ON A CASE OF MULTIPLE SPINAL AND CEREBRAL TUMOURS (SARCOMATA), WITH A CONTRIBUTION TO THE PATHOLOGY OF SYRINGOMYELIA.

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THE following case came under my observation a few years ago when resident in the Manchester Royal Infirmary; and as I was able to watch the course of the disease for a period of eight months, I have considered it worth while to now put it on record, since it possesses many features, not only of clinical, but of pathological interest.

The patient was under the care of Dr. Morgan during the greater part of his stay in the Infirmary, and it is to him that I am indebted for his kind permission to publish it.

W. D., a married man, aged 38, was admitted at the end of July, 1881, to the Manchester Royal Infirmary, under the care of Dr. William Roberts, complaining of weakness of the left lower extremity with aching pains in both legs. He stated that up to the commencement of the present attack he had never had any serious illness. No history could be obtained of any syphilitic taint.

His illness commenced about eighteen months previously, with aching pains in the lower extremities; but these were more marked on the left than the right side; in the course of a few months the left leg became weaker than the right, and this soon was so marked that, according to his own description, "the left leg would occasionally slip from under him, and he would fall to the ground." It was not until about nine months since that he noticed the wasting of the muscles on the front of the left thigh, which at the time of his admission was such a marked feature. At no time had he

noticed any numbness of either of the lower extremities, neither has he had any bladder troubles.

On August 1st, 1881, we have the following note as to his "present state":—

Patient is 5 ft. 4 in. in height, of healthy but not robust appearance; he complains of aching pains in both lower extremities, but they are much worse in the left than the right leg, and are sometimes so severe as to necessitate a sleeping draught being administered; he also complains of weakness of the left lower extremity. He is able to walk short distances, but this causes fatigue; he walks with no special kind of gait, but slight dragging of the left leg is observed. On examination, the chief feature which strikes one is the excessive atrophy of the extensor muscles on the front of the left thigh; the other muscles of this extremity appear also wasted, but not to that extreme degree which the above extensors show. He does not complain of weakness of the right leg, but all the muscles of it appear more or less atrophied. Patellar tendon-reflex of the left leg almost abolished; that of the right present, possibly in excess. At this date we have no note of any cutaneous sensory disturbance. There are no bladder troubles.

On August 6th he was sent to the Convalescent Hospital at Cheadle, but there became much worse, first noticing that the right lower extremity became numb and gradually weaker; it also became a seat of aching pains, which were far more severe than they had ever been in the left leg. He had also difficulty in passing his water, having to strain to do so.

On September 26th he was returned to the Manchester Infirmary, this time under the care of Dr. Morgan.

On his return he was just able to walk, but required great assistance to do so. He took to his bed, to which he was ever afterwards confined.

On October 1st we have the following note:—He is now not only unable to walk, but to sit up in bed, being unable also to raise himself from the horizontal to the sitting posture.

He complains of great pains in the right leg; this is not of a shooting but of a continuously aching character. There appears to be no hyperæsthesia of the skin, but when the

muscles of the leg or thigh are grasped, it gives him great pain. There is considerable wasting of the muscles of both legs and thigh, but that of the left side is more marked than the right, there being very little of the quadriceps extensor of the left thigh remaining. He has now almost complete paraplegia, being unable to flex the thighs on the abdomen, nor can he move the legs at the knee-joints; he can just manage to move the feet at the ankles and the toes on either side.

The quadriceps extensor muscle of the right thigh responds to a weak faradic current, but requires a moderately strong galvanic one to give a response, the kathodal closure contraction occurring with a fewer number of cells than the anodal closure one.

The quadriceps of the left thigh gives no response to the strongest faradic current, but with the galvanic current a contraction is obtained with a powerful current on kathodal closure, but no response can be seen with the strongest current at anodal closure.

The tibialis anticus of either side responded readily to a weak faradic current, that of the right leg to a slightly weaker current than the muscle on the other side. With the galvanic current, the kathodal closure contraction took place with a weaker current than the anodal closure contraction; the kathodal closure contraction occurring with the same strength of current on either side, but the anodal closure contraction ensued with a somewhat weaker current in the case of the right tibialis anticus, than it did with the muscle of the left side.

There is no rigidity of the lower extremities; on the contrary, they are quite flaccid.

Patellar tendon-reflex of the left side almost, but not quite, abolished, that of the right side is now considerably increased.

He has a slight feeling of constriction round the abdomen.

There now exists cutaneous analgesia and anæsthesia over the front and outer side of the lower half of the left thigh; also another small patch of anæsthetic skin, not more than an inch in diameter, exists over the margin of the costal arch

in the right mammary line. No other affection of sensation can be found in any part.

No weakness of the upper extremities.

There is no deformity of the spinal column, and no tenderness is detected on pressure along the spine,

Once since his return from Cheadle the catheter had to be used, on account of retention of urine, but usually he is able to pass his water, though he has to strain to do so. No bedsores, and no joint affections. Temperature normal.

No affection of the circulation or respiration, and the functions of other organs are performed in a healthy manner.

Nov. 8th.—He is still unable to move his lower extremities any more than he could a month since, but the continuous pain, and that caused by grasping the muscles of the legs, have both disappeared. He is still unable to raise himself from the lying to the sitting posture. Patellar tendon-reflex of left side almost abolished. That of right side slightly in excess.

The whole of the left lower extremity has now become anæsthetic and analgesic, this extending above to the level of a line drawn through the umbilicus, on the lower part of the abdomen it does not quite extend to the middle line in front. Over the right lower extremity sensation is impaired, though there are no distinct patches of anæsthesia.

The patch of anæsthesia still exists over the costal margin on the right side, and remains much the same in extent as noted a month back.

For the last three weeks he has complained of a heavy sensation over the right frontal region, and about the same time he noticed numbness of the right half of the face.

