Original Communications.

PATHOLOGICAL AND PRACTICAL RESEARCHES ON THE VARIOUS FORMS OF PARALYSIS.

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If it be permissible to write on a symptom which is common to many forms of disease, surely the disunion of the link which associates the conscious mind with the external world, or which transmits the power to execute the actions directed by the internal will, is of sufficient importance to claim an interest commensurate with these obscure and complex processes of organic life.

It is not my intention to enter into any historical account of the successive steps which have been made in the progress of the physiology and pathology of the nervous system, but it would be unseemly to forget the homage which is due to two great men who conceived the plan, and laid the foundations of those sciences.

Up to the end of the first decade of the present century, it was universally believed that every individual nerve, to whatever part of the body it might be distributed, proceeded from the brain as from a common centre, of which all parts were supposed to possess the same complex properties, and to endow the nerves with the same attributes.

To Sir Charles Bell is due the honour of having first demonstrated the fact that there are nerves of sensation distinct from nerves of motion, and that each set has a special origin in or connexion with the brain and spinal cord. He underrated, however, the important function of this latter part of the nervous centre, and regarded it simply as a main channel to convey the nervous currents to and from the brain; the conductors of sensation passing, as he thought, through the posterior and lateral columns, the conductors of volition through the anterior columns of the cord; and it was impossible, without the experiments which have since been made, that he could arrive at a correct notion on these important points. But his theory immediately suggested the obvious means of tracing back to particular parts of the brain the causes of paralysis and of many nervous diseases. It did not, however, account for those strange and mysterious sympathies by virtue of which the different parts of the body are maintained in a state of mutual dependence, and by means of which a disturbed condition of one organ produces impressions on the other, and, it may be, distant parts of the system. What, for instance, but this kind of affinity can occasion the contracted brow in severe headache, the dilated nostrils in painful affections of the chest, or the raised upper lip stretched over the gums in great suffering of the abdomen? These, and other far more important phenomena, were interpreted by the thoughtful experiments of Dr. Marshall Hall, who first taught us that they are dependent on diffusion of excitement, not by the nerve primarily affected, which acts only as a conductor of sensation to the nervous centre, but by the nervous centre itself, on which the primary impression impinges, and from which it is reflected. Thus a worm in the intestine sets up irritation, which, when transmitted to the spinal cord by the special conductors of sensation, may produce paralysis as a reflex action.

This theory, second only to that of Sir Charles Bell for its practical importance, has been followed by much philosophical research concerning the structure and function of nervous tissue; but in no respect have the labours of Dr. Marshall Hall been of greater service than in the elucidation and treatment of reflex paralysis.

We have, chiefly by the discoveries of these two men,

established on a physiological basis the separation of paralysis into a direct and a reflex form, and pathological cases have verified the principle on which the distinction is founded.

One great impediment to the investigations of pathologists has been in some degree removed by the recent researches of anatomists into the structure and relationship of the several parts of the nervous centres; and, throughout the whole domain of pathology, I know of no field which still promises a richer harvest of facts immediately applicable to practice, than that in which a knowledge of the healthy and morbid structure of the brain and spinal cord is cultivated. It is not too much to say that every new fact which has been revealed to us concerning the distribution of nervous fibres, has elucidated some previous unrevealed phenomenon observed in disease, and still there is an insufficiency of anatomical evidence for the interpretation of many morbid phenomena. I shall therefore begin with a concise account of the structure of the nervous centres; and first, of

THE SPINAL CORD.

This is divided by an anterior (α) and a posterior (β) fissure into two lateral halves; each half being intersected by the posterior or sensory nerve-roots into an anterior (γ) and a posterior (δ) column. The two posterior are regarded as the conductors of impressions of sensation to the brain; the two anterior are the conductors of the orders of the will to the motor nerves. Each lateral portion of the entire cord consists internally of grey matter, which spreads out before and behind into two horns or cornua, an anterior (ζ) and a posterior (η). These cornua vary in form in different regions of the spinal cord; but the disposition of their constituent parts is well nigh the same in all. The two halves are perfectly symmetrical, and they are connected together by two commissures (θ, ι), between which a central canal (θ) extends from one extremity of the cord to the other.

