motor areas. A trephine circle removed from over the temporo-sphenoidal lobe gave exit to a quantity of pus, and the opening was then enlarged in the direction of the roof of the tympanum, and more pus evacuated. Drainage was established, and for a few days the patient improved, but continued to exhibit signs of basal meningitis, of which she died ten days after operation. On *post-mortem* examination extensive basal meningitis, with thick pus on the surface of the brain was found. The roof of the tympanum showed a limited erosion, but the lateral sinus was intact.

(b) A specimen of a HYDROCELE OF THE CORD removed intact, along with a tubercular testicle from a boy of three.

2. *Dr James Carmichael* exhibited the brain from a case of CERVICAL OPISTHOTONOS IN AN INFANT and accompanying photograph of the patient. The brain was found to show, in a very marked manner, the appearances usually found in such cases—chronic basal non-tubercular meningitis. The two adjacent lobes of the cerebellum were adherent to each other and to the back of the medulla oblongata, so that the outlet for the cerebro-spinal fluid through the foramen of majendic was completely closed, producing an acquired hydrocephalus. The infundibulum was distended, and formed an ovoid tumour about the size of a large cherry, which had stretched the optic chiasma and atrophied it. The case showed opisthotonos in an extreme degree for a fortnight before death.

III. LANTERN DEMONSTRATION

Dr Alexander Bruce gave a lantern demonstration illustrating the endogenous fibres in the lumbo-sacral region of the cord.

IV. ORIGINAL COMMUNICATION

1. ON THE ENDOGENOUS OR INTRINSIC FIBRES IN THE LUMBO-SACRAL REGION OF THE CORD

By ALEXANDER BRUCE, M.A., M.D., F.R.C.P. Ed., &c., Assistant Physician to the Royal Edinburgh Infirmary, Lecturer on Pathology at Surgeons' Hall

FOR a number of years after it was ascertained that the posterior columns of the spinal cord were composed of two great tracts—an internal (column of Goll or postero-median

PLATE I.—TO ILLUSTRATE DR BRUCE'S PAPER ON THE ENDOGENOUS FIBRES OF THE CORD.

FIG. 7.

FIG. 8.

FIG. 9.

PLATE IV.—TO ILLUSTRATE DR BRUCE'S PAPER ON THE ENDOGENOUS FIBRES OF THE CORD.

column) and an external (column of Burdach or postero-external column)—it was generally supposed that these two tracts were found in the lumbar and sacral regions as well as in the cervical and dorsal portions of the cord, in which they were first described. Some text-books of anatomy and nervous diseases still make this statement, or if they do not do so directly, at least leave this opinion to be inferred. It has gradually, however, come to be recognised that this view is erroneous, and that in the lumbar and sacral regions it is not possible to separate a distinct postero-median column from a postero-external column in the same manner as can be done in the dorsal and cervical regions in cases of ascending degeneration. The differentiation of the two tracts does not become completed until the level of the eleventh dorsal segment is reached. Below this level the long, intermediate, and short ascending fibres (of Singer and Münzer) are intermingled, since the long fibres which pass from the lower posterior root ganglia to the medulla have not yet all reached the position near the posterior median septum which they ultimately occupy when they enter the postero-median column. In the second place a considerable proportion of the fibres of the column are not continuous with the posterior roots, but are derived from nerve-cells in the grey matter of the cord itself. These fibres have been termed by Marie *endogenous* fibres, and it is to these that this article is devoted.

These *endogenous* fibres form two very well-marked tracts, one lying in the anterior part of the posterior column in close apposition to the posterior cornu, commissure and septum; the second in immediate relationship to the posterior median septum, and in part to the surface of the cord. The former of these has been termed by Marie (1) the *cornu-commissural tract*, to indicate that it was regarded as connecting different levels of the grey matter of the cord. The German title dorsales Hinterstrangsfeld, indicates its topographical relations. The second tract has been termed by Dr Muir and myself (19) the *septo-marginal tract*, the name being designed to indicate its relationship to the posterior median septum, in the same manner as the sulco-marginal tract of Marie is related to the anterior median sulcus. Obersteiner has also termed this tract the dorso-median sacral bundle (dorso-medianes sacral-Bündel) and Edinger has called it the medianes Hinterstrangsfeld.

In order that a set of fibres may be regarded as of endogenous origin, there must firstly be an absence of degeneration in it when the posterior roots (or exogenous fibres) are divided or destroyed ; and (secondly) it should itself degenerate when that portion of the grey matter from which it arises is atrophied or softened. These two conditions hold good in the case of both of the tracts mentioned.

