

NOTES ON THE ARRANGEMENT AND FUNCTION OF THE
CELL GROUPS IN THE SACRAL REGION OF THE
SPINAL CORD.*

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ABSTRACT.

The study of the group arrangement of the nerve cells of the spinal cord has been a rather neglected subject. This refers quite especially to the sacral region, and yet this part of the spinal cord presents so striking peculiarities in the grouping of its nerve cells that it is strange that so little attention has been paid to them. Of the few authors who have contributed to this subject Waldeyer¹ takes an important place. In his classical work on the spinal cord of the gorilla he refers extensively to the distribution of the cell groups in the sacral region, but he says nothing in regard to their functions. Recently Müller in a monograph issued from Strümpell's clinic² has given suggestions concerning the function of a certain cell column ("vegetative cell column") in the middle sacral region, which suggestions partly coincide with those to be brought out in this paper. However, he touches upon this point more as upon a side issue and not in a sufficiently exhaustive manner. Of recent authors I further mention Van Gehuchten and de Buck,³ and Sano,⁴ who from a study of the chromatolytic changes occurring in anterior horn cells of the lumbar and sacral regions after amputations, have formulated definite conclusions regarding the functions of certain cell groups of the lumbo-sacral region. I shall have occasion later on to return to this point, and shall now give briefly the results of my researches which were conducted at the Pathological Institute of the N. Y. State

* Read before the American Neurological Association, June 15, 1899.

¹Waldeyer: "Das Gorillarückenmark." *Abhandlungen der Berliner Academie*, 1886.

²Müller: *Deutsche Zeitsch. für Nervenheilkunde*, 1898, Vol. 14, p. 1.

³Van Gehuchten and de Buck: *Journal de neurologie et d'hypnologie*, 1898, p. 94.

⁴Sano: *Journal de neurologie et d'hypnologie*, 1897, pp. 253 and 274.

Hospitals, and a more extensive report of which will appear in the *Archives of Neurology and Psychopathology*.

First some remarks regarding the gross structure of the gray matter of the sacral region:

In studying the sacral portion of the spinal cord from above downwards, we find that at the level of the second sacral segment the configuration of the gray matter undergoes rapid and marked changes, to which Waldeyer¹ has already called attention. They consist:

I. In a remarkable widening, in dorso-ventral direction, of the gray commissure in general, and of that part of it in particular which lies dorsad of the central canal. This latter condition, namely, the widening of the retrocentral part of the commissure is due to

II. A coalescence of the bases of the posterior horns; therefore the non-united remainder of each posterior horn appears very short, consisting only of the head and a small neck.

III. A very marked reduction in the size of the anterior horns, chiefly in dorso-ventral direction.

IV. Widening of the central canal in dorso-ventral direction, so that on the transverse section it appears as a long fissure directed dorso-ventrally.

The morphological transformations of the gray matter occurring in the conus terminalis need not be dwelt upon. Another point, however, needs mentioning. No actual lateral-horn formation is found in the sacral region of the cord. The marked projection which is seen at certain levels, in a position corresponding to the lateral horn, is not homologous to the lateral horn of the dorsal levels; for it is occupied by a group of large cells of the characteristic anterior-horn type, while the lateral horn of the dorsal levels contains a group of small cells known as the lateral-horn group or tractus intermedio-lateralis. But although an actual lateral-horn formation is absent in the sacral portion of the cord, this region contains nevertheless a group homologous to the lateral-horn group or tractus intermedio-lateralis of the dorsal region. (But of this later.) In concluding, it is interesting to remark that owing to the morphological transformation mentioned, the configuration of the gray matter of the first sacral segment resembles much more

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Arrangement of the cell groups of the sacral region :

The cell groups of the sacral region may be conveniently classified into (1) Anterior-horn groups and (2) groups or cells which are not of the anterior-horn type.

1. The anterior-horn groups.

The adjoining diagram gives an idea of the anterior-horn groups found in the sacral region, showing approximately their relative size at the various sacral levels and their extent in cephalo-caudal direction.

Some explanatory remarks may be desirable regarding the post-postero-lateral group. At the level of the first sacral segment three lateral anterior-horn groups are found: the antero-lateral, the postero-lateral and the post-postero-lateral. At the level of the second sacral segment the antero-lateral group disappears and the group "X" arises in its place, moving slightly mesiad. The postero-lateral group grows smaller, moves forward and becomes *de facto* antero-lateral. The post-postero-lateral group becomes situated dorsad of the postero-lateral group, thus being actually postero-lateral in its position.

While the antero-lateral, the postero-lateral and the post-postero-lateral groups consist of large multipolar cells, the elements constituting the group "X," although also multipolar, are characterized by their relatively small size and their rather densely packed arrangement.

