PART III.

DISEASES OF THE SUBSTANCE OF THE SPINAL CORD.

Diseases confined to the substance of the spinal cord are rarer than those of the brain substance. The cause of this may lie in the fact that not only are the vessels of the spinal cord actually less frequently the seat of disease than those of the brain, but also that when they become diseased the consequences entailed are generally not of so grave a nature as those resulting from lesions of the cerebral vessels.

As in cerebral diseases, here also two questions must ever be kept in view by the physician: (1) Where is the spinal lesion situated? (2) What is its nature? As we shall see later, it is especially the second which is of importance for the prognosis and choice of treatment. Both, however, are of equal weight for the proper recognition and conception of a given case. As in the study of the brain lesions, the topical and pathological diagnosis should here no less go hand in hand.

I. Consideration of Spinal Diseases with Reference to their Seat—Topical Diagnosis.

As a thorough acquaintance with the anatomy of the parts is of the highest importance in making a topical diagnosis, some remarks on these points may in this place not be unwarranted.

Without being separated by any sharp line of demarcation from the medulla oblongata, the spinal cord extends from the upper margin of the arch of the atlas to the first lumbar vertebra, where it ends in the conus medullaris. From this point it is seen as a long filiform continuation—the filum terminale. The cauda equina consists of the longitudinal nerve bundles which accompany the filum terminale, and corresponds to the lumbar and sacral part of the vertebral column. As it is apparent that the different pairs of nerves

do not leave the spinal cord at the level of the vertebræ after which they are named, but that they must necessarily do so higher up, it is important to know to what nerves certain parts of the vertebral column correspond. Thus we must remember that the first three cervical vertebræ correspond to the origin of the third, fourth and fifth cervical nerves, and that the seventh cervical vertebra corresponds to the first dorsal nerve. The spinous process of the fifth dorsal vertebra corresponds to the origin of the seventh, that of the tenth to the twelfth pair of dorsal nerves. Opposite the eleventh dorsal vertebra originates the first, between the eleventh and twelfth the second, opposite the twelfth the third and fourth lumbar nerves. Between the twelfth dorsal and first lumbar vertebra the fifth lumbar and first sacral nerves take their origin, the other sacral nerves opposite the first lumbar vertebra. The cervical enlargement corresponds, therefore, to the spinous processes of the cervical vertebræ, the lumbar enlargement to the spinous processes of the last dorsal vertebræ. All these relations, and, moreover, the fact that the spinous processes, which alone can be our guides, are not always on the same level as their corresponding vertebræ, are demonstrated in Fig. 132.

The relation between the white matter and the gray which it incloses becomes apparent in a transverse section of the spinal cord. Here we see also that an anterior and a posterior fissure divide the spinal cord into two halves. These fissures, however, do not meet, but are separated from each other by the so-called "commissures" which connect the two halves of the cord. The anterior part of the gray matter, the so-called "anterior horn," does not present the same diameter and form throughout, and in the cervical and lumbar enlargement is larger than in the dorsal part of

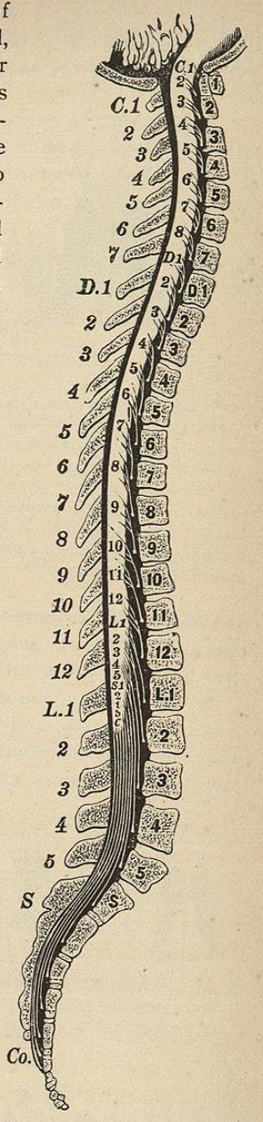

Fig 132.—The Relations of the Origin of the Nerves to the Bodies of the Vertebræ and the Spinous Processes. (After Gowers.)

