ON SOME POINTS IN THE DIFFERENTIAL DIAGNOSIS OF INTRACRANIAL DISEASE, GENERAL PARALYSIS OF THE INSANE, AND TABES DORSALIS.

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If we may be allowed to judge from pathological evidence alone, we should, I think, come to the conclusion that in some cases a sclerosis of the posterior root-zones of the spinal cord may exist, to a certain extent, without locomotor ataxy; and a chronic degeneration of the grey matter of the cortex of the antero-parietal lobes may exist without the mental derangements which are common to general paralysis. Westphal does not believe that there is any direct relation between the morbid process in the cord and the morbid process in the brain, which frequently co-exists in the general paralysis of the insane; he believes that they are the expression of an excessive proclivity to disease of the nervous system; and Hammond, in his valuable work on *Diseases of the Nervous System*, corroborates this view of Westphal, and states that locomotor ataxy is by no means uncommon in patients affected with other forms of insanity; and although I am inclined to question this doctrine of Westphal, yet, so far as I am aware, we have no direct pathological proof to upset it.

We find that, in locomotor ataxy, the mental functions—intelligence, memory, etc.—are for a long time, if not permanently, unaffected during the whole course of this troublesome and trying disease; and this leads us to infer that sclerosis of the posterior columns of the cord is for the most part secondary to the brain-changes in the general paralysis of the insane. I cannot agree with those observers who maintain that there is no relation of causality between these two conditions; for there are many and striking clinical features which are common to the two affections, and which it may be wise to consider as manifestations of a more or less diffuse process of disease extending over a great part of the central nervous system.

There is a growing desire on the part of neurologists (and justly so) by the aid of advanced pathological and clinical research, to localise changes to distinct areas of grey and white matter in the brain and spinal cord in accordance with certain well known and recognised rules; and we can now tell with a fair amount of accuracy the seat of the lesion which has given rise to a definite train of signs and symptoms; yet I must admit that we are still most woefully in the dark concerning the nature and value of many and important initiatory symptoms which may exist for years before any serious lesion has implanted itself on the brain and nervous centres; and we cannot find any better example to justify the truth of my assertion, than that which is found in tabes dorsalis and general paralysis of the insane. I may say with truth that to no living man are we more indebted than to Dr. Hughlings Jackson, for the valuable work which he has done in the field of ophthalmology. In the paper on Optic Neuritis in Intracranial Disease, which he read before the Ophthalmological Society, March 10th, 1881, he makes the following remarks; and although they do not exactly bear out in practice the precise value of my observations, still they are of important and relative worth. He states: "A man whom I thought to be hypochondriacal until I looked into his eyes, who gave only a vague history of twitching of one lip, had double optic neuritis with good vision. He seemed, superficially regarded, to have nothing the matter with him. He became suddenly apoplectic, with hemiplegia, and died. A woman who had double optic neuritis with good vision, and some other vague nervous symptoms, got well, except that the neuritis remained, vision being still good. She then had attacks of giddiness, in some of which she would fall. She, however, looked perfectly well, and yet died in a few minutes one night." I should most strongly advise all those who are interested in the study of intracranial disease to read the paper of Dr. Jackson to which I have just referred, for the reason that sufficient attention is not usually given to many of the initiatory subjective symptoms of locomotor ataxy and of general paralysis of the insane. I am led to believe that much of the evidence in reference to the occurrence of these two conditions in their relationship to each other, in regard to their origin and association, is untrustworthy and of little value.

Dr. Mickle says: "Broadly speaking, in general paralysis, the rule is that cerebral symptoms precede the spinal symptoms;" and I am bound to receive the dictum of so careful and distinguished an observer with due deference, but we must not forget that a man may suffer from tabes dorsalis, and yet be free from ataxy in locomotion,