2. Groups or cells which are not of the anterior-horn type.

(a) Scattered large cells at or near the base of the posterior horn.

(b) A cell formation which I propose to call the vegetative cell column (See Fig. II), and which can be subdivided into a lateral and central division. The lateral division may often be divided into a dorsal and a ventral part. The lateral division of the vegetative cell column corresponds apparently to the tractus intermedio-lateralis. The central division is probably identical with the paracentral group which Dr. Joseph Collins and I described in a monograph on the representation of the sympathetic nerve in the spinal cord and medulla oblongata, which will be published in the *Archives of Neurology and Psychopathology*, and an abstract of which has appeared in the *JOURNAL OF NERVOUS AND MENTAL DISEASE*, 1898, p. 661.

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of the group "X" which is almost typical for this segment, although it extends slightly also into the distal part of the first and the proximal part of the third sacral. The distal part of the second sacral segment is recognized by the appearance of an antero-mesial group which is absent in the proximal part.

The third sacral segment shows off by the presence of two mesial groups, namely, an antero-mesial and a postero-mesial, and by the marked and typical development of the vegetative cell column, especially of its central division.

In the fourth sacral segment the anterior-horn groups are practically gone, the mesial ones, and especially the postero-mesial group being the last one found. The anterior horn is beset with a great quantity of small cells. The lateral division of the vegetative cell column is still rather well developed, contains a considerable number of larger cells, and shows a tendency of extending all along the lateral border of the neck and head of the posterior horn.

In the fifth sacral segment it is chiefly the shape and size of the gray matter that distinguishes it from the fourth sacral, the anterior horn having become very short. Still further caudad the gray matter changes its aspect altogether.

Suggestions regarding the functions of the cell groups in the sacral region of the spinal cord.

I give here only the conclusions arrived at:

(1) Function of the antero-lateral, postero-lateral and post-postero-lateral groups: These three groups are evidently presiding over the muscles of the lower extremities, to judge from analogy with the cervical region, and from the researches of Van Gehuchten and de Buck,³ and Sano.⁴

(2) The antero-mesial groups is evidently the continuation of Kaiser's⁵ nucleus of the back muscles which, he finds, extends as a mesial column throughout the length of the spinal cord.

(3) The postero-mesial group is probably the nucleus for the perineal muscles, and probably the center for the spincters ani et vesicæ forms part of this nucleus.

(4) The group "X" possibly, or even probably, is a center

⁵Kaiser, O.: "Die Funktionen der Ganglienzellen des Halsmarkes." Prize essay, Hague, 1891.

for some of the striated muscles which co-operate in the acts of erection and ejaculation, especially the ischio-cavernosus or the erector clitoridis, and the bulbo-cavernosus or the sphincter vaginæ muscles.

(5) The cell column "veget" or vegetative cell column, in conformity with its strong development in the third sacral segment, is evidently a motor and vasomotor representative of important vegetative functions located in this and the fourth sacral segment, to the extent to which these functions are performed by means of non-striate muscles, namely: the function of emptying the bladder (detrusor vesicæ muscle), that of erection and ejaculation, of emptying the rectum and (in case of pregnancy for instance) probably also of emptying the uterus.

· Müller's article appeared after my researches had already been completed and their full report sent in for publications.

151. UEBER "SPRINGENDE PUPILLEN" IN EINEM FALLE VON CEREBRALER KINDERLÄHMUNG, NEBST EINIGEN BEMERKUNGEN ÜBER DIE PROGNOSTISCHE BEDEUTUNG DER "SPRINGEN DEN PUPILLEN" BEI NORMALER LICHTREACTION (Concerning "springende Pupillen" in a Case of Infantile Cerebral Paralysis with Some Remarks on the Prognostic Value of "springende Pupillen" Associated with Normal Light Reaction). W. Koenig (Deutsche Zeitschrift für Nervenheil kunde, Vol. 15, Nos. 1 and 2, p. 122).

By "springende Pupillen" is meant a condition in which mydriasis is seen first in one eye, then in the other, so that the relative width of the two pupils varies frequently. Koenig has observed this condition in a case of infantile cerebral paralysis, the first case of the kind on record. This variation in the width of the pupil has been regarded as an ill omen; Koenig thinks:

1. It is rare, but occurs with pupils reacting normally as well as pathologically.

2. It has been observed chiefly in organic diseases of the central nervous system, more rarely in functional diseases of this system, and very seldom in perfect health.

3. It is of prognostic value only when the reaction of the pupil is normal.

4. It is not necessarily a bad omen when the pupillary reaction is normal and no signs of organic nervous disease are present. It may, however, be an early sign of parietic dementia.

5. Differences in the intensity of reaction of the pupils, especially unilateral rigidity of the pupil, may lead to a mistaken diagnosis of "springende Pupillen."

SPILLER.