In both the anterior and posterior cornua there are many multipolar ganglionic cells (κ) united to one another by a network of nerve-filaments.

These nerve-cells are by far the most interesting anatomical elements in the animal body. They are the origin or the terminus of every nerve-fibre, and impart to all such fibres their peculiar endowment. Yet in structure nerve-cells are very simple, being made up of a cell-wall, with two or more caudate prolongations, a nucleus and nucleolus, and containing a few granular molecules.

The nerve-fibres consist of an external membrane, of the white nerve-marrow, and of the simple axis or cylinder. The existence of this latter character is denied by Funke, who attributes the appearance to a change which takes place after death—a contraction of the nerve-marrow; but the nerve-matter itself is composed of a material similar to, and continuous with, the contents of the nerve-cell.

From the cells, the number of which is in direct ratio to the number and thickness of the nerves with which they are connected, fibres may be traced into the anterior and posterior roots of the spinal nerves, as we shall presently see.

There are other nerve-fibres in the grey substance, which have been described by Mr. Lockhart Clarke in transverse and longitudinal orders. (*Philosophical Transactions* for 1851, vol. cxli, pp. 607-621.)

The transverse are disposed in an antero-posterior (λ) and latero-transverse (μ) directions. The antero-posterior, proceeding from behind forward, may be traced through the posterior white columns partly into the posterior roots of nerves on the same vertical plane, partly into other nerve-roots above and below. Others pass into the anterior cornua, where they interlace and form a network, in the meshes of which the multipolar

cells are contained. Some extend outwards to the lateral white columns, whilst many others appear to be continuous with the anterior roots of nerves. Others cross obliquely in front of the spinal canal, where they decussate with similar fibres from the opposite side, and penetrate into the anterior columns.

These antero-posterior nerve-fibres, therefore, connect together several posterior roots of sensitive nerves; the posterior with the anterior cornua; the posterior columns with the lateral and anterior; one-half of the spinal cord with the other; and, finally, the posterior nerve-roots with the anterior.

Transverse Section of the Spinal Cord. The outlines only are given on the right side of the figure, for the convenience of inserting letters of reference, which are explained in the text.

The latero-transverse fibres (μ) are arranged in loose bands, disposed more horizontally, and pass from one side of the grey substance to the other. Those behind the spinal canal diverge on each side into the anterior

and posterior cornua, and from them into the lateral and posterior columns. Some pass from one posterior nerve-root to its fellow on the opposite side; whilst others, in front of the spinal canal, connect the anterior

nerve-roots in a similar manner. A few may be traced from the anterior roots into the lateral columns of the opposite side.

These latero-transverse fibres, therefore, constitute the transverse commissure, and establish a communication between the opposite sides of the spinal cord on the same vertical plane.

The experiments of Dr. Brown-Séquard have proved that the decussation of the nerves of sensation takes place in the spinal cord; hence it is probable that these latero-transverse fibres are the conductors of the impressions of sensation from one side of the body to the opposite side of the spinal cord.

There are besides, in the grey substance, numerous *longitudinal fibres*, which are chiefly collected together in the so-called *substantia gelatinosa* (η). These longitudinal fibres are intimately connected with the posterior nerve-roots and with the latero-transverse fibres—*marginal fibres* of Van der Kolk (θ)—which surround the posterior cornua.

The bundles of these longitudinal fibres are thicker at the lumbar and cervical dilatations of the cord; therefore, it is very probable that they are not continued individually as far as the brain; but, as Van der Kolk has suggested, that they may contain fibres which connect groups of ganglionic cells at different heights in the anterior cornua, and so perhaps serve for the coordination of muscular motion. If this be so, we have nerves of sensation becoming exciters of motion; but in losing their character as sensitive nerves, the change is dependent on their combinations with multipolar cells, from which they transfer their reflex power of innervation.

Stillinger fancied that he had made out some longitudinal fibres in the anterior cornua; and in many careful examinations which I have made during the last six years, I am satisfied that I have seen such tubular fibres.

The *white longitudinal columns* surround and inclose the grey matter; and, by the intersections of the anterior and posterior roots of nerves, each side is divided into an anterior, a lateral, and a posterior column.