There now exists marked cutaneous anæsthesia and analgesia over the right orbit. Over the cheek and lower jaw of the same side, there is less acute sensation than on the left side, but there is no complete loss of sensation.

The conjunctiva of the right eye is much injected, and there is a superficial ulceration of the cornea of that eye.

The right masseter and right temporal muscle are considerably atrophied.

There is no affection of taste on either side of the tongue.

No vomiting or vertigo is present.

Patient is very intelligent, and there appears to be no mental disturbance.

No optic neuritis is seen in the left eye; the fundus of the right cannot be seen, on account of the ulceration of the cornea.

No oculo-motor troubles; no difference in size of the pupils of the two sides. No facial paralysis.

Hearing good on both sides, but much better on the left than on the right side. No difficulty in swallowing; no morbid symptoms connected with the circulatory or respiratory systems. Urine free from albumen and sugar.

No stiffness or rigidity of the muscles of the neck.

No paralysis of the muscles of the tongue.

No affection of speech.

He is able to pass his urine more readily, not having to strain so much to do so. Appetite good; bowels constipated. Temperature normal.

No bedsores.

Nov. 21st.—He is now unable to move either toes or feet at the ankle joints.

Some rigidity of the right lower extremity has come on; while he lies with the left leg fully extended, the right is flexed at the hip and knee joints, and the hamstring muscles stand out in marked relief; we can bring this limb into the extended position, but doing so causes patient considerable pain at the knee.

The atrophy of the muscles of the lower extremities is becoming more marked; this is especially perceptible in the right limb, where the quadriceps extensor cruris has very much diminished in volume, and is now nearly as much wasted as that of the left side, very little muscle remaining on either side; the girth of the thigh, three inches above the upper margin of the patella, is ten inches on either side.

The atrophy of the muscles of the calf and those on the anterior aspect of the leg is now rather more marked on the right than the left side. No patellar tendon-reflex can now be obtained on either side; even on the right side, where it was so much in excess, it is now absent.

No epigastric or cremasteric reflex can be obtained; but the abdominal reflex is present.

The skin on the right lower extremity is almost entirely anæsthetic and analgesic, except that at one or two isolated spots he occasionally recognises the prick of a pin, but he is still able to recognise heat and cold when applied over this limb.

The patch of anæsthesia over the right costal margin is rather more extensive, but it is separated yet by a portion of sensitive integument from the anæsthetic part below.

The anæsthesia over the left lower extremity remains the same; it does not extend higher than the level of the umbilicus, and not quite to the middle line on the lower part of the abdomen.

The anæsthesia over the distribution of the ophthalmic division of the 5th of the right side remains the same; but there is in addition a small patch of anæsthesia immediately below the right eye, while the rest of the skin of the cheek is sensitive, though not so acutely so as on the left side. The cornea has become more hazy. There is no evidence of the involvement of any cranial nerve, except the 5th of the right side.

There is no optic neuritis.

He is very little troubled with headache; there is no vertigo or sickness.

There is now complete retention of urine, and the catheter has to be constantly employed.

For the last ten days there has been a slight evening rise of temperature, while the morning has been normal. This has been constant during that time, but it has not reached a higher point than 100° F.

His general health remains fairly good.

The loss of sensation has now extended until the whole of the right lower extremity as well as the left is anæsthetic and analgesic, though occasionally he can feel the prick of a pin at a few spots over this surface, but these sensitive parts have no regular arrangement.

Dec. 4th.—The anæsthesia has now extended, until that over the right costal margin and over the right lower extremity have merged into one. The upper limit of the anæsthesia on the right side is a line drawn through the apex of the xiphoid cartilage, while on the left side it does not extend quite so

high, the upper limit being a point about two inches above the umbilicus.

The atrophy of all the muscles of the lower extremities is most marked, it being much the same on the two sides. There is now observed slight swelling of the left knee-joint, evidently due to effusion of fluid into the interior of the joint; the fluid appears limited to the joint and does not involve the surrounding subcutaneous tissues. There is no redness over the joint and no pain, and patient was unaware of the existence of the swelling. The left ankle-joint appears also a little swollen, but this is less marked than the swelling at the knee.

Retention of urine still exists; there is now also incontinence of fæces.

A small bed sore has appeared in the central line over the upper part of the sacrum.

Anæsthesia exists now over the whole of the right half of the face, except over the lower jaw. The ulceration of the right cornea and injection of the conjunctiva has increased.

The right half of the upper lip is swollen and thickened, and on the inner aspect is an ulcer the size of a sixpenny-piece; it causes him no pain, in fact he is not aware of it, merely noticing the swelling of the lip; opposite this ulcer there is rather a sharp rough tooth.

The palpebral fissure of the right side is smaller than the left. There is no evidence of any other cranial nerves being involved. He has complained lately of a little more pain over the right half of the face and right frontal region.

There appears to be distinct flattening of the left half of the chest below the nipple; the movement here is not so good as on the right side, the ribs appearing to be dragged up, but the chest undergoing very little expansile movement. There is no anæsthesia over this flattened part. Percussion and auscultation of the chest give negative results.

The temperature still shows slight evening rises.

Dec. 15th.—The limits of the anæsthesia of the lower half of the body remain stationary; the loss of sensation does not appear to be extending at all. We have a note at this date that the movement of the chest appears much the same on either side; if anything, it is deficient on both sides.

The retention of urine is beginning to give place to incontinence. The incontinence of fæces persists. The urine is acid when drawn off and contains only very little pus.

The temperature has lately shown more considerable variations; for the last three nights it has risen to above 101° ; last night it was $101^{\circ}6$, and the previous evening 102° ; it falls to normal in the morning.

There appear to be no local changes in the lungs to account for this pyrexia.

The condition of the right eyeball, as regards the neuro-paralytic ophthalmia, remains stationary; the palpebral fissure is still smaller on the right than the left side.