the cord (cf. Fig. 134). From this anterior horn proceed the anterior nerve roots and pass through the white matter which lies externally. The posterior horn is much smaller and extends almost to the entrance of the posterior roots, which reach it after passing through the external part of the posterior columns ("root zone" of Charcot). The arrangement of the white substance and its subdivision into columns and tracts is determined (1) by the existence of the above-mentioned fissures, (2) by the entrance of the nerve roots, (3) by the shape of the gray matter. We distinguish roughly an "antero-lateral column" and a posterior column on each side. The former contain (*a*) the crossed lateral or pyramidal tracts, (*b*) the direct cerebellar tracts, (*c*) the anterior direct pyramidal tracts, also called columns of Türck or uncrossed anterior columns. The posterior columns consist of the columns of Goll (at the inner side) and the columns of Burdach, which latter have also received the name "root zone" (cf. Fig. 133).

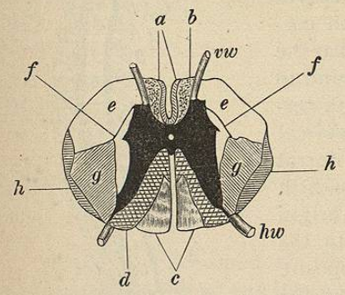

Fig. 133.—Scheme of the Conducting Paths in the Spinal Cord at the Level of the Fifth Dorsal Nerve. (After Flechsig.) *vw*, anterior, *hw*, posterior root. *a*, direct, *g*, crossed pyramidal tracts. *b*, anterior column ground bundle. *c*, Goll's column. *d*, Burdach's columns. *e* and *f*, mixed lateral paths. *h*, direct cerebellar tracts.

Physiologically, the spinal cord is primarily important as a great conducting system, and next as the seat of numerous centres. The motor impulses originate in the brain, and travel down along the antero-lateral column chiefly in the crossed pyramidal tract of the opposite side, the decussation, as has been repeatedly pointed out, taking place for the most part in the medulla oblongata. Through the large ganglionic cells of the anterior horns these crossed pyramidal tracts are continued into the anterior nerve roots and leave as such the spinal cord. The sensory impressions are transmitted through the posterior roots, hence (some passing through the postero-lateral columns) they reach the posterior horns and at once cross over to the opposite side of the spinal cord. The further course of the sensory fibres as they pass to the brain is not clearly understood; especially imperfect is our knowledge with regard to those for the different qualities of sensation—e. g., the sense of touch. It seems, however, that the central gray substance must be looked upon as the path for impressions of pain (cf. the investigations of Edinger about the continuation of the posterior spinal roots up to the brain, Anatom. Anzeiger, 1889, iv, 4).

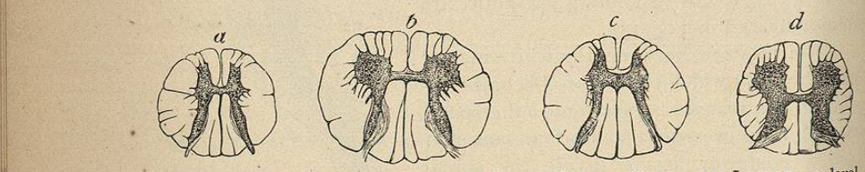

Fig. 134.—Cross-section through the Spinal Cord at Different Levels. *a*, level of the second. *b*, level of the seventh cervical vertebra. *c*, level of the second. *d*, level of the third lumbar vertebra. (After Quain.)

We know that reflexes originate by the stimulation of a sensory nerve. By this an impulse is conducted to a centre, and hence is transferred to a motor nerve—reflex arc (Fig. 135). Among such

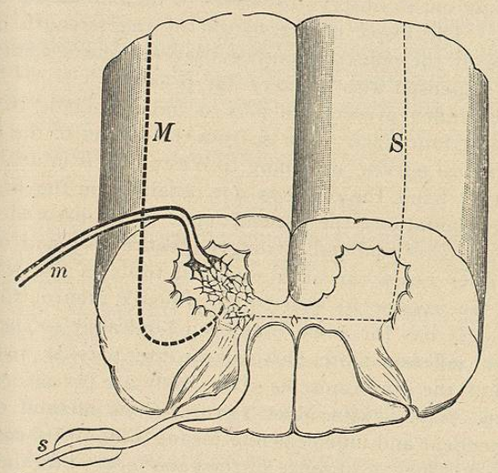

Fig. 135.—Reflex Arc. *M*, motor path. *S*, sensory path. *m*, motor (anterior), *s*, sensory (posterior) nerve root.

