeneration. When sections are acted on by ether, the granular area becomes somewhat clearer, as does also, though in much less degree, the whole interior of the cell; but the degenerated area still retains its yellow granular appearance. By this means the fatty element is removed, leaving untouched the pigmentary material, the insolubility of which in ether, in the case of the cells of the cerebral cortex in general paralysis and other forms of insanity, has been pointed out by Mierzejewski,* and Howden and Batty Tuke.† The statement of the two last observers—viz., that these granules are not of a fatty nature, is strictly correct, but that there is a fatty element in the degenerative process is none the less certain.

The degenerative atrophy affects mainly the large multipolar ganglion cells of the anterior cornua of the spinal cord, but the smaller cells of both cornua and the bipolar cells of the vesicular column of Clarke are by no means exempt. In every instance this is associated with a somewhat similar alteration of nerve-cells of the cerebral cortex. In both situations the degrees of degeneration and of atrophy vary very considerably in different cases. In the cases of imbecility, both in those with and in that without epilepsy, the most striking appearance as regards the cerebral cortex is the absence in greater or less degree, or arrested development, of the usual pyramidal large cells, contrasting with the more fully developed condition of the nerve cells of the spinal axis.

Degenerative atrophic changes of the nerve-cells of the spinal cord appear to be a constant feature of nearly all (if not all) forms of insanity when these have been of some duration. Systematic degenerations of the white columns of the spinal cord is a constant feature of general paralysis, and similar degenerations appear to be of frequent occurrence in other forms of insanity.

With regard to the question of the relation of the diseased condition of the spinal cord to that of the cerebral cortex, two separate views are available. 1st, It is either a *primary* disease of the spinal cord, developed independently of the

* Mickle's *General Paralysis of the Insane*, p. 127.

† Bucknill and Tuke's *Psychological Medicine* (4th Edition), p. 628.

cerbral; or, 2nd, it is *secondary* to the disease of the higher centre, *i. e.*, developed as a consequence of the cerebral disease.

Hitherto this question has, so far as I am aware, only been discussed in the case of general paralysis, and not of other varieties of insanity.

The degeneration of the lateral columns.—The differences which exist anatomically between consecutive lateral sclerosis and primary lateral sclerosis, according to Charcot,* are as follows:—In primary lateral sclerosis the fasciculated lesion is necessarily double, that is to say, it occupies the system of the lateral columns of the two sides at once, and not of one side alone, as always take place in consecutive sclerosis when the focal lesion which originated it is unilateral. Primary sclerosis has a great tendency to invade neighbouring regions, sometimes the white columns, sometimes the anterior cornua of grey substance; while this invasion does not occur, as a rule, in consecutive sclerosis.

In secondary degeneration the lesion occupies in the lateral columns only a relatively limited region. In the cervical region it presents on transverse section the appearance of a triangle, with very distinctly delimited borders, with its summit directed inwards towards the angle which separates the anterior from the posterior grey cornu, and with its base, slightly rounded, separated from the pia by a zone of healthy tissue. In the dorsal region the degenerated area tends to assume an oval form, while in the lumbar, as in the cervical region, its form is somewhat triangular. In primary lateral sclerosis the degenerated area occupies, in a general fashion, the same region as in the preceding case, but its limits are much more extensive. In front it tends to invade the anterior radicular zones; internally it often reaches to, and is confounded with, the grey substance, and its borders are diffuse, and badly defined. Consecutive sclerosis affects only a part of the nerve fibres which form the lateral columns—viz., the cerebro-spinal fibres, while in primitive sclerosis there is an invasion of the entire lateral system, comprising not only the cerebro-spinal or pyramidal fibres, but, in addition, those which commence and end in the spinal cord, fibres, properly speaking, spinal.

It is the rule, too, that has, however, some exceptions, that in descending degeneration following an unilateral cerebral lesion, the degeneration of the crossed pyramidal tract of the side opposite the lesion is associated with a similar condition

* *Leçons sur les Localisations dans les Maladies du Cerveau et de la Moelle Epiniére*, p. 160.

of the direct pyramidal tract, at least in the upper regions of the cord, of the side corresponding with the cerebral lesion. Such a combination does not occur in primary lateral sclerosis. In sclerosis consecutive to a brain lesion, the degeneration can be traced through the intermediate parts above the spinal cord as far as the primitive lesion.