Another ulcer has now appeared, this being on the right half of the lower lip in a corresponding position to the one on the upper lip. The latter ulcer still exists, and neither ulcer extends across the middle line to the left.

No other cranial nerves besides the 5th are involved. There is no optic neuritis. He is now very little troubled with headache.

Jan. 10th, 1882.—His general condition has changed much for the worse; his appetite fails, and he has lost a great deal of flesh this last fortnight.

There is incontinence of urine, and the fluid is very purulent, alkaline, and offensive.

The temperature chart still shows considerable evening exacerbations.

The condition of the lower half of the body remains the same, except that the effusion into the left knee-joint has disappeared, and the joint has returned to its normal condition.

There is no loss of power or anæsthesia of the upper extremities.

The ulcers on the inner aspect of the lips still persist.

Jan. 25th.—Patient continues to get worse, he has emaciated very much lately.

The urine is very foetid and purulent, so the bladder is now washed out frequently with a solution of boracic acid.

There is still a considerable evening rise of temperature; about a week ago he had a shiver, and the thermometer re-

gistered $104\cdot4^{\circ}$, but this temperature was not maintained for many hours, it soon falling to $101\cdot4$.

The grasp of the left hand has now become distinctly weaker than the right, but the anæsthesia still maintains the limit it has done for so long, and does not extend.

The expansile movement of both sides of the chest appears deficient; auscultation and percussion of the chest give negative results.

The atrophy of the muscles above the knees appears the same on the two sides, but below the knees it is more marked on the right than left side, a difference which is especially marked in the calf muscles.

During the last few days a red erythematous patch, followed by the development of a bulla, has appeared over the external malleolus of the left leg; a similar formation has ensued on the under and inner aspect of the left heel.

The anæsthesia over the course of distribution of the 5th cranial nerve of the right side still exists, but a great change has ensued in the condition of the right eye. The conjunctival injection has entirely disappeared, and the eyeball appears quite pale, like the left eye; yet the cornea is still opaque.

For the last fortnight a small ulcer, about the size of a split pea, has existed on the skin of the lower eyelid, near the inner canthus, of the right eye.

The ulcers on the mucous surface of the lips have almost healed.

No optic neuritis nor evidence of the involvement of any cranial nerves, except the right 5th.

Feb. 4th.—Patient has complained these last few days of rather more headache.

There is still incontinence of urine, but the fluid has become of a clear amber colour, not at all offensive, acid, and contains no albumen.

The temperature is still a little elevated, but does not show such considerable variations as at the date of the last note.

The ulcers at the inner aspect of the lips and at the inner canthus have now healed.

The weakening of the left arm has become very marked,

the grasp of the left hand, as registered by the dynamometer, is 9, while that of the right is 45. Not only is the grasp enfeebled, but the power of movement at any of the joints of this extremity is much lessened. No anæsthesia is found over the arms; the upper limit of the loss of sensation remains the same.

The condition of the chest movement is the same as at the date of the last note, there is very little expansion movement of the lower part on either side.

The bed sore on the sacrum still exists, but does not increase in size.

The bulla over the left external malleolus has given place to a small sore; that under the left heel has dried up.

The skin along the outer side of the left foot has become erythematous, apparently due to pressure, the foot resting on this part. The skin under the right heel has become dark, soft, and rather pulpy, but it is not ulcerated.

Feb. 10th.—The condition of the left arm remains the same; the triceps tendon-reflex is increased on either side, that of the left distinctly more so than the right.

The chest movements remain the same. Not only below but also at the upper part of the chest there is very little expansile movement, and respiration appears to be chiefly diaphragmatic.

There is effusion into the right knee-joint, which is swollen, but not reddened or painful.

Feb. 18th.—The effusion into the right knee-joint still persists.

The conjunctiva of the right eye has now again become much injected.

Triceps tendon-reflex is still increased on either side.

Feb. 25th.—Condition of the left arm remains the same; there is no evidence of the involvement of the right upper limb.

The thoracic movement still remains very defective.

There is still slight effusion into the right knee-joint.

There has now appeared internal strabismus of the right eye, with incapability to turn the eye outwards; the other movements of the right eye and all those of the left are preserved.

There is slight but distinct facial paralysis of the left side.

March 3rd.—Patient's general condition is worse, his appetite is not so good; he feels cold and shivers occasionally. The temperature shows considerable variations; last night it was 102·8°, this morning it is 100·6°. The urine has again become very foetid and purulent.

The left arm has become very rigid, and is firmly applied to the side of the trunk and flexed at the elbow-joint, while the wrist is extended and the fingers slightly flexed on the palm; he is only just able to move this left upper extremity; the triceps tendon-reflex is increased on both sides; but there is no evidence of any loss of power in the right arm.

The condition of the cerebral symptoms remains unchanged, there is no evidence of the involvement of any more cranial nerves; the internal strabismus of the right eye and left facial paralysis persist. Hearing is equally acute on either side.

The conjunctiva of the right eye is now pale, but the corneal opacity exists. The right palpebral fissure is markedly smaller than the left.

March 11th.—Patient's general condition is worse; the temperature is more continuously above normal.

The condition of the cerebral symptoms remains the same as last week, except that the left facial paralysis is a little more marked.

While the anæsthesia over the course of distribution of the right 5th still exists, *the sense of taste over the anterior part of the tongue on either side is very acute.*

The upper limit of the anæsthesia, over the lower part of the body, is now about the same on either side, it extending up to a line drawn about 3 inches above the umbilicus.

The left arm remains in the same state; he can only just move it.

The effusion into the right knee-joint still exists.

For the last week he has spoken somewhat indistinctly, but there is no loss of memory for words.

March 18th.—He is much worse to-day. His temperature the day before yesterday was 105·6°, and this morning it is 101·8°; with this exception, it has never been below 102° F. for the last six days.

