CLINICAL LECTURE ON LOCOMOTOR ATAXIA.

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REGARDING the pathology of this disease, it is not difficult, when we consider the nature of these anatomical changes, to understand the inequality and irregularity of the disturbances of sensibility which we have seen to be present in this disease. A gradually developing sclerosis of the neuroglia, exceedingly delicate and somewhat soft in texture, will, in the initial stage—which is probably always more or less inflammatory—by pressure upon, and irritation of, the sensory nerve-roots, cause those electric-like pains which are characteristic of the initial period of the disease and of each extension of it into new regions of the cord, and which pains, although referred to the limbs, are probably centric in their origin.

The advancing sclerosis, pressing unequally on different adjacent nerve-fibres, may cause great differences in the degree of the loss of sensibility in quite contiguous peripheral areas.

In those cases where absolute anaesthesia was present, but was temporarily removed by repeated strong excitations, we must assume that, in the nerve-path, the conductivity, although seriously interrupted, was not yet abolished or closed.

Delay of sensations usually affects painful impressions only, and is almost invariably associated with sclerosis of the posterior cornua of grey matter.

What is the mechanism of the inco-ordination, which is the most characteristic feature of this disease? Is there lesion of any co-ordinating centre? And, if so, what is the centre which governs the co-ordination of the movements of the arms and legs?

The centre which regulates the co-ordination of a particular muscular movement is situated, I believe, in that portion of the spinal cord from which arise the nerves which supply the muscles necessary to effect that movement. To understand the pathology of locomotor ataxia, it is necessary that you should have clear ideas on this point.

I will now endeavour to make good this assertion, that the co-ordinating centre for such highly complex muscular movements is situated in the spinal cord.

The following experiment must be familiar to all of you who have studied physiology. Take a frog and irritate the upper part of the right thigh with a strong acid. It will immediately put up the foot of the same side and rub off the acid. If by any means it be prevented from using this foot, it will then raise the left foot and rub it off. This act is an example of co-ordination. It appears like an intelligent use of the limbs, and seems at first sight to be governed by the brain. The question is easily settled. Cut off the frog's head, and repeat the experiment. You again irritate the right thigh of the decapitated frog with the acid. Again it raises the foot of the same side and rubs off the acid. Cut off the right foot, and once more apply the acid to the thigh. It raises the footless leg, cannot reach the spot, pauses a moment as if for reflection, then lifts the left foot and rubs the acid off, just as if its head were on.

In this case, an influence is transmitted along afferent nerve-fibres to the proper nerve-centre in the grey matter in the spinal cord, and in virtue of an inherent power to produce orderly reflex movements—the result of education by frequent repetition, or inherited—possessed by certain combinations of ganglion cells in the spinal cord, definite motor influences are originated, and conveyed by efferent nerve-fibres to certain associated muscles, which are brought into play in the most exact manner possible.

It is thus apparent that, in the frog, beautifully co-ordinated complex muscular movements are performed by the spinal cord as a centre. To those who are familiar, as you all are, with the number of separate muscles and nerve-fibres concerned in such a movement, this is a remarkable fact. Our patient Joseph Ritchie cannot, with his eyes shut, touch the point of his nose, of the position of which he is quite conscious; but our headless frog carries its feet accurately to the irritated spot.

Flying is a movement exactly analogous to walking. Birds suddenly decapitated often fly for a considerable distance before death brings the co-ordinating mechanism to a standstill. I have repeatedly satisfied myself of this by experiment. I have also seen a partridge whose head

had been shot right off continue its flight over half a field in the most perfect manner, until it suddenly fell dead. These are examples in a higher class of animals of spinal co-ordination. It is plain, then, that, as the result of education by frequent repetition of certain movements, there arise in the grey matter of the spinal cord "certain co-ordinations of motor elements which can apparently be called into activity, not only in a reflex manner, but also by the will". The will, however, in such cases, does not require to stimulate "each individual fibre supplying the muscles, but may simply render active the same apparatus as would have been brought into play in the reflex production of the same movement. If this were not so, the mind would have more work than it could accomplish in the production of the innumerable muscular movements required in such an apparently simple operation as walking" (Hermann's *Physiology*, Gamgee, p. 487). We may assume, then, that we do not need to go further than the spinal cord in search of those co-ordinating centres which are at fault in locomotor ataxia.