reflex movements we distinguish (1) skin reflexes, caused by irritation of the skin, (2) tendon reflexes, which are produced by tapping on a tendon. To the former belong the plantar reflex, the centre for which is situated in the lower part of the lumbar enlargement, the gluteal, the anal reflex (Rossolimo, Neurol. Centralbl., 1891, 9), the cremasteric, and the abdominal reflexes, which are obtained by irritating the skin of the buttocks, the anus, the inside of the thigh, and the abdomen respectively. If we find these present in a patient we may assume the centres, which are situated in the lumbar and the dorsal cord respectively, to be intact.

One of the diagnostically most important signs is the condition of the so-called patellar reflex. When the tendon of the quadriceps

femoris is tapped, a reflex contraction of this muscle ensues by which the leg is jerked forward with more or less vigor. This is found in most healthy persons. It has been called by Erb "patellar tendon reflex"; by Westphal, who doubted its reflex nature, "knee phenomenon"; by Gowers, "knee jerk."

To a certain extent the mode of tapping this tendon and the position of the patient are matters of indifference. The only points to remember are these: The lower leg should be held perfectly loose, and no superfluous clothing should prevent the proper striking of the tendon. The simplest way is to place the patient on the edge of a table, remove all clothing from his legs, then, while conversing with him about indifferent matters so as to distract his attention from what is going on, to observe the effect of the percussion of the patellar tendon. The exact determination of the strength of the reflex by means of the reflexograph (Bechterew, Neurol. Centralbl., 1892, 2) can be dispensed with in every-day practice.

If we find the reflex present, we may at once conclude that the spinal cord at a certain place—that is, from the second to the fourth lumbar or first sacral nerves, according to Westphal—is intact.

If, on the other hand, the reflex is not obtained on the first and after repeated examinations, the patient ought to be directed to interlock his bent fingers and pull strongly (Jendrassik), and only if the knee jerk does not occur after repeated trials in the way described, should we assume its absence (Jendrassik, Neurol. Centralblatt, 1885, 18). It has for some time been Jendrassik's experience that the tendon reflexes, more particularly the patellar reflex, is much enforced if the other muscles of the body are put into strong action (Deutsch. Arch. f. klin. Med., xxxiii). This method of Jendrassik is an excellent and indispensable means in doubtful cases for establishing the presence or absence of the knee jerk. Sternberg has recently investigated various conditions under which the tendon reflexes meet with inhibiting, diminishing, or increasing influences in the spinal cord (Die Sehnenreflexe und ihre Bedeutung für die Pathologie des Nervensystems, Leipzig und Wien, Deutike, 1893).

Besides the patellar reflex, the Achilles tendon reflex, and the ankle clonus (the foot phenomenon of Westphal) must be mentioned. The latter consists of a succession of clonic contractions of the tendo Achillis which occur on a sharp dorsal flexion of the foot. To the violent shaking movements of the whole leg, which occasionally occur under these conditions, the very inappropriate name of spinal epilepsy has been given.

If the reflex excitability is much increased, a simple tapping on the front of the lower leg is sufficient to produce a contraction of the calf muscles. This is what the English writers call the "front tap."

Whether all these so-called tendon reflexes are really of reflex nature, or whether they are not rather phenomena due to a direct stimulation of the muscles (Westphal), is still an unsettled question.

The same uncertainty exists about a symptom which has by Westphal been termed "paradoxical contraction," and which consists in a muscle remaining in tetanic contraction for quite a time after it has been passively shortened. For instance, if we flex the foot of a patient lying in bed, the tibialis anticus may under certain conditions remain for some time in a state of contraction; its tendon becomes prominent, and only gradually relaxes and allows the foot to return to its normal position of rest. Only rarely has this phenomenon been observed in other muscles.