The incontinence of urine and faeces persists. The urine is exceedingly putrid and offensive.

The injection of the conjunctiva of the right eye has now come on again. The movement of the eyeballs is perfect in all directions, except that, through the paralysis of the external rectus of the right eye, he cannot look with that eye to the right.

The facial paralysis of the left side of the face is distinct; it involves the lower facial muscles, the upper facial muscles being quite free; he can close the eye on either side. There is no paralysis of either hypoglossal nerve.

The palpebral fissure of the right eye is still much less than the left; the pupils of the two sides cannot be compared, in consequence of the corneal opacity of the right eye.

March 22nd.—Patient gradually became weaker, and died last night, not having manifested any other symptoms.

Post-mortem.—This examination was made by Mr. A. H. Young, late Pathologist to the Manchester Infirmary.

Body greatly emaciated. Rigor mortis absent. Cutaneous hypostasis was well marked on the ventral aspect of the trunk and extremities (the body has been in the prone position since death, ice being applied to the spine).

A large bed sore existed over the sacrum and a smaller one over the right external malleolus. There was slight greenish discoloration of the anterior abdominal wall.

Spinal Cord.—On opening the spinal canal the whole of the nerves of the corda equina were seen to be greatly thickened and to possess almost a cartilaginous firmness. The dura mater was with difficulty separated from the posterior common ligament of the vertebral bodies, *i.e.* in the lower part of the canal.

Five inches above the tip of the conus medullaris, the spinal cord for a distance of $2\frac{1}{2}$ inches presented an area of great firmness, cutting and looking not unlike cartilage; at the periphery small opaque calcareous-looking deposits were observed.

Elsewhere the cord was somewhat softer than normal. In the cervical region there was marked dilatation of the central canal. No other definite naked-eye changes could be distinguished.

Brain.—The right side of the pons varolii was almost entirely replaced by a mass of new growth, like that in the spinal cord, of firm cartilaginous consistency. A small nodular outgrowth of this growth penetrated into the substance of the temporo-sphenoidal lobe. Brain-substance in other respects showed no naked-eye changes. The arachnoid membrane was slightly thickened and opaque, and there was considerable subarachnoid oedema.

The Gasserian ganglion on the right side was invaded by new growth, an extension of that of the pons.

Thorax.—Old pleuritic adhesions were found at each apex. Numerous subpleural masses (of various sizes) of new formation, flattened in shape, of a whitish colour. Lung-substance generally was normal.

Pericardium showed a single secondary nodule of small size.

Heart, 10 oz., dilated and hypertrophied.

Abdomen.—Alimentary canal not examined.

Liver, 4 lbs. 10 oz., congested.

Kidneys, right, 10 oz.; left, 7 oz. Substance of each organ presented numerous small abscesses. Pelvis dilated, and also full of pus.

Spleen, 8 oz., soft and pulpy.

Right knee and hip were opened; they showed hyperæmia of the synovial fringes and some increase of synovial fluid, but in other respects were normal.

If we briefly summarise the chief clinical and pathological features of the case, we notice: A man, of about 38 years of age, had suffered for 18 months with aching pains in the lower extremities, more marked in the left than the right, together with considerable weakness of the left leg. After this 18 months he first comes under our observation, complaining only of the above symptoms; we notice considerable wasting of the muscles of the left lower extremity, especially of the extensor muscle on the front of the left thigh; no loss of sensation and no bladder and rectum troubles are yet present. However, in the course of the next month he begins to get much worse; his legs become weaker, and he now, for the first time, notices great weakness of the right leg, which becomes the seat of very severe pains, similar to those observed in the left leg at a

previous date; about the same time he also has to strain to make water. In the course of the next month the weakness so much increases, that he becomes unable to walk, and has to take to his bed, and at the end of this second month he is not only not able to walk, but cannot raise himself from the lying to the sitting posture, and can only just move the toes and bend the feet at the ankle-joint. The lower extremities are quite flaccid and not at all rigid; the muscles are wasted, especially the extensor cruris of the left side. The muscles, however, show no reaction of degeneration.

At the beginning of the third month a patch of anæsthesia appears on the front and outer side of lower half of the left thigh, just above the knee, and another patch of anæsthetic skin is found over the costal arch on the right side in the right mammary line. In the course of the next six weeks the skin over the whole of the left lower extremity becomes anæsthetic up to the level of the umbilicus; in a month more the whole of the right lower extremity has become anæsthetic, and the anæsthetic part below has merged with the patch of anæsthesia over the right costal arch. During this time also the atrophy of the muscles of the legs has increased, and the catheter has had occasionally to be passed to relieve retention of urine.

Soon after the patch of anæsthesia appeared on the left thigh, *i.e.* after he has been under observation about three months, a series of cerebral symptoms begin to manifest themselves: he first notices pain, followed by anæsthesia, over the right eye, and the skin here becomes anæsthetic, and very soon this extends to the skin of the right cheek; ophthalmia also develops on the right side. The motor division of the 5th cranial nerve is also affected. By the end of the fourth month of observation complete retention of urine has ensued.

In the fifth month of observation there is evidence of effusion of fluid into the left knee-joint, without any signs of inflammatory action. In the same month the retention of urine gives place to incontinence, and the urine becomes purulent; at the same time slight pyrexia begins to develop.

In the fifth month, also, a painless ulcer appears on the inner aspect of the right half of the upper lip, and a little later, another on the inner aspect of the lower lip on the same side.

A month afterwards an ulcer appears on the skin of the lower eyelid near the inner canthus.

In the fifth month of observation the palpebral fissure of the right side is smaller than on the left side. Towards the end of the sixth month the left arm begins to become weak and rigid, and the triceps tendon-reflex of that side is increased. In the seventh month this increases, and paralysis of the external rectus of the right eye, and of the facial muscles of the left side, is to be noted.