What, then, is the mechanism of co-ordination of muscular movements? For the performance of orderly movements of this kind, the following factors are necessary, in addition to the bony framework of the body: 1. Healthy muscles; 2. Healthy afferent nerve-fibres; 3. A healthy nerve-centre, fitted by education or inherited power to regulate exactly the muscles under its control, so as to produce harmonious action of these.

Now, you must bear in mind that, in every muscular movement, not only are the muscles directly producing the movement contracted, but there is, moreover, a simultaneous balancing and regulating action of all the antagonistic muscles, whereby the movement is rendered steady and graceful.

You will excuse a simple illustration, which may serve to fix on your memories the process of education of, and the power acquired by, the associated nerve-cells in such a finely complex movement, for example, as writing. Suppose that you have a long pole fixed to a firm base by means of a ball-and-socket joint or hinge, so as to permit of its free movement in many directions. To its free end are attached twenty ropes. These are arranged in a circle around it, and are capable, when worked by twenty men, of causing the free extremity to describe a great variety of movements. Hold a rod to some spot within reach of the point of the pole, and ask the men, by means of the ropes, to bring the pole straight to that spot. They will pull it about in a most irregular zig-zag manner before, by their combined action, it is brought to the spot indicated. But keep your rod at the same place, and let the men try it over and over again. They will observe and correct their mistakes, and coming to work more and more in harmony, will gradually bring it with less effort and in a steadier line to the point required. By careful training, the twenty men would learn to adapt their efforts so skillfully to the requirements of the case, that they would in time be able, with their eyes shut, to describe quickly and gracefully, with the point of the pole, many definite complex movements, such as the circle, figure of 8, etc.

In the spinal cord, the twenty men are represented by thousands of associated nerve-cells, which, acting by means of nerves and muscles, regulate all the complex movements of the body. In writing, for example, movements very much like those performed by the men with the pole—but infinitely more complex and difficult—are actually performed by the nerve-cells, muscles, and fingers. You know how difficult it is for a child commencing to acquire the art of penmanship to learn to make even simple straight strokes; and yet, with practice, he after a time acquires the power of forming quickly, elegantly, and without consciousness of effort, the most difficult letters and the still more difficult combinations of letters called words.

In order that perfect co-ordination be maintained, it is necessary that the whole circle we have named, of afferent nerve-fibres, nerve-centre, efferent nerve-fibres and muscles, should be in a perfectly normal condition relatively. As this disease—posterior sclerosis—affects the root-zones of the posterior or sensory roots of the spinal nerves, we may sum up the various sources from which, in the normal condition, those impressions, not necessarily revealed to consciousness, are derived which guide the actions of the co-ordinating centres. These impressions are derived through centripetal nerve-fibres from, 1. The skin; 2. The muscles and tendons; 3. Deeper structures, such as the joints, periosteum, etc.; 4. The brain.

That co-ordinate purposive movements can be excited by cutaneous centripetal impressions without the intervention of consciousness, is evident from the experiment which we have described in the decapitated frog; and that a perfectly co-ordinated movement can be continued without the brain, by the agency of the spinal centres alone, is proved by the bird performing the repeated highly complex movements of flying for a considerable distance after being suddenly decapitated.

