STRUCTURE OF THE CROSSED NERVOUS CONNECTIONS IN THE REGION OF THE SOLAR PLEXUS OF THE ALBINO RAT

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The problem of the relationship of the greater splanchnic nerves to the ganglia of the solar plexus in mammals has received little study. The number of experimental morphological investigations carried out in order to study the crossed course of the nerve fibers in the ganglia of the solar plexus and outside them is minimal [1, 3-5]. Yet this is a matter of undoubted importance.

This paper describes the results of an investigation of the relationship between the fibers of the greater splanchnic nerves and the solar plexus and adrenal glands in albino rats.

EXPERIMENTAL METHOD

Experiments were conducted on 16 adult albino rats of both sexes. Under general ether anesthesia laparotomy was performed and the right or left greater splanchnic nerve was exposed below the diaphragm and divided cranially to the suprarenal ganglion. Control experiments were also performed, in which the greater splanchnic nerve was exposed in animals without being divided. The postoperative period in all the rats was uncomplicated. The period of observation lasted from 24 h to 10 days. The animals were sacrificed by decapitation.

The region of the solar plexus, together with the kidneys, adrenals, and the fatty areolar tissue surrounding the solar plexus, was isolated in the cadaver. The block of tissue was carefully fixed to cardboard and fixed in this position in a 12.5% solution of neutral formalin or in Orth's fluid. After the preparation had been fixed, the solar plexus and nerves of the adrenal glands were dissected under the MBS-2 microscope. In the course of this procedure the specimen was immersed in a 12.5% solution of neutral formalin or in Müller's fluid. After examination the specimen was cut into separate parts which were treated by the Marchi, Bielschowsky–Gros, and Kampos techniques. Material from the cadavers of the control rats was investigated in the same manner.

EXPERIMENTAL RESULTS

The anatomical observations showed that the solar plexus of albino rats contains usually one celiac ganglion, situated in front of the aorta between the trunks of the celiac and the cranial mesenteric arteries. Caudally to the latter lies the cranial mesenteric ganglion, and between this and the right and left part of the celiac ganglion, nerve connections run along the sides of the trunk of the cranial mesenteric artery. The greater splanchnic nerves (right and left) enter the celiac ganglion. Along the course of each nerve lies a suprarenal ganglion, from which numerous slender branches run to the ipsilateral adrenal gland.

Following unilateral division of the right or left greater splanchnic nerve and subsequent treatment of the material by Marchi's method, degeneration of the myelin sheaths of a few, large medullated nerve fibers was observed in the caudal segment of the divided nerve and in the ipsilateral suprarenal ganglion. Very rarely, degeneration of the myelin sheaths of the nerve fibers was seen in the celiac ganglion at the point of entry of the divided splanchnic nerve. This was mainly due to the fact that Marchi's method reveals degeneration of the myelin sheaths of only the large medullated nerve fibers. As our histological investigations [2] have shown, only a negligible number of these

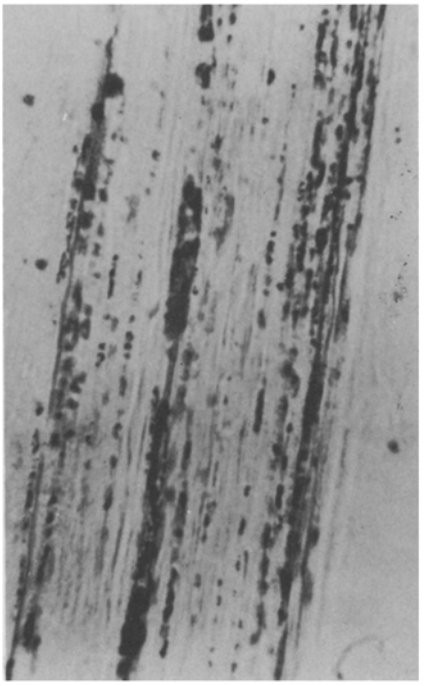

Fig. 1. Degenerating nerve fibers in trunk of left greater splanchnic nerve 3 days after division. Bielschowsky–Gros. Objective 6 ×, ocular 10 ×.

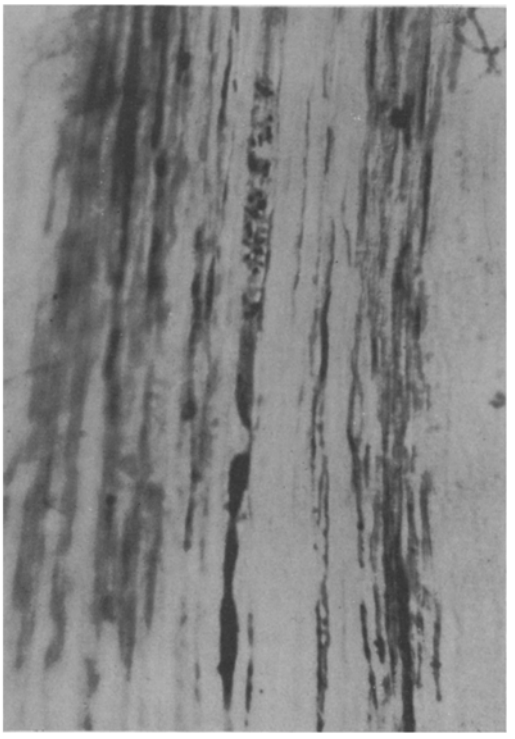

Fig. 2. Degenerating nerve fiber in the trunk of the left splanchnic nerve at the level of the suprarenal ganglion 4 days after division of the righ greater splanchnic nerve. Kampos's method. Objective 6 ×, ocular 10 ×.