Secondary degeneration is generally defined (Ross, Bramwell) as occurring when a lesion is so placed as to *separate* the pyramidal fibres from their trophic centre, the nerve-cells of the cortical motor area. Such lesions are usually focal and destructive in character, and in cerebral cases are usually situated in the deeper parts of the brain. Cortical lesions, provided they affect the cerebral substance of the motor area, and to a certain depth, likewise induce consecutive degeneration, but very superficial lesions, such, for example, as those that habitually accompany meningitis, do not produce it.*

Until quite recently, secondary degeneration has been associated with lesions called "gross," such as hæmorrhages, softenings, tumours, &c., but Charcot† has described two cases of lateral amyotrophic sclerosis, in which microscopic examination revealed a disappearance of the large pyramidal cells of the motor cortex, associated with a granule-cell myelitis of the whole length of the pyramidal tract, cerebral and spinal, and these two cases would indicate that secondary degeneration may be originated by a lesion not gross, nor yet one that separates the pyramidal fibres from their trophic centre, but by a microscopic lesion affecting the centre itself.

Cortical lesions form one of the most constant features of cases of insanity whose duration has been of any length, degeneration and atrophy of the nerve-cells, of the motor area, and elsewhere, pathological adhesion of the soft membranes, &c., and the question has often presented itself to me, how far the lateral sclerosis, so frequently occurring in general paralysis, and of not unfrequent occurrence in other varieties of insanity, might be due to such a diseased condition of the pyramidal trophic centre. It is doubtful, however, whether this view can be sustained. Instances occur, as, for example, certain cases of imbecility, in which there is a marked diminution in the number and size of the pyramidal cortical nerve-cells, but in which there is no appreciable degree of lateral sclerosis. In addition, the anatomical features of the degeneration of the lateral columns appear to approximate to

* Charcot, *Leçons sur les Localisations dans les Maladies du Cerveau et de la Moelle Epinière*, p. 154.

† *Archives de Neurologie*, July and September 1885, x, pp. 1 and 168.

those of primary lateral sclerosis rather than those of consecutive descending degeneration. In the nine cases out of the twenty, in which the existence of lateral sclerosis was determined, there appear to me to be but two exceptions to the preceding remark—namely, the case (VIII) of organic dementia associated with right hemiplegia, and the case (XVII) of hydrocephalic imbecility. With these two exceptions the degeneration of the lateral columns is bilateral in distribution, affects a considerable extent of the lateral columns; tends to invade its anterior regions; it assumes a triangular outline whose edges are ill-defined, and shade off into the normal tissue; in many instances it reaches quite up to the central grey substance; it is frequently associated with degeneration of other parts of the cord, grey or white substance or both; in no instance is it accompanied by degeneration of the columns of Türck; and in those cases in which the parts above the spinal cord (medulla oblongata; crus) were examined, no appreciable degree of alteration, or, at all events, no alteration at all proportionate to that existing in the lateral columns was found. In the case of organic dementia, with hemiplegia, the degeneration of the spinal cord presents the features commonly assigned to consecutive degeneration, depending on an unilateral lesion of the motor tract. It affects the lateral column of the side opposite the lesion; it is associated with degeneration of the column of Türck of the side corresponding to the lesion; the area of degeneration in the lateral column is of rounded form, with well defined edges; it is separated from the central grey matter by a zone of normal tissue, and it is less extensive than in primary sclerosis. The case of imbecility with chronic hydrocephalus is a somewhat complicated one; but even in this instance, judging from the appearances presented on microscopic examination, I am inclined to refer this likewise to the class of secondary descending degenerations from gross cerebral lesion; and certainly in this case the lesion was sufficiently gross to have caused such permanent damage to the pyramidal strands as would induce descending degeneration.

The foregoing considerations have induced me to adopt the view, the view which is advocated by Westphal and Schultze, in the case of general paralysis, that the degeneration of the lateral columns occurring in cases of insanity of some duration, is, with few exceptions, developed primarily; or, that at all events, it is not secondary, using that term in its usual acceptation.

The degeneration of the posterior columns, was in only

three instances, so distributed as to give rise during life to symptoms of locomotor ataxia, and, as is usual in that affection, the morbid process is of primary origin. In eight cases the postero-internal columns were alone affected, but in no instance was the sclerotic process very intense. Here, likewise, the affection is a primary spinal one, possibly dependent, in some way, as suggested by Charcot,* in a case of lateral amyotrophic sclerosis, on conditions of permanent congestion of other parts of the cord, such a congestion as is frequently observed in the central grey substance.†