The *cornu-commissural tract* is spared in locomotor ataxia (which is now by very many neurologists recognised as a disease of the posterior roots), even in its advanced stages, and in injury to or compression of the cauda equina. On the other hand, it is found to undergo degeneration in conditions which lead to the atrophy or degeneration of the cells in the posterior cornu. Thus Ehrlich and Brieger, and Singer and Münzer (4), after causing necrosis of the nerve-cells of the lumbo-sacral region by compression of the abdominal aorta, and thus cutting off their blood supply, found a distinct but somewhat diffuse degeneration throughout the whole of the posterior columns, but most marked in the anterior part of these columns. In pellagra, which is regarded as a disease of the grey matter of the cord, Tuzek (10) and Marie (1) found it distinctly affected. Still more recently Schlesinger (11) has shown that it is frequently degenerated in syringomyelia, a disease which tends to destroy the grey matter, especially that portion of it in proximity to the central canal. Lastly, Fajersztajn (9) has shown that it is composed of fibres of short course, the majority of which have a descending direction. On the other hand, Déjérine and Spiller (7) maintain that it contains a considerable number of ascending fibres derived from the posterior roots.

Sections derived from advanced cases of locomotor ataxia are particularly well suited for the study of this tract. When these are stained by Weigert-Pál's method it stands out with great distinctness against the degenerated fibres. It extends through the whole of the lumbo-sacral region of the cord, being traceable from the lowest dorsal segment to the extreme tip of the conus medullaris. It attains its greatest size at the level of the lower lumbar region, and diminishes somewhat rapidly above and more gradually below this level. Throughout its whole longitudinal extent it stands in close relation to the posterior commissure, and (except perhaps in the lowest sacral

segment) to the anterior part of the inner margin of the posterior cornu. Its inner margin, below the third lumbar segment, lies in contact with the posterior median septum. Above this it becomes gradually displaced outwards by the ascending fibres of the posterior roots of the lower spinal nerves, as they pass upwards to enter the postero-median column. When this latter column is fully developed, *e.g.*, at the level of the eleventh dorsal segment, what remains of the cornu-commissural tract is displaced from the septum completely, and also from that portion of the posterior commissure which lies immediately in front of the tip of the postero-median column. Posteriorly the tract has no definite margin. Its outer portion merges gradually into the part of the column behind it (the so-called middle root-zone of Flechsig), while in the neighbourhood of the septum, below the level of the first sacral segment, its inner portion becomes fused with the septo-marginal tract, in such a way that in sections derived from ataxia it cannot be determined where the one ends and the other begins.

A fuller idea of the topographical relations of the tract may be obtained by a study of Figs. 1 to 9, which have been made from careful drawings of Weigert-Pal's sections of an advanced case of ataxia. It will be seen from these that at the fifth sacral segment (Fig. 9), the tract is in contact with the posterior commissure and the anterior part of the septum, but that it does not quite reach the cornu, being separated from it by a narrow area of degenerated fibres. Posteriorly it passes, without any line of demarcation (Fig. 9), into the septo-marginal tract, appearing to form with it a continuous tract extending from the commissure to the periphery.

At the fourth sacral segment (Fig. 8), the external margin has reached the cornu and extends along it backwards as far as the gelatinous substance of Rolando. The other relations are unaltered. The tract is not yet of any great extent, and the apex of the column is narrow and pointed.

In the upper sacral segments (Figs. 7, 6, 5), the tract has considerably increased in size. The external margin extends further backwards along the posterior cornu, and the inner border passes along the septum to become fused with the septo-marginal tract.

At the fourth and fifth lumbar segments (Figs. 4 and 3),

at which levels, as already stated, the tract seems to have attained its maximum size, the inner margin does not extend so far along the septum, and is now distinctly differentiated from the septo-marginal tract. This latter is now limited to a small area at the posterior half of the septum. The separation of the two tracts seems to be effected by the ascending (in this case degenerated) fibres of the posterior roots, which are becoming applied to the septum in their passage upwards to aid in the formation of the column of Goll. As additional fibres from the posterior roots become applied to these at higher levels (upper lumbar, Fig. 8), the separation of the cornu-commissural and the septo-marginal tracts gradually increases (as in ataxia these root-fibres are degenerated the intervening space is paler than either of the tracts in question). The cornu-commissural tract is also displaced outward, till at the twelfth and eleventh dorsal segments (Fig. 1), it comes to form a narrow band bordering the posterior commissure and grey matter of the posterior cornu.