So much for the mechanism of co-ordination. How, in the next

* Concluded from p. 859 of last number.

place, is that inco-ordination which is so characteristic of the disease produced? The inco-ordinate movements have by some writers—such as Leyden, Landry, Ruehle, Clifford Allbutt, etc.—been attributed solely to the simple loss of tactile sensibility. Leyden's theory of ataxia is thus stated by Professor Erb (Ziemssen's *Cyclopaedia of Practice of Medicine*, English edition, vol. xiii, p. 87): "Co-ordination of movements is rendered possible and is effected through sensibility; suspension of the sensibility (of the skin, joints, muscles, etc.) suspends co-ordination; grey degeneration of the posterior columns is accompanied by disturbance of sensibility along with the ataxia; we are acquainted with no other than sensory functions in the posterior columns; consequently, ataxia is a result of disturbance of sensibility." Friedreich, Niemeyer, Späth, Erb, and others, hold, on the contrary, that the inco-ordination is a motor phenomenon, caused by disturbance of the centrifugal paths.

There is evidence, both physiological and pathological, to show that complete abolition of the transmission of centripetal impressions, either cutaneous or muscular, does not produce true ataxia. The movements of a skinned frog are not ataxic; neither does division of the posterior roots of the spinal nerves, although it impairs the muscular movements, produce true ataxia in the limb which the divided nerves supply. In the case of Remigius Leins cited by Professor Erb, sensibility to all impressions is almost entirely extinct in the upper extremities and in the soles of the feet; in the legs and trunk, there is diminished sensibility. In this case, voluntary co-ordinated movements are perfectly and strongly performed. There is, however, in this case no evidence of those peculiar inequalities and errors of sensibility or other centripetal impressions which are characteristic of posterior sclerosis.

Späth, Erb, and others, are disposed to believe that there must exist in the spinal cord special centrifugal co-ordinating nerve-fibres, situated probably in the posterior columns, implication of which in the sclerotic process is the cause of the ataxia.

Among those who have looked for the fault exclusively in connection with the muscles and their nerves, is Dr. J. Lockhart Clarke. He regards the habitual state of the muscles in health as one of reflex tension or tone, a moderate but constant state of contraction, by which antagonistic groups are kept in equilibrium or static tension; and upon the integrity of which tension the proper performance of combined voluntary movements depends. If some of the muscles of the group employed for any complex movement have in any degree lost their normal tension or tone, they will fail to the same degree to respond to the voluntary stimulus, and to perform their proper part in balancing the effects of the other muscles of the group that retain their tension, and thus the resulting movement will be proportionally disorderly. (BRITISH MEDICAL JOURNAL, September 20th, 1869.)

Now, unfortunately for this view, automatic muscular tonus is by no means proved. On the contrary, physiological experiments tend directly to disprove its existence, and to show that the retraction of severed muscles is due, not to any contraction of this kind, but to the fact that, in the normal condition, the muscles of the body are, in virtue of their elasticity, extended somewhat beyond their natural length. "Thus the retraction of severed muscles, which was supposed to be due to muscular tonus, takes place when the nerves supplying the muscles have been previously divided." (Hermann's *Physiology*, Gamgee's translation, p. 487.) Nor would this theory of Dr. J. Lockhart Clarke explain—what is unquestionable—the occurrence of well marked ataxic symptoms where there is little interference with the transmission of muscular centripetal impressions, and where the principal cause of the inco-ordination is evidently interruption to the transmission of cutaneous centripetal impressions.

The following appears to me the true interpretation of the phenomena met with in this disease. Correct centripetal impressions—not necessarily sensations, remember—regarding the movement, or changes in the position of the limb or portion of a limb acted upon, received during the successive stages of the movement must greatly influence the properly co-ordinated performance of it. The movement of a limb is believed to be estimated, not merely by impressions received by the nerve centre regarding the state of muscular contraction, but also by impressions received regarding the state of tension, relaxation, or folding of the skin and the state of pressure on the joints, etc. Now it stands to reason that, if there reach the nerve-centre regarding these points such a series of erroneous impressions as are present in, and characteristic of, posterior spinal sclerosis, the resulting act must cease to manifest that precision and smoothness of co-ordination which would characterise it in a perfect state of the mechanism.