The *anterior columns* consist of longitudinal tubular nerve-fibres, and of transverse fibres, by which they are penetrated. They have no proper commissure, although they are united in the centre, at the bottom of the anterior fissure, by decussating nerve-fibres, which pass from the grey substance on one side through the raphe into the anterior column of the opposite side (δ).

The *lateral columns* are contained between the anterior and posterior roots of the spinal nerves; and, in addition to the longitudinal fibres of which they are chiefly composed, they are penetrated by filaments from the transverse commissure, and by others from both anterior and posterior nerve-roots (ϵ).

Now, the *anterior nerve-roots* (π) traverse the antero-lateral columns in distinct bundles, until they reach the grey substance, and there the ultimate filaments diverge in every direction; each one, if carefully followed, being traceable to a multipolar ganglionic cell; and these cells increase in number at every point where the roots of the nerves enter the spinal cord.

The decussating fibres of the anterior commissure, having communicated with the ganglionic cells, penetrate deeply into the anterior columns; and Van der Kolk has figured a multipolar cell, which he observed to connect the longitudinal tubular fibres with the penetrating transverse filaments. He has also observed the innermost longitudinal fibres of the anterior columns to curve towards the grey substance, and pass into ganglionic cells of the anterior cornua.

On these anatomical grounds, he inferred that each longitudinal fibre of the anterior columns is the conductor of the orders of the will to a group of reciprocally connected multipolar ganglionic cells, from which the motor nerves derive their origin; and that the in-

fluence of each fibre may be communicated directly to the cells by the fibre itself, or transmitted indirectly by the penetrating commissural filaments which communicate with both.

The *posterior columns* (δ), which are contained between the posterior nerve-roots, are comparatively small, and, like the anterior, possess no proper commissure of their own; for the posterior fissure (θ) which separates the posterior columns, reaches down to the posterior border of the transverse commissure of the grey substance. They are chiefly constituted of longitudinal tubular fibres, derived from the nerve-roots, and of transverse filaments from the posterior border of the transverse commissure.

The *posterior nerve-roots* (ρ) do not traverse the posterior columns in distinct bundles, like the anterior roots; but, on entering the cord, they split up into three kinds of fibres, which have been minutely described by Mr. Lockhart Clarke. (*Philosophical Transactions*, 1853.) The first kind enter the cord transversely, and pursue a transverse course through the posterior columns into the grey substance, where they bend on themselves at right angles, and pass, in a longitudinal direction, some upwards, others downwards, joining corresponding fibres from other roots above and below, and thus form a continuous longitudinal band in the *substantia gelatinosa* (η). From this band are derived many, if not all, of the antero-posterior nerve-fibres in the grey substance, which have been described.

A second kind of fibres traverse the posterior columns transversely, and expand themselves in the grey substance as the latero-transverse fibres, which have also been described.

The third kind of fibres enter the cord obliquely, and immediately spread out in different directions. Some fibres passing into the posterior cornua, whilst others diverge and take a longitudinal course, either downwards or upwards within the posterior white columns; but whether any of these latter are continued as far as the brain, is a question which has not yet been determined. Wagner regards them as purely sensitive fibres, which, without being connected with ganglionic cells in the spinal cord, pass directly upwards to the brain, and there excite sensation.

But experimental observations and pathological cases are not wanting to show that the anterior columns are not the exclusive conductors of the influence of the will to the anterior nerves, and that the posterior white columns are not the sole channels of communication between the posterior nerves and the brain.

With respect to the anterior columns, an explanation is afforded by the connecting links which have been described between the anterior roots and the longitudinal fibres in the anterior cornua; and a more obvious clue is given to account for the transmission of sensation—at least, as far as the spinal cord is concerned—by the course and distribution of the posterior roots, and by the longitudinal nerve-fibres contained in the grey substance.

Dr. Brown-Séquard has been led, by his experiments, to the conclusion, that the transmission of sensitive impressions to the sensorium takes place by both cells and nerve-fibres united together. (*Lectures on the Physiology and Pathology of the Central Nervous System*, delivered at the Royal College of Surgeons of England in May 1858, p. 23.) But the very objection which he admitted in opposition to Longet, who supposed that the sensorium received sensitive impressions only from the posterior columns, exists to a greater degree in respect of the notion that cells transmit such impressions.

