In *disseminated sclerosis*, where the symptoms are particularly variable on account of the sclerosed areas being so inconstant in their distribution, the patient's legs are weak and spastic with all the tendon-reflexes exaggerated, while his (or her) arms, also weak, may be paraesthetic. More striking than this, however, and more important in the diagnosis, are its three cardinal symptoms, tremor, nystagmus, and staccato speech. By these it may be known, although in the earlier stages, before these three have fully developed, a hysterical counterfeit may lead us astray.

Compression of the cord, the result usually of caries of the spine, an aneurysm or a secondary growth, produces twofold symptoms—those of spinal root irritation followed by root paralysis, and those of a transverse lesion of the cord itself. Apart from these, however, we may expect a third set due to whatever is causing the compression. If this last group is not to be found, we are then thrown back on the possibility of some primary new growth inside the spinal canal, or a patch of chronically thickened meninges; in either case, the site of the pressure is identified by the distribution of the symptoms. The distinction between the two, however, may be a matter of difficulty. Perhaps the most suggestive differences are that in chronic meningitis the course is slower and that the pain, even from the beginning, is bilateral and spreads over a wider area. Moreover, the meningitis may improve without surgical treatment.

REMOVAL OF EXTRAMEDULLARY TUMOUR OF CERVICAL CORD: RECOVERY.

(AREA OF SUPPLY OF EIGHTH CERVICAL AND FIRST DORSAL POSTERIOR ROOTS.)

BY

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In connexion with the following case, it is permissible to recall the frequency with which extramedullary tumours of the spinal cord are benign in character, and that this holds good when the patient is in later life. Hence the great importance of diagnosis, for by leading to operation it enables a patient suffering from one of the most painful and disabling of diseases to be restored to ease and active life. It is as well, also, to bear in mind the great power of recuperation possessed by the spinal cord, so that it can recover its functions even after very severe and long-continued compression, when the pressure is removed.

L. D., aged 55, married, was sent to the Bristol General Hospital by Dr. Harvey Bird, of Bridgwater, on May 2nd, 1911. Family history good.

The patient had small-pox when a child, and fifteen years ago had exophthalmic goitre for about five years. She then completely recovered, and shows no sign of this disease now, except, perhaps, that her pulse is habitually rather quick—84 to 90 per minute. The menopause occurred at 45 years.

History of Symptoms.

1. *Pain*.—Two years ago (1909), following influenza, attacks of "cutting" pain in left shoulder, lasting a few weeks and then disappearing, and worse in damp or cold weather, occurred. Dull aching pains in the left arm followed shortly after those in the shoulder. For a time in 1910 she was much better, though not free from pain at intervals. In November, 1910, she had a fresh attack of "influenza," with severe vomiting and diarrhoea; since then pains in upper part of left chest, left shoulder, and shooting down left arm to fingers, especially little and ring fingers, have been more or less constant, varying in severity, and often preventing sleep. February, 1911, girdle pain around waist.

2. *Paraesthesia*.—About May, 1910, numbness in left arm from elbow to wrist, around waist, and in her feet and legs. The numbness of legs "felt as if it were in patches"; that around the waist disappeared again; in the other parts it remained permanent. Later, numbness and "pins and needles" affected ulnar border of left hand and little and ring fingers.

3. *Muscular Wasting*.—First noticed in left hand and forearm after influenza in November, 1910, then improved; but in January, 1911, reappeared, and since then steadily increased, affecting all muscles of hand, and also anterior aspect of forearm. Slight wasting of right hand muscles during last month.

4. *Paralysis*.—Loss of power in left shoulder, twelve months, probably at first due to pain; she kept her shoulder at rest because movement increased pain. Gradually increasing

paralysis of left arm and hand. For two months left hand and forearm almost completely paralysed and useless. Partial paralysis right hand, one month. Gradual loss of power in legs, two months; unable to walk or to stand without support, two weeks; unable to sit up in bed, one week. Muscular cramps in legs not marked.

5. *Sphincters*.—Difficulty in micturition, four months; worse, three weeks; chief difficulty is in starting micturition. Obstinate and increasing constipation for about same time. General health good; all symptoms have progressed rapidly since shock of husband's sudden death three months ago.

State on Admission.