Above this level it is not easy to distinguish it as a distinct tract, but it apparently diminishes rapidly in size. The fibres which compose it can be seen entering it from the grey matter of the posterior cornu, and almost exclusively from that of the same side.

The *septo-marginal descending tract* also remains undegenerated in ataxia, and its position very closely corresponds to the area of fibres which Dr Muir and I (19) found to degenerate after a crush of the cord at the level of the upper lumbar segments. In this case very little degeneration was found in the cornu-commissural tract, an evidence that the greater part of the fibres of the latter arise below this level, while many of the septo-marginal tracts have a higher origin. This is in agreement so far with Hoche's observations as to the high origin of the tract. (The lesions in Hoche's cases were respectively below the level of the eighth cervical, and between the fourth and fifth dorsal segments (14).) It also enables us to indicate where the septo-marginal and cornu-commissural tracts meet each other. The fact that it has degenerated in a downward direction, renders it quite certain that it is not an upward continuation of posterior root fibres, and this has been corroborated by the observation of Pineles (23), that it remains unaffected in ataxia affecting the sacral segments. It stands out from the

degenerated fibres in the lumbo-sacral portion of the cord even more distinctly than does the cornu-commissural tract.

At the level of the lowest sacral root (Fig. 9), the undegenerated area in question is situated at the postero-internal angle of the posterior column. It forms a racquet-shaped area, or a triangle with the edges rounded off, two of its sides being applied to the posterior median septum, and to the periphery respectively, and the third forming a somewhat indefinite margin between the degenerated and undegenerated parts of the cord, which at this level are not sharply differentiated from each other. The anterior angle of the tract seems to merge into the undegenerated area lying in the anterior part of the column;—the cornu-commissural tract. The remainder of the posterior columns is not so degenerated as at higher levels, so that the healthy areas do not stand out so clearly. In the next segment, the fourth sacral (Fig. 8), the tract has greatly altered. It has become narrower, and much elongated antero-posteriorly. In the greater part of its extent it forms a very narrow band along the posterior median septum, which as it nears the periphery, suddenly widens out into a club-shaped head. This head is rendered more prominent by the apparent shrinkage of the degenerated areas of the column, which produces a retraction of this part of the periphery of the cord from which the rounded club-like head of the tract projects boldly, the depression thus formed in the outline of the cord being filled in by the connective tissue and vessels of the thickened membranes. It is seen in the illustration as a pale area on the outer side of the projecting head. At this level the undegenerated area is very distinctly marked off from the remainder of the column. In the third sacral segment (Fig. 7), there is very little change in the appearance of the tract, what change there is being in the shape of the head. This, instead of being rounded, is almost pointed, like the head of a broad spear, and projects further beyond the remainder of the column than in the former section. The recession of the periphery is deeper and more angular, and is as before, filled up by the thickened membranes. In this, as in the previous sections, the anterior end of the tract becomes merged in the fibres of the undegenerated cornu-commissural tract.

At the level of the upper sacral segments (Figs. 6 and 5), the tract has become distinctly larger, the band along the pos-

terior median fissure being broader and the head also larger. The head still retains its pointed appearance, but does not project beyond the general line of the periphery of the cord: the angular depression at its outer side is still filled up by connective tissue. The tract continues to be sharply differentiated from the remainder of the column and to merge in the cornu-commissural tract anteriorly.

When the fifth lumbar segment is reached (Fig. 4) there is again a great change in the appearance of the tract. It has greatly diminished in extent, now occupying only about a third of the length of the posterior median fissure instead of the greater part of the length; and, further, it no longer reaches either the cornu-commissural tract or the periphery of the cord, but forms a narrow tract, with a rounded posterior extremity and tapering to a point anteriorly. Roughly speaking, the shape resembles that of an Indian club. The broad posterior end bulges somewhat toward the posterior median septum, beyond the general surface, and a small interval is thus formed behind it, between the two posterior columns; this is filled up by connective tissue as in the previous sections. At this level the tract corresponds fairly closely to the "oval field" of Flechsig.

In the fourth lumbar segment (Fig. 3) the tract is further diminished in size, and altered in position. It has passed backwards again, and forms an angular band outlining the postero-internal angle of the cord, one limb being placed along the periphery, the other along the posterior median septum for rather less than a fifth part of its extent. The tract is thus separated by a considerable interval from the cornu-commissural tract, which is well marked at this level.