and when a man once becomes a general paralytic it would not advance clinical research if we paid any attention to his statements in regard to what may or may not have been the initiatory symptoms before the grandiose mania became developed; and, as I before stated, a man may be an insane general paralytic although the grandiose mania has proved abortive. I believe it is the unqualified experience of most observers "that headache more or less persistent and attended with elevation of temperature, optic neuritis, or atrophy, is indicative of gross organic change within the cranium; that pupils which do not contract to light but contract during accommodation (with or without atrophy of the discs), when associated with an absence of knee-reflex, and with the existence of dysæsthesia and analgesia of the lower limbs, are indicative of sclerosis of the posterior columns of the cord; that either of these states just mentioned, or the two combined, when associated with marked labial and lingual tremor and the *délire des grandeurs*, are indicative of the general paralysis of the insane. If a man dies from some intercurrent affection during what is called the stage of grandiose mania, and we examine the nervous centres, we shall most probably fail to find any extensive gross change, and we are thus led to believe that, during this stage, there is an instability and retardation in the normal sensory and motor reflex processes, due to an impairment of nutrition, which ultimately leads to organic dissolution and general paralysis with the pathology of which we are now quite familiar; and I feel quite sure that there are also stages in tabes dorsalis where no pathological change could be detected in the posterior columns of the cord. If a man lose his reason, and declare that he is the Emperor of Morocco and brother to the Sultan, he passes at once into the hands of the psychologist, who tests his mental condition, and classifies him accordingly; but little knowledge is gained of the antecedent features of the patient's case from a psychophysical point of view, and all hearsay evidence is valueless in reference to the formation of scientific clinical deductions, although I must admit that, for all practical purposes and for treatment, no such knowledge is imperatively demanded.

I will now draw attention to some of the disturbances of reflex action common to general paralysis of the insane and tabes dorsalis. Possibly the most important initiatory sign in all the reflex processes of the body is that which is connected with the pupil of the eye. This condition, known as spinal myosis, has long been fully recognised, and is unquestionably due, as pointed out by Erb, to some morbid inactivity in the reflex processes which normally exist between the optic nerve, the medulla oblongata, and the cilio-spinal centre; and here would demonstrate a point which I consider to be of some importance in relative diagnosis. In tabes dorsalis, we invariably find pupillary immobility more or less marked, and such is often the case in the general paralysis of the insane; but in the former we find the reflex action of the skin retained, whilst in the latter we find that it is partially lost; and the same condition may be said to exist in reference to common sensation, although the reverse is sometimes found in regard to the tendon-reflex.

The abolition of the reflex action of tendons in tabes dorsalis is, with very few exceptions, an accepted doctrine; but it is very questionable whether the absence of tendon-reflex is found in the general paralysis of the insane without some change in the posterior columns of the cord. Erb states that the tendon-reflexes stand in no demonstrable relation to cutaneous or muscular sensibility, nor to the reflex action of the skin. He says that he has seen the reflex action of tendons fail when the cutaneous and muscular sensibility were entirely intact, and that they were greatly diminished when the reflex action of the skin was normal, raised, or lowered. I need scarcely say that these are facts borne out by our every-day experience. Disturbances of vision are common both to the tabetic and to the general paralytic; and I have verified the assertion of Gräfe that patients who are suffering from diplopia in tabes show slight tendency to the blending of images in binocular vision; but the reverse, in my opinion, often occurs in the vision of the general paralytic. With regard to degenerations of the optic nerve, I am sorry that my experience in this respect is extremely limited in the general paralytic; but Hammond states that ophthalmoscopic examination will very generally detect degeneration of the papilla at a very early stage of this disease, together with retinal and choroidal anæmia. We know that atrophy of the optic nerve is common in the initial stage of tabes, and may exist, according to Charcot, for many years as an initial sign of ataxic symptoms. In the third case which I reported, the grey degeneration of the optic nerve, which was associated with severe headache, increase of temperature, and emotionability, was rapidly succeeded by sclerosal atrophy; and, although there was scarcely a trace of vision, yet the pupils contracted slightly to light and during accommodation. I am, however, greatly inclined to believe, from some cases which I have under my observa-