fibers is present in the caudal segment of the splanchnic nerve and in the celiac ganglion. We obtained more complete information by using the Bielschowsky–Gros and Kampos methods of silver impregnation; these methods revealed degeneration of the axons of the thin as well as the thick fibers.

As a result of this investigation it was found that unilateral division of the right and left greater splanchnic nerves (separately) gives rise to a mass of degenerating thin nerve fibers in the trunk of the nerve cranially to the suprarenal ganglion. Among the degenerating nerve fibers there were five or more fibers of large caliber which were broken up into fragments (Fig. 1). These fibers were more often situated at the periphery of the nerve bundles. At the level of the suprarenal ganglion, besides relatively unchanged fibers, the splanchnic nerve contained many degenerating fibers of small caliber. The disintegrating large nerve fibers were found mainly in the bundles passing through the periphery of the suprarenal ganglion. More rarely, fibers of this type were found in bundles or occurred singly among the ganglion cells. Caudally to the suprarenal ganglion, i.e., after the departure of the branches to the ipsilateral adrenal gland, the total number of degenerating nerve fibers, and especially of large fibers, in the splanchnic nerve fell. In this portion of the nerve the number of degenerating nerve fibers of larger caliber did not exceed 1-2. The fragmented large nerve fibers lay mainly at the periphery of the bundles, as in the more proximal portions of the nerve.

In the celiac ganglion of the solar plexus the nerve fibers of both the right and the left greater splanchnic nerves were directed laterally, medially, and caudally. The nerve fibers directed laterally emerged from the ganglion and spread along the renal vessels; the fibers directed caudally entered trunks * joining the celiac ganglion to the cranial mesenteric ganglion. Finally, the nerve fibers of each of the splanchnic nerves running in a medial direction passed through the ipsilateral part of the celiac ganglion, crossed the midline in bundles or singly, and reached the opposite portion of the celiac ganglion. Some of these fibers formed arcuate connections in the ganglion, connecting the right and left greater splanchnic nerves with each other. Other fibers, oblique in direction,

*We call these trunks conventionally celiaco-mesenteric.