With regard to the fatty-pigmentary degeneration and atrophy of the nerve cells of the spinal grey substance, so constant a feature of these cases, I am again inclined to the view that it is, in the majority of cases, a primary affection. Such a condition is often, no doubt, associated with degenerations of other parts of the spinal cord—*e. g.*, the lateral columns which show a marked tendency to invade neighbouring parts, and in such cases it is to some extent secondary, but not unfrequently it exists alone and unassociated with changes elsewhere. Many of the symptoms occurring in the course of cases of mental disorder are, I believe, referable to this condition of the nerve cells, more especially the trophic troubles, the emaciation, muscular atrophy, more particularly that atrophy which is designated by Erb‡ simple atrophy, and which, he thinks, does not occur without some distinct preceding change in the spinal cord, the bedsores, and other cutaneous alterations, the alterations of reflexes, pupillary changes, and to some extent the sensory changes, and affections of bladder and intestines. The altered condition of nerve cells in the spinal cord may, in many instances, be attributed to the same causal agency as operates in producing the alteration of the nerve cells of the higher centres. This applies more to those causes distinguished as "physical" in contrast with those called "moral," such as sexual and alcoholic intemperance, toxic agents, syphilis, destitution and other bodily disorders, while in many instances the altered condition of the essential nervous elements of the spinal cord is manifested, I believe, as part and parcel of that inherited instability which is so commonly associ-

* *Arch. de Neurologie*, vol. x, p. 174.

† It could not be determined, from the history of any of the cases, that the spinal affection had in any instance preceded the mental. The occurrence of psychical troubles in cases of long standing spinal diseases is well attested; but that question, as well as the question of direct extension of the morbid process from the spinal axis to the cerebrum, has not been touched in this paper.

‡ Ziemssen's *Cyclopedia of Medicine*, vol. xiii, p. 114.

ated with mental and other nervous disorders. I do not consider that this condition of nerve-cells is to be explained as depending on muscular inaction and confinement to bed. It is found, for instance, in cases which have been characterised by motor excitement and restlessness, as in Case XIV, where the motor restlessness was extreme, and persisted almost till the time of death.

What is the nature of this pathological process occurring both in the cerebrum and spinal cord? is it an "irritative" lesion, or a purely "degenerative" lesion? is it primarily a parenchymatous, or primarily an interstitial lesion? That in many instances it is of an irritative nature is evidenced by many of the symptoms occurring during life—the muscular tremors and contractures, the motor excitement, the cutaneous eschars, the depression, irritability, restlessness, and other mental phenomena. But often symptoms of degenerative lesion, the mental enfeeblement, various atrophic manifestations, are apparent during life; and the appearances after death are those mainly of degeneration. The probability is that the lesion is more often a combined than a simple one. A lesion may be primarily an irritative one, but gradually it passes into a degenerative: or again, a lesion mainly degenerative, may at some part of its course have irritative phenomena superadded. With regard to the question as to the interstitial or parenchymatous origin of the lesion, the systematic manner in which the lesion affects definite areas of the spinal cord is an element which is in favour rather of the latter view, and recent investigations on the subject of granule-cell myelitis, point in a similar direction, the lesion in this case being primarily parenchymatous. But here again we have to deal in all probability not with a simple process. and in cases in which the disorder has been of some durotion the pathological lesion is probably always a combined parenchymatous and interstitial one. The pathological changes found on microscopic examination of the spinal cord are, more or less, those figured by Erb* in describing chronic myelitis, under which term he includes "all those slowly developing processes in the spinal cord which run a tedious, lingering course, without fever, and which in the present state of our knowledge are ascribed to chronic inflammation."

From the foregoing considerations it will be apparent that not only are changes in the essential nervous elements of the higher centres a constant feature in cases of insanity, but that these centres are not alone implicated. It is exceptional that

* Ziemssen's *Cyclopædia*, vol. xiii, p. 426.

any one case of insanity is characterised by mental symptoms alone; it is difficult to imagine how, in such a complex organism as the cerebro-spinal axis, those parts which subserve the purely mental processes could be affected, without involving in some degree the regions which subserve its other functions. In the majority of instances of mental disorder, disorders of sensation, motion, or alteration of trophic functions, as well as symptoms indicative of disorder of spinal functions, are of constant occurrence. In the words of Griesinger, "diseases of the nervous system form one inseparable whole of which the so-called mental diseases only embrace a certain moderate proportion." The Psychoses form but a group of the class of disorders of the nervous system, in which the mental manifestations, though they usually constitute the most prominent feature, and for practical reasons, serve to distinguish the class, are by no means the only, or even sometimes the most prominent, feature of the symptomatology, and an investigation of the other functions, sensory, motor, nutritive and reflex, of the cerebro-spinal centre, as well as of the purely psychological manifestations will often afford valuable indications as to the pathology, the treatment, and the prognosis of individual cases of mental disorder or defect.

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