Further, reflex centres are found in the lumbar region of the spinal cord for the emptying of the bladder and rectum, for the erection of the penis and the ejaculation of the semen—reflexes which are concerned with the sexual functions. According to the researches of Sarbo (Arch. f. Psych., 1893, xxv, 2) the centre is situated between the levels of the first and fourth sacral nerves.

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With regard to the localization of the spinal cord lesion, two questions arise: (1) Which portion of the cord is diseased? Is it the cervical, dorsal, or lumbar? (2) Which part of the cross section of the cord? Is it the gray or the white matter, or both? The first question can be answered without difficulty in cases where the vertebral column is diseased; we only need to examine the latter by pressing upon the vertebræ or by applying a hot sponge, etc., over them. Those spots at

which tenderness is elicited by the application are the seat of the disease. The occurrence of spontaneous pain is rarer in diseases of the cord. It should, above all, be remembered that lesions of the spinal cord, as such, wherever they may be, almost never produce pain in the back, but that this is in a majority of cases due to trouble in the muscles or their nerves. It is a characteristic feature of these pains that they become especially marked after prolonged standing and stooping, and that they are very bad on rising in the morning. They may occur sometimes after a quick movement, in which case some muscle bundles have been overstretched or even torn. Pains in the back which persist for months and years unaffected by any therapeutic measures justify a suspicion of the existence of an aortic aneurism which may be pressing against the vertebral column or of enlarged carcinomatous abdominal glands (Johnson, British Medical Journal, February 12, 1881). In disease of the vertebral column, especially if it be cancerous, pain in the back is a prominent symptom, as we have said.

But, leaving out the tenderness on pressure, there are other symptoms which may help us to decide what segment of the cord is diseased in a given case.

Diseases of the cervical cord generally produce symptoms of motor or sensory irritation or of paralysis in the upper extremities, pains, paræsthesias, feelings of weakness, jerkings, and the like in arms, hands, and fingers, to which may be added also trophic disturbances. Muscular atrophies and loss of reflexes in the upper extremities are often observed. The lower extremities, however, remain intact, and the patellar reflex is present and sometimes increased. Repeatedly a very decided slowing of the pulse (as low as thirty-two beats to the minute in a case of Lebrun's, Bull. de l'Acad. de méd. de Belgique, 1, 1887, 1) has been met with in lesions of the cervical cord, and has been attributed to a chronic state of irritation of the vagus due to compression or some similar influence.

Affections of the dorsal cord are mostly accompanied by sensory disturbances, paræsthesias in the back, intercostal neuralgias, aching, boring pains, which sometimes radiate into the lower extremities. Anæsthesias, though they are not the rule, may be found. If a distinctly circumscribed zone of anæsthesia is made out, it corresponds exactly to the place where the lesion in the spinal cord is situated (cf. what will be said about lesions of one half the cord on page 456).

Lesions of the lumbar cord entail symptoms in the lower extremities, giving rise to weakness and paralysis, sometimes also jerkings and stiffness; furthermore, to pains, numbness, anæsthesias of the legs and feet. The reflexes are lost and vesical and rectal symptoms are present, the former consisting of retention or dribbling of the urine, pains, strangury, etc. Of course, the symptoms may greatly vary according as the whole transverse section or only some or even one system of fibres alone is affected in the given level of the cord. Fracture of the first lumbar vertebra causes a lesion of the conus terminalis; a lesion at the level of the second lumbar vertebra and below it gives rise to affections of the cauda equina; the clinical symptoms of these conditions have been ably described by Valentine, who worked under Lichtheim; besides the symptoms above referred to, he has called attention to the atrophy of certain muscle groups (the glutei, flexors of the thigh, muscles of the lower leg and foot) and the reaction of degeneration occurring in them.

An answer to the second question demands a thorough acquaintance with the symptoms produced by lesions of the different portions of the cross section. These we will therefore now consider.

I. LESIONS OF THE GRAY MATTER—"POLIOMYELITIS."

In giving the name poliomyelitis (πολιος, gray) to all spinal affections confined to the gray matter, we must at once insist that these lesions are almost entirely limited to the anterior portion of the gray matter, the anterior horns, and more especially to the large ganglionic cells in them. Other portions have only rarely been found affected, and then only in connection with the just-mentioned lesion. The diseases of the gray substance proper which have come under observation were confined to the groups of ganglionic cells of which we have just spoken. Clinically, there are two such diseases to be distinguished, namely, poliomyelitis anterior acuta, or spinal paralysis of children (infantile spinal paralysis), and progressive muscular atrophy.