While, therefore, it is not proved that there exists any loss of tonus in individual muscles previous to movement, and while I consider Dr. Lockhart Clarke's view insufficient to account for all the phenomena of the disease, I may now sum up what I believe to be the correct ex-

planation of the various phenomena connected with the mechanism of the inco-ordination of locomotor ataxia in this way. During every co-ordinate movement, there is an exact, but constantly changing, degree of contraction of each of the muscles which directly effect the movement, and of each of the antagonistic or balancing muscles which steady and regulate the movement. The degree of contraction of each of these muscles is accurately and continuously regulated by impressions continually received by the nerve-centre through centripetal nerve-fibres from the muscles, on the one hand, regarding their state of contraction and the amount of resistance encountered by them, and from the skin, joints, ligaments, etc.; on the other hand, regarding the changes being effected in the position of the limb by the movement. The inco-ordination which characterises this disease is not caused by any general abolition of sensibility or of superficial or deep centripetal impressions, as we have seen proved by the experiment of the skinned frog, and division of the posterior roots of the spinal nerves, and by the case of Remigius Leins; but is the result of false, unequal, varying, and otherwise misleading impressions received by the nerve-cells in the grey matter of the spinal cord during the succeeding stages of the actual movements regarding the state of certain muscles in the acting groups, and regarding the actual position of the limbs. These must, of course, originate equally untrue resulting combinations of muscular movements when the automatic reflex spinal centre is called into action by the will. To make this intelligible, I recapitulate the principal errors in the centripetal impressions met with in this disease; and with regard to each of these, it should be borne in mind that quite contiguous portions of the cutaneous and deep tissues may present the most widely different conditions of sensibility or other centripetal nerve conductivity. These sources of error are: 1. Diminished intensity of impressions; 2. Erroneous localisation of impressions; 3. Delay in the rapidity of their transmission; 4. Conversion of one kind of impression into another; 5. Variability of the phenomena in the same spot at different times and under different conditions.

Recall to mind the illustration of the twenty men educated to perform, with closed eyes, by means of ropes, co-ordinate movements with the end of the pole. Imagine similar errors to those just enumerated introduced into the impressions received by their hands through the ropes regarding the movements and position of the point of the pole. One man receives diminished impressions and will act too feebly; another delayed impressions and will act too late; another erroneously localised impressions and will act in the wrong direction; another false impressions and will act wrongly; and so on. You will see at once that the resulting action must be irregular and ataxic. With their eyes open, the men will be able by constant corrections partially to improve the movement, just as all the muscles of the balancing groups in the leg of an ataxic patient, when standing, are seen to be in a perpetual state of movements of correction. The analogy is complete.

The explanation here given has this advantage, that it embraces all the varieties of the disease which have been insisted on by different authorities, instead of necessitating their separation, which some propose. It satisfactorily accounts for, 1. Those cases in which cutaneous sensibility and centripetal impressions are principally or entirely at fault; 2. Those cases in which the conduction of muscular centripetal impressions is principally deranged; 3. Those cases in which both of these causes of inco-ordination are present; 4. It accounts also for the "confusion worse confounded", which is met with in the advanced stages of many cases of all these varieties, when even the last guide, the eye itself, becoming afflicted with diplopia, amblyopia, or amaurosis, the once perfect automatic mechanism of the body can only produce movements which are utterly disorderly and purposeless.

Advanced cases of this disease present a further stage, in which the sclerosis having overstepped the boundary line of the posterior columns and the adjacent posterior cornua of grey matter, new phenomena, indicative of the other tracts invaded, are added to the clinical picture. This third stage, through which most cases finally pass in their progress towards the almost inevitable fatal termination, is really no longer simple posterior spinal sclerosis; and its complex phenomena must be interpreted by a correct knowledge of the symptoms referable to sclerosis of the various other tracts of the spinal cord. Thus invasion of the posterior portion of the anterior cornua of grey matter is often associated with trophic disturbance in the joints; a further extension forwards leads to muscular paralysis and rapid atrophy; while, if the lateral columns be implicated, besides paralysis, various clonic and tonic contractions result; and so on.