Well nourished, rather anaemic, with a distressed expression. She could not walk, nor could she stand without being held up. She could just sit up in bed with support. There was no paralysis of any cranial nerve. The pupils were equal, of normal size, and acted well to light, accommodation, and to painful stimulation of skin of neck. The neck muscles were unaffected.

Upper Extremities.—*Right*: Grip of hand very weak, moderate degree of wasting of small muscles of hand; arm and forearm unaffected. The hand muscles reacted to faradism, but required a strong current. No affection of sensation. *Left*: Small muscles of hand uniformly and extremely wasted, including muscles of thenar and hypothenar eminences, dorsal interossei and lumbricales. The muscles did not react to a strong faradic current. The little and ring fingers were slightly over-extended at proximal and flexed at distal joints. The little and ring fingers were most flexed. The hand was completely paralysed and useless. The long flexors of forearm were paralysed and did not react to faradism; the extensors were not paralysed and reacted. The elbow could not be fully extended. She could not raise her arm above the shoulder; movements of the shoulder were generally limited, and the shoulder muscles contracted, especially the pectorals, but not much wasted, from disuse owing to pain, and there were adhesions about the shoulder joint. Partial loss of sensation over inner (post-axial) side of limb. (See Fig. 1.) The elbow and wrist jerks were present on both sides. No loss of sense of position of either hand or arm, and objects placed in hands recognized at once.

Spine.—Some kyphosis in dorsi-lumbar region and slight lateral curvature.

Abdomen.—Apparently defective sensation to pin-prick over abdomen. Abdominal reflexes absent.

Lower Extremities.—The legs could be drawn up but not lifted off the bed. There was marked spasticity, the muscles being in a state of active spasm, but not wasted. Knee-jerks much exaggerated; slight ankle clonus on right side, not on left. Plantar reflex, extensor and Oppenheim's and paradoxical reflexes present on both sides.

Sphincters.—Complete retention of urine, which was acid, and contained no albumen or sugar. Obstinate constipation. Thoracic and abdominal organs normal.

Wassermann's reaction negative. Tuberculin test negative.

Cerebro-spinal fluid appeared under slightly diminished pressure and contained a considerably increased number of lymphocytes, but was otherwise normal.

It was considered advisable to give her a course of potassium iodide with liq. hydrarg. perchlor. This she had.

Condition on June 14th (Five Weeks after Admission).

She had a great deal of pain during this time in the left shoulder, passing down into the arm, and painful spasmodic contractions of left shoulder muscles and those of lower part of neck. Pain was increased both by passive and active movements. Pains had also begun to affect the right shoulder and arm. They were never so intense as to cause her to cry out, but often prevented sleep.

Wasting of small muscles of the hand was complete on left side and had rapidly advanced on right. There was also wasting of muscles on anterior surface of left forearm, and to a less degree of the right. The left upper extremity was completely paralysed. She could not hold a pen or spoon in the right hand, but could move the arm and forearm. The hands were therefore useless, and she had to be fed. Except that she could draw up the legs a few inches in bed, they were also paralysed. She could not sit up or turn in bed. Except for movements of the head and neck, of the right shoulder and arm, and, to a less degree, of the right forearm and of those muscles supplied by the cranial nerves, she was therefore completely paralysed. The pupils were unaffected. There was complete retention of urine and incontinence of faeces. Some defect of sensation to pain and temperature had now appeared over trunk and legs, and there was some loss of sense of position of the left arm and of the legs. The condition of the reflexes was the same as above stated.

After this period of observation the diagnosis was arrived at of tumour of the cord, external to it, on the left side, and at the level of, and compressing, the eighth cervical and first dorsal roots. I therefore asked my colleague, Mr. Hey Groves, to see the case, and he operated on June 21st.

Operation.

Solution of adrenalin, 1 in 50,000, was injected into the skin and muscles. The laminae of the sixth and seventh cervical vertebrae were first removed, then those of the eighth cervical and first dorsal. The laminae were removed on the left side

In each of these diagrams the figure on the left represents the posterior, that on the right the anterior, surface of the left arm and hand.

Fig. 1 shows the sensory loss before operation. Over dotted area prick felt as touch over hand as high as *a*; above this very imperfectly felt as prick at certain points only. Slighter loss to light touch (cotton-wool) and to lesser degrees of heat and cold, but not to pressure, over whole dotted area.