The urine becomes more purulent and offensive, and the pyrexia greater. Bedsores appear on the sacrum, and bullæ are seen about the heels and malleoli. He gradually becomes weaker, and dies, after being under observation for about eight months, and having suffered from spinal symptoms for a little over two years.

At the autopsy is found a sarcoma, matting together the nerves of the *corda equina*; another sarcoma exists in the dorsal region, replacing the cord for a distance of two and a half inches, but the shape of the cord being here, nevertheless, still preserved; and a third tumour replaces the right half of the pons, and involves the 5th nerve and the Gasserian ganglion. Marked dilatation of the central canal of the spinal cord.

Secondary tumours in the lungs and pericardium. Suppurative nephritis.

Microscopical Examination and Commentary.—The various new growths—viz. that in the *corda equina*, spinal cord, pons varolii, and lungs—were all of the same nature, viz. spindle-cell sarcomata. Further, they appeared to be pure spindle-cell growths, no other kind of cell entering into their composition. We have already remarked upon the fact, so unusual in intraspinal tumours, that the growth in the dorsal part of the cord simply replaced the nervous elements of the cord, the shape of the cord being, nevertheless, still retained; so that no distinct outgrowth or tumour projection from the cord at the seat of the disease occurred, except the affection of the various nerves along which the new growth had extended. It may, in fact, be said that we had, for a distance of two and a half inches in the dorsal region, what was apparently at first sight a portion of the spinal cord, but in reality was that structure replaced

by sarcomatous elements. The growth extended along the cord, above and below, by growing along the outside of the blood-vessels, so that nearly every small arteriole at the periphery of the growth was surrounded by a mass of spindle cells, and its lumen was considerably narrowed from the pressure exerted by these from without. This mode of extension left traces of its previous existence in the older parts of the tumour, where the spindle cells were seen to be arranged in concentric groups, forming very small nests, the centre of which represented the narrowed, and in many parts completely obliterated, lumen of a blood-vessel.

At the extremities of the growth in the dorsal region, the nervous matter, which still existed between the masses of spindle cells arranged in groups round the blood-vessels, was very much degenerated, large accumulations of myelin being present at these parts; these myelin masses appeared to be gradually absorbed, and to be replaced by the sarcomatous elements. At some parts of this tumour in the dorsal region, and at the periphery of it, similar masses of myelin still existed to those which were found at the extremities of the growth, and it was the persistence of this myelin that gave the appearance described in the post-mortem report as resembling calcareous collections; there was, however, no calcareous matter.

The nerves issuing from the part of the cord which was replaced by the new growth, all suffered from an invasion into their substance of the sarcoma elements. The spindle cells had developed in the perineurium, surrounding and isolating the true nerve fibres, without apparently exerting very great pressure on those fibres, for even in the oldest parts of the growth the arrangement of the fasciculi of these nerve-roots was still distinct, but no axis cylinders could be recognised at any part of them; the absence of the latter, and the disappearance of the myelin, left a large number of small, more or less circular spaces, which had been previously occupied by the nerve fibres; the large number of these spaces in the sarcomatous infiltrated nerves, gave a hyaline appearance to the sections taken from these parts. The spindle cells of the tumour appeared to have simply replaced the perineurium, and

the true nervous elements, the axis cylinders and their myelin sheaths, had then become absorbed.

The appearance which these nerves presented on emerging from the affected portion of the spinal cord, was likewise again seen in the growth affecting the corda equina, only here it was seen on a larger scale, the growth having matted together the various nerves composing that structure. The spindle cells had here extended again between the separate nerves of the corda equina and between the various fasciculi of each nerve; but still the original arrangement of each nerve could be still recognised, for though the axis cylinders and their myelin sheaths had disappeared, the small spaces which they had occupied still persisted, surrounded on all sides by the spindle cells of the growth.

Those parts of the growth in the cord and in the corda equina which had developed most recently, were very rich in nuclei; but in the older parts these were far less numerous, and the growth had there taken on a uniform hyalin-fibroid appearance. With this exception, the tumours had not undergone any degeneration or further change with age.

There was nothing in the microscopic appearance of the growth in the spinal cord, or of that in the corda equina, to allow us to say positively which was the older of the two, and which consequently represented the primary one, but that in the pons was certainly of more recent development than either of the other two.

Although the pathological details collected after death do not allow us to solve this point, I think there can be very little doubt that the tumour in the corda equina was the primary growth, and the growth in the dorsal part of the cord was secondary to it; the pons tumour developing still later. It is highly probable that for the first eighteen months of his illness he was suffering from the growth in the corda equina alone, and it was only in the first month that he came under our observation that the tumour in the dorsal region began to develop, and that the complete paraplegia was brought about by the combined effect of the two tumours, and was not to be attributed to the tumour in the corda equina alone; that it was the development of this tumour in the dorsal region

which in great part accounted for the marked downward progress of the man when he was at the Cheadle Convalescent Hospital, and the rapid development of the complete paraplegia after his return to the Royal Infirmary. What speaks very strongly in favour of this view is, I think, the fact noted that soon after he became completely paraplegic, a patch of anæsthesia appears, not only over the left thigh, but also over the *costal margin* of the right side, a position which could not be accounted for by the tumour in the *corda equina*, but was probably due to the growth in the dorsal region, and possibly its extension along some of the sensory nerve roots from that portion of the spinal cord.

The spinal cord below the tumour in the dorsal region presented very well-marked and very advanced sclerosis of both lateral tracts, and also of Goll's and Burdach's column. The lateral sclerosis on either side was due to the interruption of the cord in the dorsal region by the tumour there; it was, in fact, a descending sclerosis.

