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Measurement Studies on the ILN in Cat Spinal Cord

(ILN/spinal cord)

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In this study, the rostro-caudal localization of the perikaryons of the intermedio-lateral nucleus (ILN), examination of the cytoarchitectonics and measurement of the short diameters of the cells are measured. For this purpose, serial transverse sections 6 cats and serial sagittal sections 2 cats of the spinal cord were stained with Klüver-Barrera ; the Golgi-Cox method was also used (2 cats).

Results were as follows :

1) The ILN neurons were found to extend from C_8 to L_4.

2) The cells in the ILN were grouped rostro-caudally (i. e. longitudinally) especially those in the T_2, T_3 and T_5-T_{10} segments.

3) The cells in the ILN could be classified into three types :
A) multipolar large cells : about 30μ. B) small round cells : about 10μ.
C) spindle form cells : 10−30μ.

4) No difference in cell number between each half of the neurons could be observed.

5) The total neuron number ranged from 10,000 to 17,000 in each half.

6) The average number of neurons in one segment was about 700.

Ever since Clarke(1) first identified the intermedio-lateral nucleus (ILN) in several species as a column of neurons extending from the spinal accessory nucleus to the lumbar spinal cord, it has been referred to as the Seiten Horn Gruppe (Stilling 1851) or the Seiten Horn Zellen (Waldiyer 1888).

The localization and longitudinal extent of the ILN in the cat have been reported upon (2, 3, 5, 6).

Gaskell(7), in studying degeneration of the ILN fibers, surmised the presence of sympathetic preganglionic neurons in the ILN and in the axons extending from the ILN through the ventral roots via the white comissure into the truncus sympathicus.

Polijak(8), using the Golgi-Cox method, revealed that the axons of the ILN flow out through the ventral roots.

The main object of this study was measurement. No additional information was available on the relation between neuron function and the collateral or prevertebral ganglions.

MATERIALS AND METHODS

Ten cats (0.6 to 5.1 kg) were anesthetized and perfused with 10% formol solution. That cats sufferd no disease of the CNS.

The spinal cords were removed and fixed in 10% formol-saline for at least one month.

After fixation, the dura mater were removed, each segment was marked, and the spinal cord were cut out into small wedges of tissue which were C_7 to L_5, total number being 20 blocks (Fig. 1 and Table I).

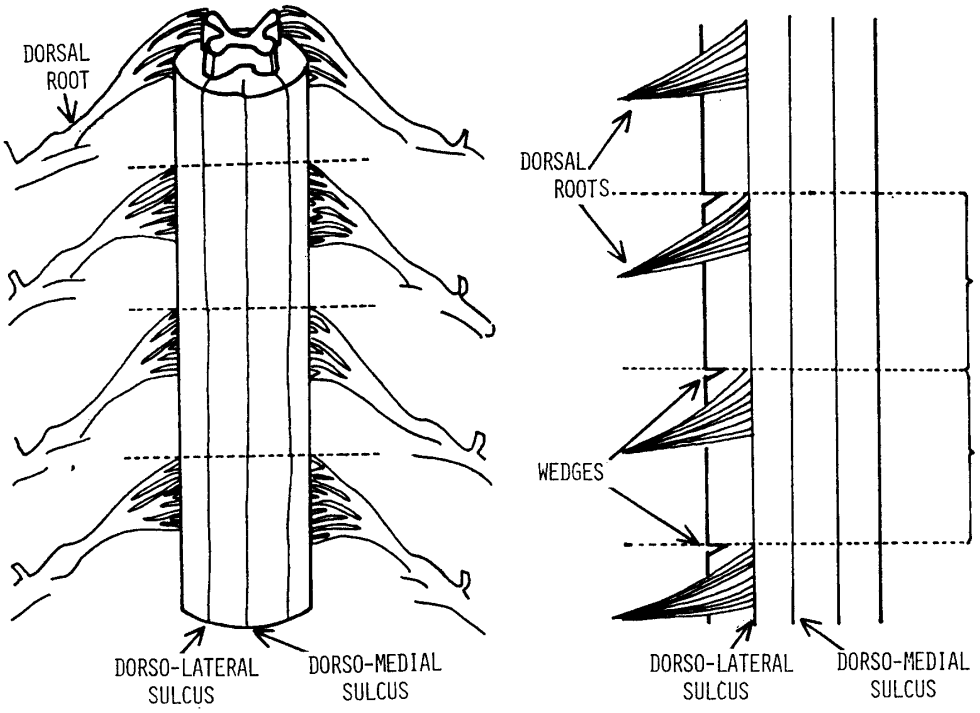

Fig. 1. Cutting planes in the spinal cord.