Fig. 2.—Sensory loss six weeks after complete division of left eighth cervical and first dorsal posterior roots. Over dotted areas a partial loss only. Over shaded area loss of sensation to light touch, pin-prick, heat, and cold. Boundary of each coterminous, except on anterior surface, where prick or touch on dotted area *b* provoked a "disagreeable" sensation. Sensation to pressure unaffected.

Fig. 3.—Sensory loss on hands. Shaded areas show same complete loss of sensation as on forearms. Over dotted area *c* touch or prick provokes a very "disagreeable" sensation. Over area *d* inside dotted line only slight loss of sensation, but no "disagreeable" sensation.

only. The dura mater was then opened, and it was noticed that the pulsation in the lower part of the exposed cord was deficient, and that there was very little cerebro-spinal fluid. The left half of the fifth cervical lamina was then removed, and a tumour was seen lying under the pia, opposite to the ligamentum denticulatum, at the level of the eighth cervical and first dorsal roots, attached by a short pedicle to the posterolateral aspect of the cord. The left eighth cervical and first dorsal posterior roots lay over the tumour, and had to be divided to remove it. The tumour was a laminated fibroma, round or oval in shape, and measured $1\frac{1}{2}$ in. by $\frac{3}{4}$ in. The cord was much compressed and narrowed, and was jammed up and flattened against the right side of the spinal canal.

After-History.

The patient recovered from the operation without a bad symptom.

By July 20th—one month after operation—she was able to sit up and to move her legs freely in bed and had a fair grip in the right hand, so that she could feed herself. She had nearly recovered power over the bladder and completely so over the rectum.

Electrical Reactions—Left Forearm and Hand.

Constant Current:

Supinator longus ...	...	KCC 2 ma.	ACC 3 ma.
Long extensors... ..	...	KCC 3 "	ACC 2 "
Ext. indicis	...	KCC 3 "	ACC 2 "
Small muscles of thumb	...	KCC 2 "	ACC 2 "
Dorsal interossei ...	...	KCC 3 "	ACC 4 "
Long flexors	...	KCC 8 "	ACC 7 "

Faradism (Left Hand and Forearm).—No reaction in long flexors of fingers; a doubtful, very feeble reaction to a very strong current in small muscles of little finger, thumb, and interossei; all other muscles of left arm and forearm react.

All muscles of right forearm and hand react to faradism, but require a strong current, and to galvanism.

The abdominal reflexes on the right side had returned; the left were still absent. The plantar reflex was extensor on the right, and mixed—that is, extensor response in great toe and flexor in the other toes on the left foot.

By August 2nd (nearly six weeks after operation) she could raise herself unsupported in bed, and had regained complete control over her bladder. The superficial reflexes as above. The knee-jerks were hardly exaggerated, there was no ankle clonus, and the spasm in the legs was rapidly diminishing.

On September 10th there was usually a flexor response in both plantar reflexes, but occasionally an extensor movement of the great toe appeared—a month later this could not be obtained. The left abdominal reflexes were obtained about this time, namely, about eleven weeks after operation.

Without going into details, it may be added that she is well on the road to complete recovery; she has recovered good use of the right hand and arm, and of her left arm; partial, and steadily increasing, use of the left hand, but the degenerated and wasted muscles of this hand must take several months to recover; she can walk well, unaided and with a natural gait, at the present time at least half a mile; she is rapidly extending her range of movements, and can go up and down stairs. At the date of writing this she is steadily and progressively gaining power over all the limbs, with an eventual prospect of complete recovery.

A few more details about sensation as regards the area supplied by the eighth cervical and first dorsal roots, which were completely divided at the operation, may be of interest. Unfortunately she was not a very good subject for investigation of sensation, and was not sufficiently well to be examined for some time after the operation. The slight disturbances of sensation present in the latter stages of the case over the abdomen and legs, chiefly defective sensation to pin-prick, had disappeared a fortnight after the operation.