The sclerosis of Goll's and Burdach's column on either side presented itself as a marked sclerosis, which extended on both sides from the posterior median fissure to the inner aspect of the posterior grey cornu, with no break of intervening healthy nerve tissue. This sclerosis we must regard as an ascending sclerosis from the effects of the growth in the *corda equina*. It is interesting as illustrating the fact that extensive lesions of the *corda equina* cause, not only a sclerosis of Goll's tract, but also of Burdach's as well. A considerable portion of Burdach's column, in the lower portions of the cord, being probably composed, either directly or indirectly, of fibres which proceed from the various nerves of the *corda equina*, and so consequently, when the latter is divided or interrupted by such a growth as we have in this case, sclerosis of that column results.

Above the tumour in the dorsal region there was well-marked evidence of ascending sclerosis, the column of Goll being very sclerotic in its whole vertical extent, and sclerosis could be traced as far as the posterior surface of the medulla. Immediately above the tumour, for a distance of about a quarter of an inch, there was not only a sclerosis of Goll's

tract, but also of Burdach's, exactly as we saw was the case below the tumour. We must consider this change in the posterior root zone as an ascending sclerosis; but it is not probable that it represents the effects of the growth in the corda equina before the tumour in the dorsal region began to develop, since probably the latter tumour grew, and practically divided the cord, before the one in the corda equina had completely cut off the nerves going to the lower extremities; at the same time we cannot forget that lesions of the great sciatic nerve alone have been followed by a sclerosis of Goll's column and of the posterior root zone. However, I should be much more inclined to attribute this sclerosis of the posterior root zone, which existed for a very short distance immediately above the tumour in the dorsal region, to the effects of that growth, which would cut off a large number of the fibres which would subsequently proceed upwards for a certain distance in Burdach's column: in support of this we may note the complete destruction of all nervous elements in both the spinal cord, and in the nerves which entered that structure opposite the seat of the new growth.

In the cervical region distinct sclerosis of the cerebellar tract also existed; this could be traced into the medulla, where it occupied a small tract in the restiform bodies. This is again to be regarded as an ascending degeneration.

From the position and extent of the cerebral tumour, we should have expected some evidence of descending change in the left lateral column; there was, however, no continuous tract of sclerosis, though some sections did show slight increase of the neuroglia in the lateral column of one side, and there was a small patch of sclerosis in the anterior pyramid of the medulla on one side.

The cavity existing in the cervical region of the cord, which in the post-mortem report is attributed to a dilatation of the central canal, was in reality to be so explained, as microscopic examination clearly proved. In the above region only one cavity existed, which occupied the median line, and was quite $\frac{3}{8}$ th inch in transverse measurement; it was flattened from before backwards, and so measured much less in that direction. It diminished in size from above downwards, being

distinctly smaller in the lower cervical region (from which Fig. 2 was taken) than just below the medulla oblongata (Fig. 1). In the upper dorsal region two canals existed, both of much smaller dimensions than the single one above: one of these occupied a central position, and represented the dilated central canal; the other occupied the position of the posterior grey cornu of the right side, having quite replaced that portion of grey substance. These two canals extended downwards about one inch, and were succeeded by a single canal occupying a central position, and evidently the original central canal of the cord, but now dilated, for a distance of about another inch, below which the canal again became double for a distance of half an inch, the two canals being again here situated as the two were higher up. Then below these two canals we had only a single one, occupying a central position as far as the tumour in the dorsal region. Below that new growth the central canal presented but slight increase above the normal dimensions, and was a single channel occupying its usual central position.

Consequently we had in the greater part of the cord an apparently very much dilated central canal; but in the upper dorsal region at two places two canals existed, between which two points there was only a single centrally situated channel. The wall of the canal in the cervical region (Figs. 1 and 2) was much thinner than in the dorsal region, where two canals existed (Fig. 4), although in the former place it enclosed a much larger channel than in the latter, where the lumen of either was very small. Further, the wall of the canal in cervical region was composed of firm, fibrous tissue, evidently of much older date and more fully formed than in the dorsal part of the cord, where each canal was surrounded by a fibro-nuclear growth, which was really very rich in nuclei. At the same time it could not be considered to represent a tumour mass, a new growth such as a glioma, but undoubtedly was an inflammatory tissue, and was probably to be regarded as the result of pressure exerted from within the canal. The lining membrane of the canal or canals was always well-defined, and often had a corrugated sinuous outline, or, as it has been described by some authors, of a shirt-frill character,

and we could hardly conceive how such a canal, with so thick walls and such an internal limiting membrane, could have originated by any decay in a previously existing tissue; far more probable appeared to be the explanation, that the cavity first existed with a thin wall, and that the latter thickened and became stronger to support the increased pressure.

The canal in the cervical region was so large, that though occupying a central position, it involved to a large extent the grey cornua, especially the posterior, which had practically disappeared (Fig. 1); the anterior cornua, on the other hand, were comparatively little implicated; but in parts even they were much compressed and diminished in size. The wall of these canals was composed of a fibro-nuclear tissue: in the cervical region, where the canal was large and single, the fibrous element predominated, and the wall was not so thick as elsewhere; in the parts where there were two canals, the nuclear element was in excess, and the wall was much thicker (Fig. 4), while the lumen of the canals was less than in the case of the single cavity in the cervical region. Towards its inner aspect, the wall of the cavity often presented a corrugated, folded appearance, just like the elastic coat of an artery. No endothelial lining existed.

The pathogenesis of such cavities as these in the spinal cord is still very uncertain. Although a really large amount of attention has been given to the study of the subject, hardly any two authors will be found to agree as to the exact sequence of events which has led to their formation, and it is quite possible, in fact, from the recorded cases *probable, that the same explanation will not suffice for all instances of the morbid appearance.*

It is well that we should start with a clear idea of what we mean by the term syringomyelia, and what by hydromyelia. Simon, Leyden, and Ziegler separate congenital enlargements of the central canal under the term hydromyelia, from those cases where we get cavities formed from pathological causes subsequent to birth, and to which the term syringomyelia is applied. To the latter group would belong our present instance.