The objection to the views of Longet was first pronounced by Dr. R. B. Todd, who contended that the posterior columns are not, as they should be, according

to the theory, larger, the higher they are examined in the spinal cord; but Mr. Lockhart Clarke has shown that the longitudinal fibres of the lateral columns, which contain sensitive fibres, do gradually increase as they ascend in the cervical region, and that the posterior cornua gradually become narrower. (*Philosophical Transactions* for 1851.)

On these anatomical considerations, therefore, together with others which have been stated, there is reason to infer that the ganglionic cells and their intermediate filaments transmit their influence across the cord, and that the longitudinal nerve-fibres are the conductors of impressions to and from the encephalon.

In the immediate neighbourhood of the origin of the fourth pair of cervical nerves (the phrenic), Mr. Lockhart Clarke traced the commencement of the spinal accessory nerves, some filaments of which proceed from cells in a network of minute blood-vessels on the outer part of the posterior cornua. After traversing the grey substance, they unite with others which originate from caudate cells in the anterior cornua, through which they pass upwards, in company with the roots of the anterior nerves, to the medulla oblongata. (*Philosophical Transactions*, 1851.) At about the same part the central canal begins to incline backwards. (See fig. 396 of the *Cyclopædia of Anatomy and Physiology*, vol. iii, p. 708; also, Schröder van der Kolk, *On the Medulla Oblongata*, plate II, fig. 2A.)

MEDULLA OBLONGATA AND MESOCEPHALE.

At the junction of the spinal cord with the medulla oblongata, the relative position of the elementary parts of the cord is changed.

The anterior columns thrust themselves backwards and upwards, pushing, as it were, the lateral and posterior columns aside, and become continuous with the corpora pyramidalia.

The transverse commissural band behind the central canal, connecting the posterior cornua of the cord, disappears, and thus it is that the posterior columns divaricate, and the canal terminates in the fourth ventricle.

The anterior cornua, following the backward direction of the columns, are eventually found immediately below the floor of the fourth ventricle, where, according to Stilling, the nuclei of the hypoglossal, the sixth, seventh, fourth, and third pairs of nerves are located, close to the middle line, and from which nuclei these several nerves derive their origin.

The two lateral and posterior columns, being thus pushed aside, pursue a forward and upward direction, and become continuous with the corpora restiformia which are situated on the sides of the medulla oblongata; but, turning from the higher parts of the medulla in a forward direction, they pass into the lower part of the pons Varolii. Here they diverge again, each restiform body passing through the middle of the crus cerebelli into the hemisphere of the cerebellum of the corresponding side, from whence other fibres pass into the processus cerebelli ad testem, overlying the fibres from the restiform body, and therefore composing the superior layer of fibres of the crus cerebelli.

The inferior layer is formed by fibres which pass from each hemisphere of the cerebellum transversely across the inferior surface of the mesocephale or pons, where they occupy the same relative position with respect to the fibres of the corpora restiformia, as they do in the crus cerebelli. These transverse fibres are the commissures of the cerebellum.

Together with the corpora restiformia there are two bundles of longitudinal fibres—the posterior pyramidal columns—which descend from the cerebellum on the inner borders of the restiform bodies, and form between them the fissure of the calamus scriptorius. These fibres resolve themselves into transverse or commissural fibres in the medulla oblongata.

The *Corpora Restiformia*, in their course through the medulla oblongata and mesocephale, contain the nuclei of the nerves of sensation, namely, of the vagus, the glosso-pharyngeus, the auditory, the sensitive roots of the trigeminus, and, as Van der Kolk has said, "We might even add the optic nerve from the corpora quadrigemina, and the olfactory, both of which arise more to the side of the middle line." (Schröder van der Kolk, *op. cit.*, p. 92.)