The condition of the left forearm and hand is as follows:

Forearm (see Fig. 2).—Over an area on the ulnar side of the forearm, extending about $1\frac{1}{2}$ in. on the anterior and posterior surfaces, upwards to about 2 in. above the elbow and downwards to the wrist, light stroking with cotton-wool and pin-prick are not felt. With regard to the latter, no difference is felt between gentle pressure with the head or the point of the pin, but a pin-prick is sometimes felt as such. The edge of this anaesthetic area to prick varies as much as $\frac{1}{2}$ in., according as it is determined by approaching from the anaesthetic or sound skin. Heat and cold are not distinguished over the same area. The limits of loss to light touch (cotton-wool and pin-pricks) are, so far as can be made out, coterminous back and front. Two blunt points of aesthesiometer were not distinguished as two transversely to the long axis of the limbs in this area, in the long axis they were noticed as two at distances of 4 in. anteriorly and 7 in. posteriorly.

Hand (see Fig. 3).—A line drawn from the fissure between the little and ring fingers on the palm to the wrist parallel with the ulnar border of the hand, marks off an area on the ulnar side of the palm over which light touch, pin-prick, heat and cold are not distinguished, and two points not felt as such in either transverse or longitudinal axis at 2 in. The same affection of sensation is found on the little finger and ulnar half of the ring finger. Unlike the forearm, on the border of this area on the palm there is a zone about $\frac{1}{2}$ in. wide on which any touch or light stroking is very unpleasant, giving rise to an ill-defined but painful sensation; two points can be distinguished at $\frac{5}{8}$ in., and extremes of hot and cold felt. A pin-prick is felt rather as painful than as an actual prick. The outer margin of this area is ill defined.

On the dorsum, the little and ulnar half of the ring finger show the same anaesthesia. On the hand, a narrow area of anaesthesia on the ulnar border is bounded by a line drawn from the fissure between these two fingers to the wrist, parallel to the ulnar edge of the hand. Outside this there is a narrow zone where a prick is felt as touch, a light touch is felt, extremes of heat and cold are doubtfully distinguished, but there is not the same disagreeable sensation as in the palm. As in the forearm, the edge of the area of altered sensation varied according as it was approached from the anaesthetic (passed further out) or from the sound side. Pressure was felt everywhere over the anaesthetic area, and there is little or no loss of the

sense of position of the little finger. There are no distinct trophic changes over the anaesthetic area, except that the skin is a little shiny over the fingers.

REMARKS.

The differential diagnosis in this case, although in the light of the conditions found at the operation it may seem to have been fairly straightforward, was not definitely settled until the patient had been some little time under observation. That there was a lesion at the level of the lower part of the cervical region of the cord with affection of the pyramidal tracts below this level was of course obvious. The further points to determine were (1) whether the disease was extramedullary or within the cord, and (2) what was its nature.

Undoubtedly the first clue to the extramedullary seat of the lesion was the discovery of the partial loss of sensation on the post-axial side of the left upper extremity, showing that the left eighth cervical and first dorsal posterior roots were definitely involved. This was supported by the distribution of the muscles affected with wasting and altered electrical reactions, which coincided with the motor supply of the corresponding anterior roots. The pain was more widely diffused, but in its chief intensity corresponded fairly to the same roots. Further confirmation of an extramedullary lesion at this level was afforded by the order of onset of the cord symptoms, that is (1) pain, (2) paraesthesiae, (3) paralysis, (4) wasting of muscles, first at the level of the lesion, and then, as pressure began to be exerted on the cord itself, the appearance of spasm, increased reflexes, and paralysis in the legs, with finally, much later in the case, some sensory loss over the trunk and legs, and affection of sphincters, as the cord gradually became more severely compressed. On the other hand, there were perhaps three features of the case which were difficult of explanation on the above hypothesis of an extramedullary lesion involving at first these roots and then pressing upon the cord.

These were the paralysis of the left shoulder muscles, the atrophic paralysis of the small muscles of the right hand, and at first sight the absence of such severe pain as would be expected from such a lesion. This last point I will refer to again later. As time went on further acquaintance with the patient made it quite clear that she had intense pain at times, which she bore bravely. Further investigation enabled the paralysis of the left shoulder and upper arm muscles to be eliminated as a direct result of the lesion, for it presented the characters of that found in long-continued disuse of the shoulder and elbow joints, and the consequent formation of adhesions about there, and it was, therefore, regarded as due to the attempt to minimize the pains by keeping the joints immobilized, and accordingly only as an indirect consequence of the lesion.