It is noteworthy that this affection is most commonly either

limited to the cervical or dorsal parts of the cord, or is most advanced there; also that the cavities which are formed are most frequently situated either in the posterior white columns, the posterior grey commissure, or in the posterior cornua, very rarely do they appear in the anterior portions of the cord, either in the grey or white substance.

Leyden¹ regards syringomyelia really as a consequence of congenital hydromyelia, attributing it to an interference with the closing the central canal, which is at first so large in the embryo. The position in which these cavities are found, chiefly in the posterior parts of the cord, would be held to support this view.

Westphal² and Simon³ both attributed it to the development of a new growth, a tumour (and not inflammatory tissue) in the spinal cord with a subsequent degeneration of the centre of this, and the formation of a cavity or canal. According to their views, the cavity has nothing directly to do with the original central canal of the cord. Westphal, however, in a more recent paper,⁴ shows that his former view must to a certain extent be given up, and that a certain relation of such cavities to the central canal must be acknowledged. And he says, the changes found in the cases most recently observed by him were doubtless congenital, and that we must assume that disturbances of development of the central canal ensued with cavity formation, accompanied by a tendency to the development of fibrous new growth. He adds, however, that "in other cases there seems to be a tendency to the development of another form of new growth (glioma, myxoma)."

Schultze⁵ likewise holds the view, that these cavities owe their origin to a decay of proliferated neuroglia tissue, which may take its origin at various parts of the spinal cord, or in the medulla oblongata.

Hallepeau⁶ regarded a central myelitis as the primary

¹ 'Klinik der Rückenmarkskrankheiten,' ii. p. 447; and Virch. 'Archiv,' vol. 68. Compare also Taylor, F., 'Trans. Path. Society,' 1884, vol. xxxv. p. 36.

² 'Archiv f. Psychiatrie,' vol. 1, 1874, pp. 30 and 109.

³ Ibid.

⁴ 'BRAIN,' July 1883, pp. 149 and 165.

⁵ Virch. 'Archiv,' vol. 87.

⁶ "Contribution à l'étude de la sclérose diffuse périependymaire," &c., 'Gaz. Méd.' 1870, 30, 32, 34, 35.

lesion; a diffuse sclerosis ensuing round the central canal, and in consequence of degenerative changes which ensued in this inflammatory tissue, cavities were formed.

Langhans¹ attributes the cavities to a dilatation of the central canal of the cord, and the formation of diverticula from it, brought about by blood stasis, which stasis may be occasioned in various ways; in three of his four cases it was effected by tumours in the posterior fossa of the skull.

My own case I am inclined to attribute to dilatation of the central canal, and the formation of diverticula from that, but I am less inclined to explain that dilatation by a blood stasis occasioned by the tumour in the pons, than by an obstruction to the circulation of the cerebro-spinal fluid, and to a damming up of that fluid in the central canal of the cord, whereby great pressure was exerted, diverticula formed, and as a consequence of that pressure, a sclerosis ensued round the canals so arising, and that consequently the sclerosis was not a primary element in the case.

The most recent writer on the subject is Dr. Ed. Krauss,² who ably reports a very interesting case. He explains the syringomyelia which existed, as a consequence of proliferation of the neuroglia tissue, which first formed, as it were, a kind of glioma, and then the central part of this undergoing decay, cavitation resulted. After carefully considering the previous history, and the pathological appearances found after death in Dr. Krauss's case, I am much more inclined to think that the primary lesion there was a hæmorrhage into the upper part of the spinal cord, and possibly medulla, with a secondary descending sclerosis of the lateral column of the one side, together with the formation of a cavity, the greater part of which was due to a dilatation of the central canal of the cord, but that part of the cavity above might be due to changes ensuing in the hæmorrhagic focus itself.

Dr. Krauss believes that there had previously existed a syringomyelia which had caused no symptoms until those ensued quite suddenly (the patient waking up one morning

¹ "Ueber Höhlenbildung im Rückenmark als Folge von Blutstauung," Virch. 'Archiv,' vol. 85, p. 1.

² "Ueber einen Fall von Syringomyelia," Virch. 'Archiv,' August 1885, vol. 101, p. 304.

and finding the right leg and arm paralysed), and he is evidently of the opinion that the most probable explanation of the sudden onset of those symptoms was a hæmorrhage, which, as he remarks, is no seldom occurrence in the case of a glioma. For my own part, I can see no reason or necessity to assume, that before the hæmorrhage ensued such a proliferation of the neuroglia did exist, nor that there was before the onset of the symptoms, any syringomyelia. A far more rational view appears to me to be, that hæmorrhage into the spinal cord (rare as such lesion is) was the primary change.

As regards my own case, I think few could study the sections from which the figures were taken without coming to the conclusion, that most probably the sequence of events had been increased pressure within the central canal, dilatation of this (Figs. 1 and 2), formation of a diverticulum (Fig. 3) or out-growth from the same, and eventually the establishment of two distinct channels (Fig. 4) with very thick walls.

From cases recorded, it is evident that syringomyelia may reach a very advanced stage without giving rise to any definite symptoms during life. In others it occasions marked atrophy of various groups of muscles, with or without sensory disturbances. It is doubtful whether, in our own case, any of the symptoms could be referred to the syringomyelia and to the sclerosis round the canals which existed. The grey matter was very extensively involved, as Figures 1 and 2 show; in some parts not only was the posterior (Figs. 1, 2 and 3), but also the anterior cornu of one or other side considerably affected (Fig. 3). It is hence possible that such a lesion might have been really the cause of the deficient chest movement, which was noted in the latter part of our patient's existence. It is certain that the position of the tumour in the dorsal region, and the involvement of the issuing spinal nerve-roots, would not account for this paralysis of the intercostals.