I will not detain you many minutes with the treatment of this disease. As a rule, patients suffering from posterior spinal sclerosis go on from bad to worse; and whether the cases of cure which have been recorded were really cases of locomotor ataxia is, to say the least, doubtful. But the disease may, and often does, become stationary; and, if this result

can be brought about by any means, it is worth our efforts as physicians. For the damaged mechanism, if it cannot be repaired, can, to a certain extent, be re-educated; and, by learning to make allowance for certain errors, the nerve-centres may reacquire a certain amount of the lost power of co-ordination. Thus we may have apparent, but only apparent, improvement. Our patient Ritchie, by finding that his forefinger, when he tried to touch his nose, went two inches beyond it, learned by practice to correct this error, and could after a time, with his eyes shut, hit the mark much better.

In the earlier stages of the disease, when there is reason to believe that there is a good deal of congestion or even of inflammation, ergot of rye in full doses—a drachm of the liquid extract three times a day—or bromide of potassium or sodium, may be given. Under this treatment, Joseph Hunter, who was in Ward 7 in 1877, and whose case, although not severe, was an unquestionable one and in the early stage, improved greatly. The electric-like pains disappeared, and he recovered the power, which he had lost, of standing with his heels and toes together and his eyes closed, although he swayed from side to side a good deal. Nitrate of silver in quarter-grain doses has been extolled by many authorities, and my experience of it has been satisfactory. The constant galvanic current to the spine and nerves is often useful. The actual cautery is most worthy of trial, having been employed in some cases with encouraging results. The electric-like pains are best treated by means of the subcutaneous injection of morphia. Where a syphilitic history is present, the prognosis is more hopeful, and bichloride of mercury with iodide of potassium should be given.

Some of the facts brought out in these cases seem to indicate that an important part of treatment may consist in stimulating the anæsthetic areas. However, I hope to be able to speak more fully and decidedly on this subject in a future lecture.

ENLARGEMENT OF BRONCHIAL GLANDS WITH RELATION TO WHOOPING-COUGH.

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I WISH to give a few facts in reply to Dr. Gueneau de Mussy's remarks on the above subject in this JOURNAL of October 25th. Since the beginning of 1877, when there was considerable discussion of Dr. Gueneau de Mussy's doctrine, I have seized such few chances as came to my hand of testing, by *post mortem* examination, the statement that the bronchial glands are enlarged in whooping-cough.

1. Out of seven *post mortem* examinations on cases of undoubted whooping-cough, there was one in which the enlargement was considerable; and I took the specimen to the Pathological Society at the same time as the one to which Dr. Gueneau de Mussy has referred. There was one where the enlargement, though slight, was, I believe, definite; and there were five where there was no enlargement. The actual measurements I cannot give; but I have a note about one of the above cases, a child aged four months, that not one of the bronchial glands was as big as a red currant. I strongly suspect, from other observations, that the amount of enlargement of the bronchial glands, when found, must have some sort of relation either to the severity of the bronchitis, or, still more, to the extent of bronchopneumonia, if present. It seems possible, also, that the idiosyncrasy of the patient may have something to do with it. But this is speculative; and I am concerned only at present to state that the enlargement is not constant.

2. Dr. Gueneau de Mussy objects to arguments drawn from chronic enlargement of the bronchial glands, where nothing like whooping-cough had been present; but it is necessary that he should show how such cases anatomically differ from other chronic cases where paroxysmal cough is present, and which he claims in support of his theory. The distinction drawn between the effect likely to be produced by a slow chronic enlargement and an acute sudden congestion is reasonable; and therefore, at present, I will not consider the cases of tuberculosis with involvement of bronchial glands where the process is at all chronic. But, in infants under twelve months, tuberculosis is often moderately acute. I have examined such children in whom the duration of illness had been from six weeks to two months. Paroxysmal cough had not been present, and the tracheo-bronchial glands were considerably enlarged.