tion, that those cases of ataxy which are preceded by sclerosal changes in the optic nerve are frequently cases of abortive general paralysis, and which are decidedly cerebro-spinal, rather than purely spinal; and, furthermore, when the acute symptoms set in, they become more or less rapidly fatal. When the sensory division of the fifth nerve is involved in association with amaurosis due to sclerosal atrophy of the optic nerve and other signs of tabes dorsalis, we must be guarded in making a diagnosis and in giving a prognosis. Now, in making a diagnosis, we have to study very carefully the head-pains, which are very diagnostic in the general paralysis of the insane, as they differ from those of tabes dorsalis, which are equally diagnostic. In the former case, the headache is primarily of medullary origin, is more diffuse, and invariably associated with marked elevation of temperature; but it may appear and disappear suddenly; and it differs altogether from the chronic form of headache which supervenes and becomes more localised and persistent as organic changes ensue in the later progress of the disease. In tabes, when the fifth nerve is involved, the pains are rapidly migratory, and resemble more the pains of neuralgia; and, what is most important to remember, they are not accompanied by an increase of temperature of the head. The fifth nerve is more frequently implicated in the general paralytic than in the tabetic; hence we find disturbances of sensation in those parts supplied by the sensory division of this nerve more frequent in the former than in the latter. I have seen patients with commencing general paralysis who have stated that their teeth felt like so much India-rubber; and I have also found that, throughout the whole distribution of this nerve, there has been a decided retardation in the conduction of sensations as well as of the sense of pain.

It is generally considered that the seventh is, of all the cranial nerves, the first nerve to be objectively involved in general paralysis, and especially those branches which serve for the mimetic movements of the mouth and lips; and this is unquestionably true as far as the objective signs are concerned; but more recent observation has led me to conclude that the deficiency in normal sensation of those parts supplied by the fifth nerve precedes the exaggerated and inco-ordinate movements of the lips in articulation, which are strikingly characteristic of general paralysis, and which distinguish this condition of disease from tabes dorsalis; and the same may be said of an associated lingual tremor and muscular inco-ordination. The special senses of taste and hearing are more defective in the general paralytic than in the tabetic. The varying morbid reflex actions and trophic disturbances which produce the different crises in tabes are for the most part of spinal origin, and are common to other degenerative changes in the spinal cord, and cannot be said to be due entirely to sclerosis of the posterior columns; at all events, they are not found to exist in the primary stages of the general paralytic. In tabes dorsalis, ataxy, and not paralysis, is the essential and characteristic disturbance. This disturbance is usually first manifest in the lower extremities.

In the general paralysis of the insane, the first sign of ataxy is usually seen in some derangement of those complicated and combined movements of the tongue and lips in articulation; but we find more than mere disturbance in the co-ordination of these movements, for there is, in addition, actual muscular paresis; and the power for the engenderment of individual and simple movements is greatly lessened, and no sustained muscular effort can be supported.

THE PHYSICS OF NERVE-STRETCHING.

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ON the 15th May 1878, I read a paper on the above subject before the Medico-Chirurgical Society of Edinburgh. At that time, the operation of nerve-stretching was chiefly resorted to for severe and intractable cases of sciatica. Having seen the greater sciatic nerve stretched by several of the Edinburgh surgeons, and the limb with part of the trunk lifted from the table by the nerve, I thought it would be useful to ascertain the amount of force that could be applied to the nerve without any liability of rupturing it.

On consulting the various text-books of anatomy and physiology, little or no information could be obtained. Thus Hermann, in his *Human Physiology*, translated by Gamgee, dismisses the subject with the remark, that "the mere mechanical properties of nerves have, as a rule, no interest, physiologically speaking;" but, in view of the operation we have mentioned above, they would appear to have some interest surgically. In Valentin's *Physiology*, translated by Dr. W. Brinton (page 20), there is a table, showing the relative cohesion of the tissues of the body. These are stated as follows, in kilogrammes, per square millimetre of section: muscle, .06; arteries, .14; veins, .23; nerves, .96; tendons, 5.3; bone, 8.0. It will be noticed that tendons are