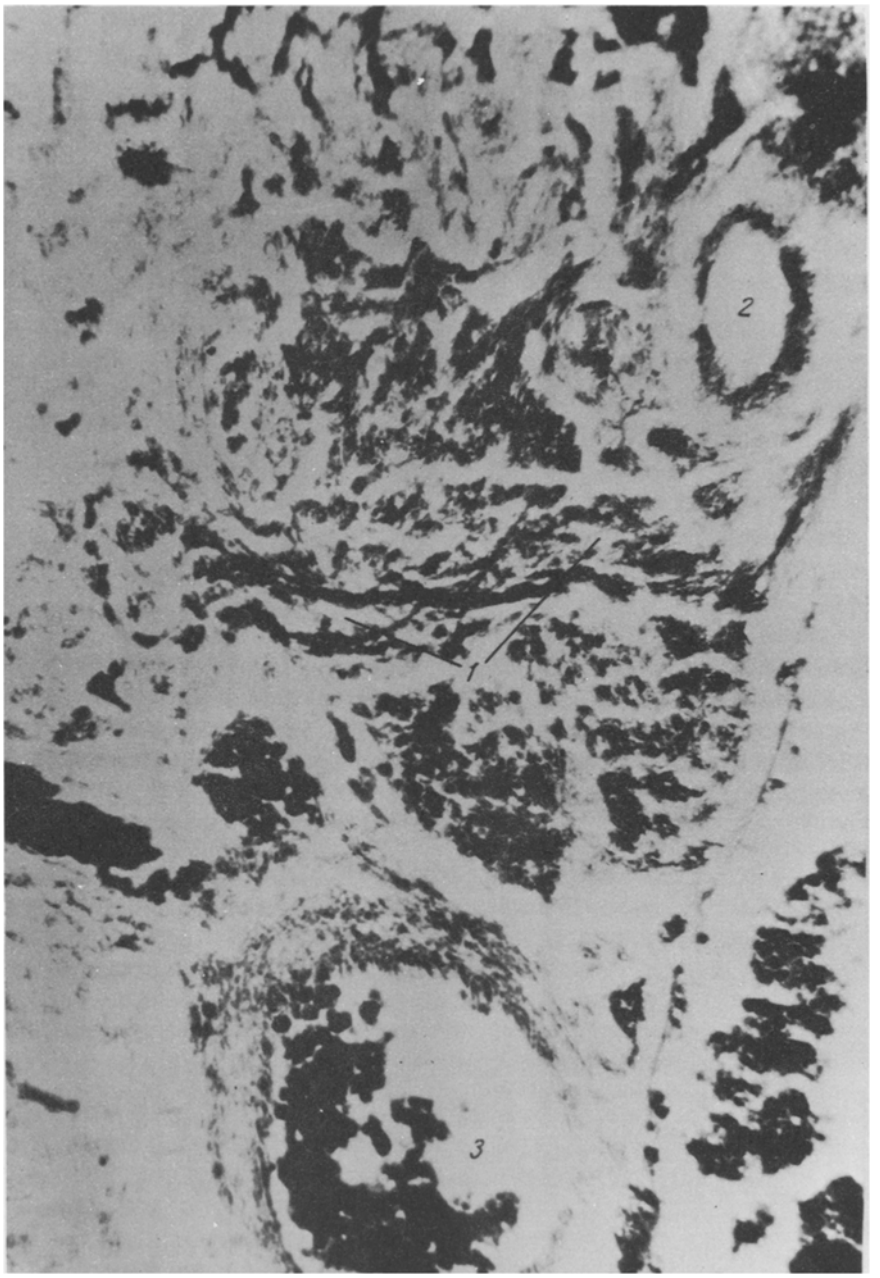

Fig. 3. Horizontal section through a 10 mm albino rat embryo. 1) Crossed connection in the cranial mesenteric ganglion; 2) cranial mesenteric artery; 3) abdominal aorta. Magnification 300 x.

passed through the opposite portion of the celiac ganglion and entered the trunk on the contralateral side runni ıg from the celiac ganglion to the cranial mesenteric ganglion.

Following unilateral division of the right or left greater splanchnic nerve, besides degenerating thin fibers, single large, fragmented nerve fibers were found in the ganglion of the solar plexus on the side of the operation. These large fibers were seen in the bundles running in the lateral, caudal, and medial directions. The degenerating nerve fibers in the bundles running caudally reached the celiacomesenteric trunk on both ipsilateral and contralateral sides; the nerve fibers crossed to the contralateral side along communications running caudally from the celiac ganglion and joining the two celiaco-mesenteric trunks mentioned above. In the opposite part of the celiac ganglion

degenerating nerve fibers were mainly of small diameter. Only in rare cases was degeneration of single nerve fibers of larger caliber observed in the contralateral part of the ganglion. These fibers crossed to the opposite side in communications running in the ganglion itself or joining the symmetrical celiac ganglia together. In the contralateral ganglion the degenerating nerve fibers ran in two directions. Some ran caudally and entered the celiacomesenteric trunk of the opposite side; others took an ascending course and could be traced among the cells of the contralateral part of the ganglion as far as the point of entry of the greater splanchnic nerve.

During the investigation of the greater splanchnic nerve on the opposite side, a few degenerating thin nerve fibers were found situated caudally from the suprarenal ganglion and also in the ganglion itself. In individual cases, besides degenerating thin fibers, single fragmented and mummified nerve fibers of large caliber were discovered (Fig. 2). Degeneration of nerve fibers was not always observed in the contralateral celiac nerve trunk cranially to the suprarenal ganglion. We never observed degenerating large nerve fibers in this part of the nerve. This evidently shows than such fibers in each of the splanchnic nerves which pass to join the contralateral splanchnic nerve are mainly destined for supplying the contralateral adrenal gland. Evidence to support this conclusion is furnished by the discovery in some cases of degenerating nerve fibers mainly of thin caliber, running to the contralateral adrenal in the nerve branches given off by the corresponding suprarenal ganglion. Further confirmation is given by the fact that the fragmented fibers were found in the medulla of the contralateral adrenal following division of one of the greater splanchnic nerves.

It may be concluded from a comparison of the results of the experimental unilateral division of the splanchnic nerve and the morphology of the corresponding nerves in normal intact animals and in animals undergoing control operations that the observed degeneration of the nerve fibers was the result of division of the splanchnic nerve. No pathologically changed nerve fibers could be found in the structures studied from the intact animals. During investigation of the control animals, single nerve fibers showing reactive changes were found in the trunk of the exposed splanchnic nerve: they were slightly thickened and more intensively impregnated.

The crossed nervous communications between symmetrically opposite portions of the solar plexus were also demonstrated when we investigated albino rat embryos. In the early stages of development (embryos 10 mm in length) crossed bundles of nerve fibers could be seen, connecting the right and left splanchnic nerves. These bundles were situated between the trunks of the celiac and the cranial mesenteric artery. Besides these, crossed connections were also found in the cranial mesenteric ganglion (Fig. 3).

The results described above demonstrate that the fibers of the right and left greater splanchnic nerves cross to the opposite side within the celiac ganglion and outside it. In the ganglion of the solar plexus arcuate communications are formed, joining the two greater splanchnic nerves. Besides these, crossed fibers were seen which left the greater splanchnic nerve and entered the celiac ganglion, in which they crossed to join the celiaco-mesenteric trunk on the opposite side.

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