CHAPTER I.

POLIOMYELITIS ANTERIOR ACUTA—INFANTILE SPINAL PARALYSIS.

INFANTILE paralysis, first accurately described by Jacob von Heine in 1840, is one of the best-known diseases of the spinal cord, both as regards its anatomical seat and its clinical course. As has been demonstrated beyond doubt by Charcot, Prévost, and Joffroy, it is an acute inflammation of the anterior horns, or rather, as is usually the case, of one of them. This leads to an atrophy and sclerosis, so that a dense tissue remains, containing the dilated vessels and small remains of ganglionic cells, which are not rarely found to be calcified (Friedländer, cf. Fig. 136). The seat of the process is usually either in the

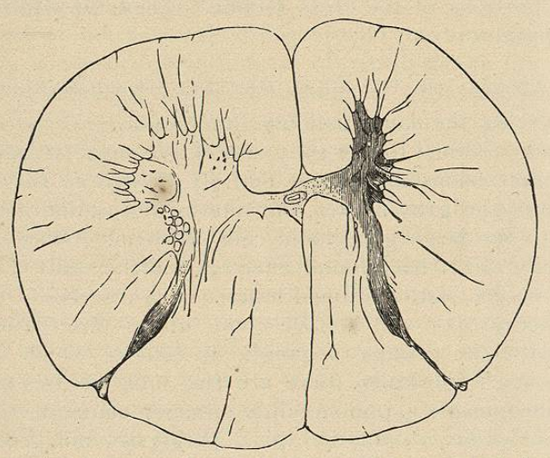

Fig. 136.—TRANSVERSE SECTION FROM THE CERVICAL PORTION OF THE SPINAL CORD. Atrophy and sclerosis of the right anterior horn. (After CHARCOT.)

cervical or the lumbar enlargement. In the former case the paralysis affects the upper, in the latter the lower, extremity. The secondary degeneration, which ensues as a consequence of the atrophy of the ganglionic cells, extends to the anterior

nerve roots, the motor nerves, and the muscles supplied by them. It is a genuine degenerative atrophy, just as much as the one described as coming on after peripheral paralyses.

Symptoms.—The clinical picture of the disease is very characteristic. The onset bears a striking resemblance to that of cerebral infantile paralysis, described on page 271. In the midst of perfect health the child is suddenly seized with headache, vague pains in the limbs, and fever, the temperature reaching 104° F. or even more; he becomes stupid and somnolent, and soon, while complete unconsciousness is developed, general convulsions set in, which last usually from one to three days and then disappear. The patient's condition becomes better, consciousness is fully regained, he becomes bright and talkative, and the relatives think that the malady has already

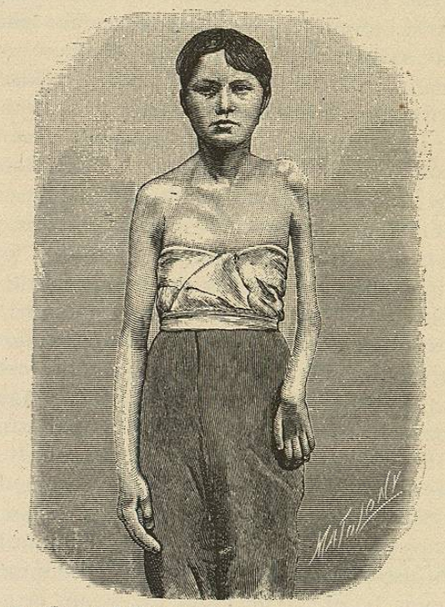

Fig. 137.—SPINAL INFANTILE PARALYSIS (personal observation).

spent itself, when unfortunately a more careful examination reveals that the movements of the child are impaired, that one, more rarely both, upper or lower extremities are paralyzed. The paralysis, which usually affects one arm (Fig. 137) or one leg, has developed rapidly and reached a considerable extent,