That the nerve-current of the corpora restiformia is an ascending one in the medulla oblongata, has been proved by the experiments of Dr. Brown Séquard, who, on cutting through one-half of the medulla, found that the portion of the corpus restiforme above the incision was deprived of sensation; and that there is an opposite direction of the molecular influence above the pons varolii appears equally well established by the experiments of Szokalski, who, on removing the cerebral and cerebellar connections from the pons, found that he had not destroyed the sense of feeling. Hence it is highly probable, as Schröder van der Kolk has suggested, that the seat of sensation is in or about the medulla oblongata.

The *Corpora Olivaria* consist externally of longitudinal fibres derived from the optic thalami and corpora quadrigemina, whence they may be traced backward through the mesocephale, on a plane superior to that of the corpora pyramidalia, to the grey vesicular matter of the corpora olivaria.

From the corpora ciliaria or dentata numerous fibres pass inwards to the nuclei of the hypoglossal nerves; and from these nuclei, as well as from every portion of the grey matter, transverse fibres pass through the raphe* to corresponding parts of each side. Thus the corpora olivaria are united in the middle between the corpora restiformia and the corpora pyramidalia.

The corpora olivaria are more highly developed in man than in any of the lower animals; and although the medulla oblongata bears some relation, as to its size, with the bulk of the entire body, yet is that size determined by the corpora restiformia and the corpora pyramidalia.

The nuclei of the hypoglossal nerves, however, and the corpora ciliaria, obtain their maximum of development in man; and Schröder van der Kolk argues that the delicate combinations of motion in the human tongue in articulation and speech, afford an explanation of the great size of the olivary bodies, and of their intimate connection with the nuclei of the hypoglossal nerves.

He has adduced some illustrative instances of atrophy of the corpora olivaria, and of structural diseases of those organs, to prove that they are subservient to the articulation of sounds. (*Op. cit.*, p. 149-169.)

Corpora Pyramidalia. From the corpora striata chiefly, and also from the optic thalami, numerous tubular fibres pass backward through the crus cerebri into the pons Varolii and medulla oblongata, where they constitute the corpora pyramidalia. In the pons or mesocephale these fibres immediately overlie the transverse fibres which have been described as passing from each hemisphere of the cerebellum. With the deeper seated of these latter, a curious interlacement occurs by the longitudinal fibres passing alternately above and below them; and in the meshes of this interlacement numerous patches of grey vesicular matter exist, but these latter are nowhere seen where there is no interlacement, as in the lowest and most superficial layer of fibres, which are exclusively transverse.

In their outward course, the fibres from the nuclei of the abducent and hypoglossal nerves, communicate

* The raphe is the seat of a very complicated decussation between the posterior halves of the medulla on the one hand, and between each of these and the corpora olivaria of opposite sides on the other.

by means of ganglionic cells with the fibres of the corpora pyramidalia.*

Towards the inferior extremity of the medulla oblongata, the fibres of the corpora pyramidalia are divisible into three distinct kinds. 1. The decussating fibres, which pass downward and backward into the antero-lateral columns of the spinal cord on the opposite side, so that the right pyramid sends fibres into the left side of the cord, and the left pyramid into the right side of the cord. These decussating bundles of fibres are doubtless the channels through which the mandates of the will are conveyed to the four extremities; and that they are so, is proved by the experiments of Dr. Brown-Séquard, who, on dividing the whole of these decussating fibres, produced entire paralysis of all the limbs. 2. A few fibres which are continued from the pyramids directly down to the anterior surface of the cord on the same side. These latter are continuous with the antero-lateral columns, and appear to serve the purpose of establishing a direct communication between each half of the medulla oblongata and the corresponding half of the spinal cord. 3. The arciform fibres, which curve round the corpora olivaria, and appear to incorporate themselves with the corpora pyramidalia in front, and with the corpora restiformia behind, and are thus the superficial connecting fibres between the anterior and posterior parts of the medulla.

In man, quadrumana, and carnivora, the corpora pyramidalia are larger in proportion to the size of the body than in hoofed animals, probably in consequence of the more varied motions of the fingers and toes.

[To be continued.]

NOTE ON THE LARYNGOSCOPE.