The atrophic paralysis of the small muscles of the right hand without sensory affection was never satisfactorily accounted for until the operation. It might have been taken as an evidence of an intramedullary pressure effect, for example, myelitis, or a small extravasation of blood. That no lesion of this sort occurred, however, is proved by the rapid recovery after removal of the tumour. It only appeared late in the illness, and the explanation afforded by the conditions seen at the operation was that the nerve roots on the right side at this level must have been compressed against the bone, possibly against the edges of the bony foramina. The large size of the tumour, which seemed almost too great to be accommodated in the spinal canal, would account for this, though, even if this explanation be correct, it is difficult to see how the corresponding posterior roots escaped.

The other evidences of an extramedullary tumour on the left side were, however, to my mind, so strong that I felt justified in neglecting this feature of the case, leaving it unexplained before the operation.

As to the nature of the lesion, all the above symptoms, especially the localized nature of the focal symptoms, pointed to a tumour pressing on the left eighth cervical and first dorsal roots, but she had also kyphosis and lateral curvature of the spinal column, and therefore the possibility of tuberculous disease of the bones had to be considered. This was eliminated, however, by the absence of a local deformity of the spinal column, or of local tenderness of the spines, by the characters of the cerebro-spinal fluid, by

the test for fixation of the complement for tuberculosis being negative, and by the absence of any tuberculous lesion elsewhere in the body. A syphilitic lesion was excluded also by the examination of the cerebro-spinal fluid, and a negative Wassermann reaction. There is just one other point of interest. There appears to have been no period in the case in which Brown-Séquard's syndrome was present. This syndrome is of frequent occurrence at some stage of cases in which there is either a unilateral lesion of the cord itself, or unilateral pressure upon it. In this case the affection of sensation below the lesion over the legs and abdomen appeared quite late, affected both sides equally, and was slight in degree.

The case further illustrates the fact that if it is not destroyed, or there is no pressure-myelitis, the cord is capable of recovering from an enormous amount of pressure when this is removed.

The order of return of reflexes is of interest:

Two weeks after operation: Sensory disturbance of legs and abdomen disappeared.

Four weeks after operation: Right abdominal reflexes returned; ankle clonus disappeared; left plantar reflex became "mixed" in character.

Six weeks after operation: Power over bladder recovered; knee-jerks still exaggerated.

Eleven weeks after operation: Double flexor plantar reflex; abdominal reflexes returned on both sides.

Another point of interest is the complete recovery from exophthalmic goitre some years previously, and that the patient was able to go through a severe operation without any return of it. Further, there was risk of being deceived by her statements as regards pain; she minimized this, but when one got to know her one learnt that she had very severe pain, but bore it bravely. Pain is a most important symptom in the diagnosis of cases of this kind, and yet its value in diagnosis is diminished by the difficulty of estimating it exactly, because patients vary so greatly in their power of endurance.

I cannot conclude without a grateful acknowledgement of what a large share in the successful result of the case was due to the very skilful manner in which the operation was performed by Mr. Hey Groves. There was no haemorrhage and no shock, and the patient recovered without any bad effects due to the operative procedures—a noteworthy fact in a woman of 55 years of age, and one to encourage explorations in doubtful cases of a similar kind. Lastly, the limitation by Mr. Groves of the operation to removal of the laminae on the left side only, whilst at the same time it afforded easy access to the seat of disease, no doubt resulted in greater subsequent stability to the spinal column, and earlier recovery of power in the back.

AN INVESTIGATION ON THE REGENERATION OF NERVES, WITH REGARD TO THE SURGICAL TREATMENT OF CERTAIN PARALYSES.

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PART V.

This article deals with secondary nerve suture, and the facts are derived from clinical and experimental studies.

The term "secondary," as opposed to primary nerve suture, is applied to cases in which the two ends of a divided nerve are not immediately united; or, at any rate, an interval of more than a few days is allowed to elapse before suture.

The condition present is a variable one. Much depends on the time interval before secondary union is performed. It is stated that two (Bowlby¹) and three (Sherren²) years seems to be the time after which we cannot expect any useful recovery in the paralysed muscles, even if secondary union of the nerves be performed.

A great deal depends on the condition of the wound with regard to sepsis or otherwise. A suppurating lesion complicating a nerve division seriously alters the prognosis for the worse. This is well exemplified by two extreme cases.

I had had very little function return after union of the median when only six months had elapsed since the original division. This particular accident was caused by