given as about six times as strong as nerves. In the *Annales de Clinique et de Physique*, for 1847, is a valuable "Memoire sur l'élasticité et la cohésion des principaux tissus du corps humain," by Wertheim. At the end of his paper, he gives, in a tabular form, the result of his experiments upon various tissues. In the list of nerves, there are four great sciatics. The following was the method he employed, and the result obtained. As long a portion of the great sciatic nerve, presenting a tolerably uniform size, as could be obtained, was removed from the body, measured and weighed. One end of it was then fixed, and a weight attached to the other; the increase in the length of the nerve was observed; and, the weight being removed, its length was taken immediately, and again after a short interval. This process was repeated, the weight being gradually increased each time, until the nerve was broken. This was accomplished in a man, aged 35, by 47 lbs., and in one aged 74 by 51 lbs.; in two females, aged respectively 21 and 60, by 59 lbs. and 39 lbs. From experiments on various nerves, he came to the conclusion that, in proportion to their size, the branches of a nerve were stronger than the main trunk. These experiments of Wertheim did not appear to give the surgeon a reliable guide to the amount of force he might safely apply in the ordinary operation of nerve-stretching; and that mainly for two reasons.

1. His experiments being made chiefly with a view to ascertain the elasticity of the nerves, these were subjected to a considerable amount of stretching for some time before a force sufficient to rupture them was applied; and, as is well known, *time* is an important factor in testing the cohesion of a substance.

2. The nerves being first removed from the body, his experiments afford no information as to the strength of the upper and lower attachments of the nerve.

In order to obviate these objections, I made a series of experiments, in which the force was applied, as nearly as possible, in a manner similar to that in the operation of nerve-stretching. The subject being placed on its face, the nerve was exposed at the point where it is usually stretched—viz., at the lower border of the gluteus maximus. One end of a strong S-shaped hook was passed beneath it, special care being taken to include the whole of the nerve. The body was then turned on its back, and the buttocks supported on one table and the knees upon another. To the lower curve of the hook, weights were then rapidly attached until the nerve gave way. By this means, the force was applied at right angles to the thigh, as in the operation when the limb is lifted by the nerve; and, by the rapid addition of the weights until the nerve ruptured, the force acted only, as in the operation, for a short time.

EXPERIMENTS.

Experiment 1.—Male, aged 37, well-developed, but lower limbs oedematous; heart and lungs healthy; liver markedly cirrhotic; a clot in left iliac vein. During life, the left limb had become dropsical before the right one. Right sciatic: 100 lbs. failed to break, even after it had been on for fifteen minutes; had no heavier weights at this time. Left sciatic: 100 lbs.; the nerve came away, with its connections to the spinal cord, in less than one minute.

Experiment 2.—Female, aged 50, of average size and muscular development; aortic disease; lower extremities slightly oedematous. Right sciatic: 100 lbs.; came away from spinal cord in less than a minute. Left sciatic: 100 lbs.; came away as on right side, but almost immediately.

Experiment 3.—Male, aged 22, well developed. Right sciatic: 126 lbs.; failed to break. Left sciatic: 126 lbs.; failed to break. I had no more weights, but turned the body, and lifted the lower extremities and as much of the trunk as I could by the nerve, and I failed to break the nerve.

Experiment 4.—Female, aged 17, small for her age and ill-developed. Died of phthisis, waxy disease, etc. Right sciatic: 98 lbs.; gave way in less than a minute from spinal cord. Left sciatic: 84 lbs.; same result as above.

Experiment 5.—Male, aged 36, well developed; aortic disease; slight dropsy of lower limbs. Right sciatic: 158 lbs.; nerve broke across immediately at the point of attachment of the hook. Left sciatic: 154 lbs.; same result.

Experiment 6.—Female, aged 60. Died from fracture of skull. Right sciatic: 140 lbs.; broke as in Experiment 5. Left sciatic: 126 lbs.; the same result.

Experiment 7.—Female, aged 36, well developed. Died of cardiac disease. Right sciatic: 145 lbs.; immediately broke from the spinal cord. Left sciatic: 160 lbs.; same result as on right side.

Experiment 8.—Male, aged 40, very muscular; height, six feet. Died from injury of head. Right sciatic: 176 lbs.; broke immediately at the point where the hook was applied. Left sciatic: 170 lbs.; same result.