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My principal object in this communication is to bear my testimony to the value of the suggestions made by my friend Dr. George Johnson in the *Medical Times and Gazette* for February 14th, in relation to the use of the laryngoscope. Having myself tested the utility of these suggestions, I feel assured that they are calculated materially to facilitate the employment of the instrument, and to bring it into more general use. They will, I think, attain this end by enabling any one who is interested in the matter to obtain for himself, with very little trouble, that practical acquaintance with its manipulation which is absolutely necessary in order to obtain admission for it into the throat of his patients.

The position of the frontal mirror on the forehead is, unquestionably, a great improvement over the position hitherto directed by Czermak. Not only does it avoid the difficulty created by endeavouring to look through the central aperture in the mirror, but the adjustment of the mirror itself is far more readily effected, and the direction of the light is altered, according to the requirements of the particular case, with far greater facility when no obligation exists for maintaining a particular portion of the mirror opposite to the eye. Nor are these advantages gained at the cost of illuminating power.

But the most important part of Dr. Johnson's suggestion is that which presents so ready and effective a method for performing autolaryngoscopy, as that which is attained by the aid of the ordinary toilet looking-glass. By this method, a means of conducting the operation, which is always at hand, is substituted for the more costly apparatus of Czermak; and, what is of no small importance, the process of inspecting one's own throat is closely assimilated to that which we em-

ploy in examining the throat of our patients. By following his directions, I have been able, not only to exhibit to others my own vocal apparatus, but also to introduce them readily to the use of the instrument. In more than one instance, persons who have witnessed its employment for the first time, succeeded at once in using it upon myself.

I cannot yet boast of much experience; but, from the observations I have made, it has appeared to me that the practice of autolaryngoscopy affords the most effectual means of acquiring that facility in the use of the instrument which is requisite, not only to enable the operator to view the interior of the larynx, but also to obtain tolerance of the faucial speculum. So far as I have seen, the difficulty experienced by the patient depends to a very large extent upon the delicacy of manipulation possessed by the operator, and particularly on his success in avoiding contact between the throat-mirror and the posterior wall of the pharynx. Unless I mistake, it will be found that, by mastering the greater difficulty of autolaryngoscopy, our further progress will be materially advanced.

It need not be remarked, that some perseverance will be needed before a beginner can assure himself of success on his own person; and, no doubt, the difficulty will be greater in some persons than in others, from variations in the conformation of the parts concerned in the examination, and particularly from differences in the degree to which the epiglottis naturally conceals the parts below it; but a little experience will suffice to overcome the difficulty; and I think it will then be found that, as in morals, careful self-examination will advantageously precede the examination of other persons.

Two cases of laryngeal affection, which have lately presented themselves to me in the General Hospital, afford an interesting illustration of the gain in forming diagnosis which is offered to us by the laryngoscope. The subjects of these cases entered about the same time; each presented the ordinary symptoms of sub-acute laryngitis. In one, the symptoms were of a fortnight's duration; in the other, they had been present for a month, but with a brief interval of relief. Each patient had been exposed to the ordinary exciting causes of laryngitis. The last mentioned patient, however, was affected with advanced disease of the heart, and presented the rare phenomenon of a double mitral bellows-murmur. In this man, certain symptoms suggested a suspicion that the laryngeal affection might possibly depend rather upon some defect of innervation, than upon an inflammatory affection, but the evidence was too incomplete to warrant of itself the neglect of the ordinary treatment for laryngitis.

When the interior of the larynx was illuminated in these two men, a most striking contrast appeared in the condition of their respective vocal apparatus. In the patient last mentioned, the condition of the parts closely corresponded to that exhibited in Figs. 1 and 2, taken from my own throat. The glottis was widely open (Fig. 1) during tranquil respiration, so that the upper rings of

Fig. 1.—a a. Apices of Arytenoid Cartilages. b b. Vocal Cords.

the trachea were brought into view; the mucous membrane of the larynx and the vocal cords were perfectly healthy; and the cartilages of Santorini, indicating the situation of the apex of the arytenoid (a a) cartilages, were distinct. From time to time alternate movements of

* The nucleus of the hypoglossus and the passage of the fibres through the fibres of the corpora pyramidalia, are beautifully shewn by Sillig, in his illustrations of the Pons Varolii, plate III, h. u. P.