TABLE I. *Materials*

Cases	Sex	Body weight	Serial sections	Staining
1	M	4450(g)	Trans.	Klüver-Barrera
2	M	5100	〃	〃
3	M	3700	Sagitt.	〃
4	F	950	Trans.	Silver impregnation method (Suzuki)
5	M	3400	〃	Klüver-Barrera
6	F	1350	〃	〃
7	M	4250	〃	〃
8	F	4900	〃	〃
9	M	900	〃	Golgi-Cox
10	F	600	Sagitt.	〃

Staining

Embedded in paraffin, the spinal cords were cut into 10μ sections transversely (6 cats) and sagittaly (2 cats) and stained with Klüver-Barrera. The Golgi-Cox method was also used.

Counts and Sizes of the ILN Neurons

The neurons of every tenth section were counted in search of this numerical differences on the left and right sides of the intermedio-lateral nucleus. Then, the mean numerical value of the left side neurons (ILN) in every transverse section was calculated.

To avoid overlap in counting the neurons, the nucleoli of the ILN were counted. Furthermore, the sizes of the neurons were determined by measuring their short diameters with a stage micrometer.

This measurement proves to be the most accurate.

Criteria for the Identification of ILN Neurons

The ILN neurons were observed within the lateral horn which is a fingers-like projection of the gray matter. The ILN neurons are easily differentiated from the other neurons in the neighboring structures.

The ventral border is usually distinct as the ILN and the ventral horn neurons are different in size.

The neurons in the dorsal horn are small and are scattered all over and rather than grouped ; their medial border is occasionally difficult to establish, but they are clearly separated from ILN neurons which are grouped.

RESULTS

Neurons Number

To see whether a difference in neuron number between the left and right sides of the intermedio-lateral nucleus could be seen or not the number of the neurons of every tenth section (3,430 specimens) were counted.

However, the right side mean was 5,175 and the left side mean was 4,878.

Therefore, they did not show a significant difference of $p<0.05$ (Fig. 2 and Table II).

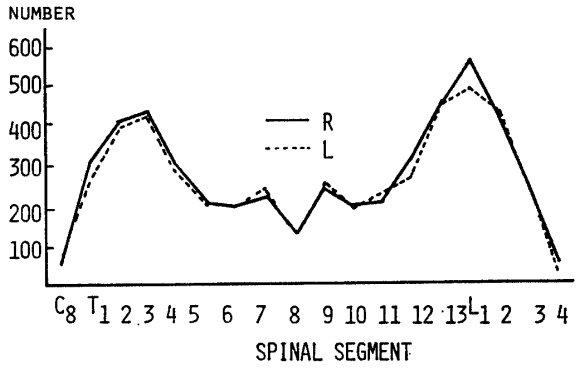

Fig. 2. Comparison between right and left sides in the ILN.

TABLE II. *Number of the ILN in the Right and Left Sides*

Segment	R	L	Sections
C_8	50	69	110
T_1	307	255	130
T_2	403	389	130
T_3	437	410	230
T_4	290	277	120
T_5	222	207	190
T_6	219	218	160
T_7	236	249	140
T_8	139	127	180
T_9	269	271	240
T_{10}	202	201	250
T_{11}	228	242	260
T_{12}	329	264	250
T_{13}	475	472	240
L_1	563	497	240
L_2	412	444	260
L_3	254	249	180
L_4	69	37	120
Total numbers	5173	4878	3430

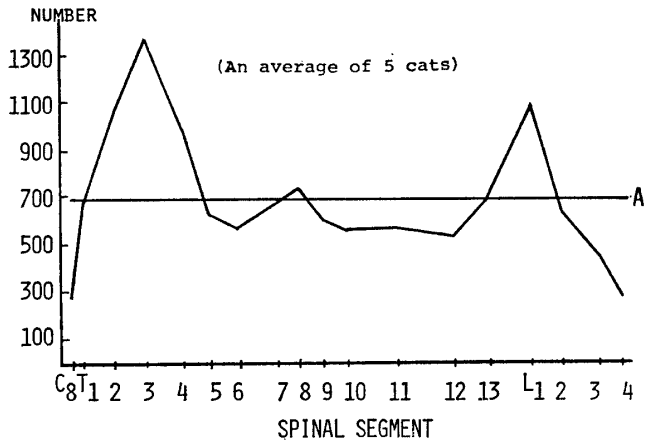

Fig. 3. Number of the sympathetic cells in the ILN.