In the segment above this, the third lumbar (Fig. 2), the tract is still diminishing. It is no longer applied to the posterior median septum in any of its extent, but forms a very small, narrow band, of which one extremity touches the middle line, the other terminates gradually a short distance along the periphery. The tract has now become scattered, with no very definite line of separation from the degenerated areas.

The final position taken up by the tract is seen at the level of the twelfth dorsal segment (Fig. 1). Here the tract is represented by a small group of fibres, somewhat triangular in shape, placed at the periphery of the cord, about

one-third of the distance from the middle line to the posterior roots. The fibres are few in number, but constitute a perfectly well defined tract seen in many successive sections. Lying anterior and external to it is an area containing more diffusely scattered healthy fibres.

The tract cannot be traced clearly higher than this level in cases of locomotor ataxia, but Hoche's case of degeneration after a lesion in the lowest cervical segment (14) has proved that it may originate as high as this. Above the eleventh dorsal segment, however, it appears to become diffused within the hinder part of the postero-external column, and is therefore not so easily followed as at lower levels. The evidence as regards its origin is still thus insufficient, and it can only be said at present that the tract originates in part in the higher segments of the cord, gains greatly in bulk about the level of the first sacral segment, and terminates in the lower sacral and the coccygeal region, by sending fibres forward along the posterior median septum into the grey matter near the central canal where they are lost amongst the other fibres in this part. The endogenous nature of many of its fibres is proved by the fact that in the case of ataxia described by the writer, there was a great accession to the number of its fibres at the first sacral segment, in spite of the almost complete degeneration of the posterior roots for some distance above and below this level.

It is very probable that at one part of its course, *i.e.*, in the lower lumbar segments, the tract corresponds to the "oval field" described by Flechsig, since at this level it occupies a small area close beside the posterior median septum and at some distance from the periphery, which when taken together with its fellow of the opposite side is oval in form. The discrepancies in the descriptions given by the various authors as to the exact level at which this oval field appears are no doubt due in part to differences in the situation and nature of the lesion and in part to the different methods of staining employed. This also applies to some other slight differences in the descriptions.

The tract is undoubtedly mainly a descending one, but Déjérine and Spiller have concluded that it also contains some fibres which degenerate upwards after injury to the cauda equina. This is very probable, but there are as yet

so few cases on record in which this tract has been accurately described, that on this and on many other points it is quite impossible as yet to form a definite conclusion.

As regards the cells from which the cornu-commissural and the septo-marginal tract are derived, it is not possible as yet to make a definite statement.

Cajal first showed that in the chick some cells of the posterior horn sent their axis-cylinder processes to the posterior columns, and Lenhossek has been able to demonstrate similar cells in the guinea-pig, etc., as well as in the human embryo. They are situated at the base of the horn and in the Rolandic substance. None of the cells of Clarke's column send their processes to the posterior column.

With regard to the function of these two tracts nothing definite can be stated further than that they are longitudinal and commissural in character. Their position strongly points to their being connected with the lower organic reflexes.

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DESCRIPTION OF PLATES.

The lettering is the same throughout.

c.c. = Cornu-commissural tract.

s.m. = Septo-marginal tract.

The figures are reproduced from drawings of the posterior columns made by Dr Jessie M. MacGregor.

FIG. 1.—Level of twelfth dorsal segment.

FIG. 2.—Level of third lumbar segment.

FIG. 3.—Level of fourth lumbar segment.

FIG. 4.—Level of fifth lumbar segment.

FIG. 5.—Level of first sacral segment.

FIG. 6.—Level of second sacral segment.

FIG. 7.—Level of third sacral segment.

FIG. 8.—Level of fourth sacral segment.

FIG. 9.—Level of fifth sacral segment.

Meeting XI.—July 7, 1897

Dr ARGYLL ROBERTSON, *President, in the Chair*

I. ELECTION OF MEMBER

Dr J. Frank Crombie, North Berwick, was elected an Ordinary Member of the Society.

II. EXHIBITION OF PATIENTS

1. *Dr William Stewart* exhibited a patient after operation for DRAINAGE OF DILATED LATERAL VENTRICLE. A full account is given of this case in Dr Stewart's paper read at this meeting.

2. *Dr Norman Walker* exhibited—

(a) The case of SCLERODERMA exhibited for him at the previous meeting. In the various journals he saw that he was reported to have said that the disease was getting well under thyroid. He had not intended to give this impression. Certainly the case was improving, but to what the improvement was due he was not prepared to say. During the past month Dr Laing had kindly taken the case under his charge for thorough massage, and the results were remarkably good; especially where the process was deep, and the whole of the