An interesting point also in our case was the existence in the anterior pyramids of the medulla, close to the anterior surface (Fig. 5 *a*), of a distinct and well-marked nucleus of grey matter, which was so large as to be quite easily visible to the naked eye. This nucleus commenced immediately above the

decussation of the pyramids, and ran upwards to close upon the lower border of the pons, a vertical distance of nearly $\frac{3}{4}$ inch. Quite at its upper part this nucleus divided into two, one occupying the position the whole did lower down, viz. the anterior surface of the medulla, while the other and smaller half was situated at the side of the anterior median fissure, rather more posterior and internal than the above-mentioned half.

At its point of greatest size, which was at its lower part, this nucleus presented upwards of two hundred ganglia cells; these diminished in number towards the upper limit of the nucleus.

No nerves were seen coming off from the anterior surface of this nucleus, but from its deeper part, filaments of nerves ran into and were lost, in the deeper parts of the medulla. No connection could be traced between this nucleus and any of the other nuclei in the medulla (Fig. 5 a).

Another well-marked nucleus of grey matter existed at the posterior part of anterior pyramids immediately to the inner side of the hilum of the olivary body (Fig. 5 b). I specially mention the existence of these two nuclei, since the majority of our English anatomical text-books quite ignore their existence, and I possibly may hence be forgiven for having at first considered them to be but another item in making our patient a pathological curiosity.

Both of these nuclei are, however, recognised in the majority of the anatomical works of continental authors; they are, in fact, the nuclei arciformes of Henle,¹ or the anterior and posterior pyramidal nuclei of Kölliker, and the small pyramidal nuclei of Stilling.²

In our present case they were both exceedingly well developed.

The cerebral symptoms call for special mention in reference

¹ 'Handbuch der systematischen Anatomie des Menschen,' von Dr. J. Henle, 1868, Nervonlehre, p. 194.

² See also 'Allgemeine und microscopische Anatomie,' von W. Krause, III Auflage, 1876, I. Bd., page 413 and Fig. 242; also 'Zehn Vorlesungen über den Bau der Nervösen Centralorgane,' von Dr. Ludwig Edinger, 1885, page 121, Fig. 107. Also Ross 'On Diseases of the Nervous System,' 2nd edit., vol. i. p. 807: "The nucleus of the pyramid (internal parolivary body)."

to one point. The trophic lesions in the area of distribution of the right trigeminus were highly interesting, but what I would specially call attention to is, that though the post-mortem proved how complete had been the implication of the 5th nerve with the Gasserian ganglion of the right side, yet there had not been the slightest affection of taste on the corresponding side of the anterior two-thirds of the tongue. I repeatedly tested for this, since the case was under observation at the time when I became acquainted with Erb's views on the course, which the gustatory fibres supplying that part of the tongue took to the brain.¹

Whatever may be the course of the gustatory fibres of the chorda tympani in the majority of cases, it is certain that in our case they did not pass with the 5th nerve on the right side. Although many cases are recorded of loss of taste over the anterior two-thirds of the tongue from disease of the 5th nerve, others have existed, and been put on record, where complete paralysis of that nerve left taste unaffected.

In conclusion, I would subjoin a few further references to the subject of syringomyelia :

NONAT : "Recherches sur le développement accidentel d'un canal rempli de sérosité dans le centre de la moëlle épinière."—'Archives générales,' 1838, i.

JOLYET : "Sur un cas d'anomalie du canal central de la moëlle épinière."—'Gaz. Méd. de Paris,' 1867.

VIRCHOW : "Die Betheiligung des Rückenmarks an der Spina bifida und der Hydromyelia."—Virch. 'Archiv,' xxvii. 1863, p. 575.

LANCEREAUX : "Un cas d'hypertrophie de l'épendyme spinal avec oblitération du canal central de la moëlle."—'Mém. de la Soc de Biol.' Paris, 1862.

SCHÜPPEL : "Ueber Hydromyelus."—'Archiv der Heilkunde,' vi. p. 289.

GRIMM : Virchow's 'Archiv,' 1869, vol. 48, p. 445.

NAUNYN and EICHHORST : "Ueber die Regeneration und Veränderungen im Rückenmark."—'Archiv f. exper. Pathol. und Pharmacol.,' ii. 1874, p. 225.

STRÜMPPELL : 'Arch. f. Psychiat.,' x.

FRIEDREICH : Virchow's 'Archiv,' vols. 26 and 27.

¹ "Ueber den Weg der geschmackvermittelnden Chordafasern zum Gehirn," 'Neurol. Centralb.,' vol. i., 1882.

Fig. 4.

Fig. 5.

Fig. 1.

Fig. 2.

Fig. 3.

- PICK : 'Archiv f. Psychiatrie,' viii. p. 285
 RIPPING : "Cystoide Degen. der Hirnrinde."—'Allg. Zeitschr. f. Psych.' vols. 30 and 32, 1874 and 1875.
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 SCHULTZE : Virchow's 'Archiv,' vol. 102. 1885.

EXPLANATION OF THE PLATES.

- Fig. 1. From the extreme upper part of the spinal cord.
 a. Extremely dilated central canal with comparatively thin fibrous wall.
 b. Sclerosis of Goll's columns.
- Fig. 2. From lower cervical region.
 a. Dilated central canal, here smaller and with a thicker fibrous wall.
 b. Sclerosis of Goll's tracts.
- Fig. 3. Lower cervical region.
 a. Formation of a diverticulum (c) from the dilated central canal.
- Fig. 4. From dorsal region.
 a. Two cavities (a and c) with thick fibro-nuclear walls.
- Fig. 5. From the medulla.
 a. Anterior pyramidal nucleus.
 b. Posterior pyramidal nucleus.