For this reason, the number of neurons in each section was determined by counting only the nucleoli in the left ILN neurons at a magnification of 400× using a Nikon microscope.

In using the spinal cords of 5 cats, the accuracy of this method could be clearly observed. The total neuronal counts ranged from 9,994 (cat No. 6) to 17,547 (cat No. 5).

Those of cats No. 2 and No. 9 were 12,296 and 12,131, respectively.

Those values were in the mid-range.

The number of ILN neurons was found to vary considerably from segment to segment, with the highest counts occuring in segments T_3, T_8 and L_1.

The counts of the ILN neurons in one segment in 5 cats is averaged in Fig. 3. A-line is average in one segment of ILN neuron number.

Classification of the ILN Neurons

After the short diameters of the neurons had been measured with a stage micrometer, the ILN neurons were classified into three types with a measurement study using Golgi-Cox and Nissl staines.

Type A : the short diameter is over 20μ and the cell is multipolar ; the axons are long and the Nissl substances are gross and dense.

Type B : the short diameter is 11. 1μ to 20.0μ and the cell is nearly piriform ; the axons are long and the Nissl substances are gross but not dense.

Type C : the short diameter is under 11. 1μ and the cell is small and round ; the axons are shorter than those of the other cells but they extend from the gray matter into the white matter.

These three types would be classified as Golgi Type I ; their counts are shown in Fig. 4.

DISCUSSION

The autonomic ganglia which have a wide distribution in the visceral periphery, may be classified in three groupes ;

1) The paravertebral, which are arranged in a segmental fashion along the anterolateral surface of the vertebral column and are connected with each other by longitudinal fibers from the two sympathetici.

2) The prevertebral, which are irregular aggregation of cells found in the mesenteric neural plexuses surrounding the abdominal aorta and its larger visceral branches.

3) The terminal are parasympatheticus, according to Carpenter (1972).

Cells originating in the pregangilonic fibers are present in the ILN.

These axons enter the truncus sympathicus. The shortest axons enter the truncus sympathicus and terminate in the ganglion of truncus sympathicus.

The longest axons enter the truncus sympathicus and ascend to the ganglion

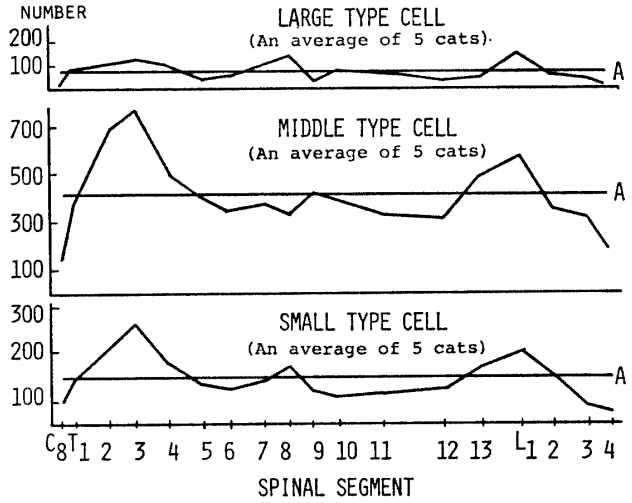

Fig. 4. Distribution of ILN neurons in spinal segment.

cervicale superior or descend to the lowest ganglion of the truncus sympathicus.

The highest neuron counts were found in segment T_2—T_3, and L_1.

From the results of rostro-caudal counting, three peakes, α, β and γ, were detected (Fig. 4).

The type A axons consisting of peak α enter the truncus sympathicus and ascend to ganglion cervicale superior. The type A axons consisting of peak γ enter the truncus sympathicus and descend and terminate in ganglion trunci sympathici. The type A axons consisting of peak β pass through the truncus sympathicus and into the collateral ganglion. Type B axons consisting of peak α ascend in the truncus sympathicus and end in the ganglion trunci sympathici. The type B axons consisting of peak β ascend or descend, and in the ganglion trunci sympathici. The type B axons consisting of peak γ descend in the truncus sympathicus and end in the ganglion trunci sympathici.

The type C axons end in the ganglion trunci sympathici which is at an equal lebel with the spinal segment.

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