To consider still more acute cases: Along with my colleague Dr. David Lees, I have lately made *post mortem* examinations on two children where there was considerable enlargement of bronchial glands, associated in one case with severe bronchitis and collapse, and, in the other, with extensive bronchopneumonia. In neither case had whooping-cough been present during life, nor had the cough been at all

paroxysmal. I have made *post mortem* examinations, also, on cases of diphtheria with bronchopneumonia, where acute enlargement of bronchial glands occurred, although, during life, no cough simulating whooping-cough had been present.

To sum up these conclusions:

1. Enlargement of the bronchial glands in whooping-cough is not constant.

2. Acute and subacute enlargement of bronchial glands occurs without paroxysmal cough.

To these may be added:

3. Dr. Gueneau de Mussy's admission that paroxysmal cough may occur without enlargement of bronchial glands.

Holding these three propositions to be true, I cannot admit that enlargement of bronchial glands pressing on the vagus is the *vera causa* of the characteristic symptom of whooping-cough.

There are many clinical arguments which might be considered, but I do not think with much profit. In spite of all that has been written on the subject, I cannot acknowledge that the diagnosis of enlargement of the bronchial glands during life is sufficiently satisfactory to admit of sound deductions. Where such enlargement is guessed at with a fair amount of probability, it is, in the majority of cases, so much complicated by morbid conditions of lung, pleura, or bronchus, that it seems a fruitless task to attempt to unravel results special to it.

RECURRENT HEADACHES IN CHILDREN, AND ASSOCIATED PATHOLOGICAL CONDITIONS.*

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THE object of this paper is to draw attention to the frequency of recurrent headaches at an early age, and to point out some symptoms and objective conditions commonly associated with headaches in children; some clinical facts which seem to be connected with the development of chorea will also be noted.

In studying a group of cases as to which we have no known pathology to define the class, it appears convenient to start with a general description; and, for this practical purpose, a summary has been made of the principal symptoms of fifty-eight cases of headache in children under fifteen years of age. Though recurrent headache was the most prominent and constant symptom met with in this group of cases, it was not always the one first complained of by the patient or mother. Classifying the symptoms, we find the largest number referable to the mental and cerebral condition of the child. We are told that he is excitable, melancholy, passionate, or fretful; that sleep is restless and disturbed by dreams and night-talking, by attacks of terror and screaming, or by somnambulism. Often there are vague pains in the limbs, chest, or abdomen. The appetite is often variable, voracious or entirely lost; there may be considerable emaciation with a good appetite, and without any accompanying signs of organic disease; often there is considerable nausea or retching with the attacks of headache. Hacking cough, without physical signs to account for it, is often met with, and usually the child is excessively fidgety.

In studying this group of nervous excitable children in whom recurrent headache was a main symptom, it was first necessary to look out for certain objective signs by which they might be identified; and these were principally found in the condition of the nervo-muscular system, the teeth and the urine, but chiefly in the muscular system.

The principal means at our disposal for studying the condition of the brain during life is by observing nervo-muscular phenomena. All expression of the subjective states is effected by muscular action, whether expression be produced by speech in words, by the facial movements or gesture, in which cases voluntary muscles are called into play; and such modes as dilatation of the pupil, erection of the hair, or disturbed action of the heart, are due to the condition of inorganic muscular fibre.

Local paralysis, and, in some cases, localised convulsion, may give definite indication as to the part of the brain affected and its conditions. We commonly recognise certain appearances of the face, and certain positions of the body and limbs, as indicating a fatigued or exhausted condition of the brain; and it is frequently with truth said that such an one looks as if he had a headache. Again, the look of expression in the face, and the tremulous condition of the muscular fibre of the tongue, is characteristic in general paralysis, as the depression of the angles of the mouth and the other signs of mental dejection are in melancholia. All these symptomatic conditions will, I think, if analysed, be found to depend on muscular conditions due to the conditions of the nerve-centres. Indeed, excluding the use of the ophthalmoscope, we have but

* Read before the Hunterian Society.