HISTOPATHOLOGY OF THE SYNAPSES IN THE GANGLIA OF THE HUMAN SOLAR PLEXUS

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The problem of the existence of interneuronal connections is an important one in modern neurology. The so-called pericellular apparatuses or synapses, representing the terminations of the preganglionic fibers on the nerve cells and their outgrowth appear to be the form in which the structures are identified morphologically. Despite the large number of works dealing with the structure of these interneuronal connections, there are a wide variety of interpretations.

We have set out to study the structure of the synaptic apparatus of the ganglia of the solar plexus and to give a comparative account of their condition in various diseases.

EXPERIMENTAL METHOD

The work was carried out on ganglia of the solar plexus taken from corpses of eleven human subjects aged from 23 to 81 years, all of whom had died from various serious diseases (see table). Also, as control we studied the corresponding ganglia from eleven corpses of generally healthy people aged from 2 to 74 years which had died from accidents.

The material was fixed in 10% neutral formalin and treated with Campos, counterstained with hematoxylin, or by Nissl's methylene blue method. Sections 30-35 μ thick or paraffin sections 8-10 μ thick were cut.

It is important to note that the synapses of the ganglia of the solar plexus show many features which distinguish them from synapses of other autonomic ganglia. In the superior cervical sympathetic ganglion and in the stellate ganglion the characteristic form of the synapse is the fibrillar ring or loop, whereas in the ganglia of the solar plexus spherical or flask-shaped endings of various forms distinguish the endings. Our observations agree in this respect with those of Kirsche [5, 6] who showed that there was a varying percentage relationship between the ring-shaped and flask-shaped forms in the different autonomic ganglia. For ganglia of the solar plexus the ratios are as follows: ring 34%, flask 66%; for the stellate ganglion: ring 90%, flask 10%. We have frequently been able to observe a large number of rings and flasks of normal appearance distributed on the body of the neurone and on its outgrowths (Fig. 1). These results run counter to the conclusions reached by Gibson [4] who showed that the characteristic feature of the autonomic neurones was the presence on the cells of solitary synaptic swellings.

In the ganglia of the solar plexus of generally healthy people we found no noticeable deviations from the normal either in the nervous structures, in the stroma of the ganglia, or in the vessels.

Over the whole of their length, from the point at which they enter the ganglion to their terminal branchings on the nerve cells, the preganglionic fibers presented a perfectly smooth outline and terminated on the bodies and outgrowths of a neurone in synaptic swellings of various sizes. In cases when the fibers could be followed to their terminations they were found to end in delicate fibrillar rings or spherical structures (Fig. 2).

The spherical forms of synapse in healthy people never reached the size found under pathological conditions.

Disease	Age in years	Sex	Time after death at which material was collected (h)
Generalized atherosclerosis	81	M	10
" "	74	"	12
" "	62	"	11
" "	53	"	9
Glioma of brain. Skull trepanned	35	"	$1^1/_2$
Neuroma of brain. Skull trepanned	23	"	8
Prostatic hypertrophy. Urinary sepsis.	68	"	8
Chronic glomerulo nephritis	56	"	12
Adhesive pericarditis with cardiac decompensation	25	"	11
Pulmonary emphysema with cardiac decompensation.	54	F	10
Chronic ulcerative colitis. Laparotomy.	44	M	11

Of the 11 control preparations in only 2 cases did we find any increase in the size of the synaptic endings. In the remaining 9 cases these endings did not exceed 1.5-3.5 μ .

Some authors regard the largest of these structures as hypertrophied synapses developing in healthy people in connection with diseases suffered in the past [1, 2].

It is however, essential to remember that hypertrophied synapses may easily be confused with spherical structures on the ends of nerve cells (Kugel-phenomenon). Our results indicate that in the ganglia of healthy subjects sometimes hypertrophied swellings of synapses are encountered. The phenomenon of spheres on dendrites of nerve cells is here very rarely encountered. Under normal conditions most synapses are 1.5-3.5 μ in diameter.

Fig. 1. Numerous synaptic swellings on a nerve cell of semilunar ganglion of the solar plexus. Urinary sepsis. Man aged 68 years. Micrograph. Campos. Objective 40, ocular 10.

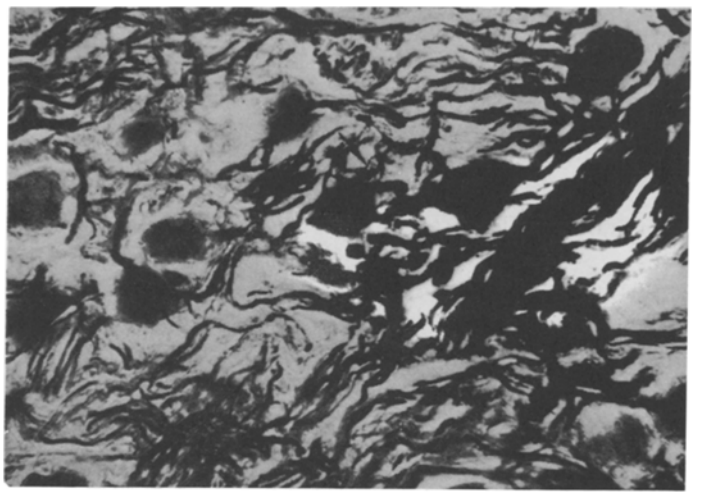

Fig. 2. Normal synaptic swellings on neurones of the semilunar ganglion of the solar plexus. Control group. Girl aged 15. Micrograph. Campos. Objective 40, ocular 10.

A quite different state of affairs is found in the ganglia of people who have died from the diseases we have listed.

In these cases in the stroma of the ganglia (particularly in atherosclerosis) there are numerous infiltrations of rounded cells. The blood vessels of the ganglia were dilated and engorged with blood. In impregnated sections, in all cases the preganglionic fibers and their terminal portions showed varicose swellings along their length which in places were quite large. The fine nerve threads forming the pericellular apparatus also showed varicose thickenings. They usually terminated by greatly enlarged swellings which sometimes reached a size of 6-20 μ (Fig. 3). The latter quite frequently assumed the form of large spheres pressing on the body of the nerve cell.

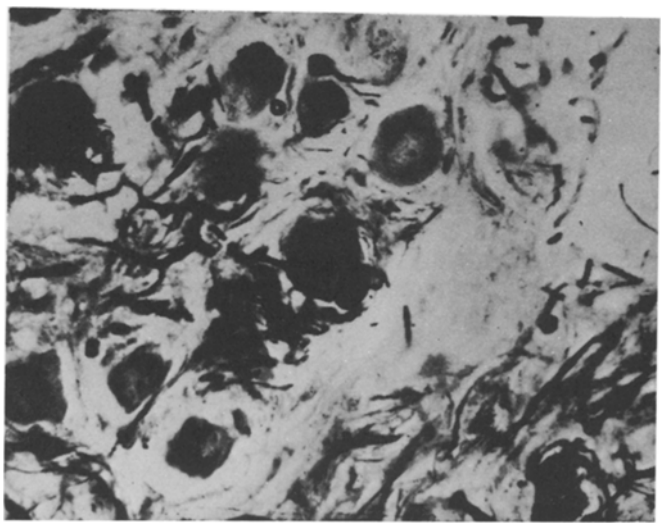

Fig. 3. Normal and hypertrophied synaptic swellings on neurones of the semilunar ganglion of the solar plexus. Chronic enterocolitis. Man aged 44 years. Micrograph. Campos. Objective 40, ocular 10.

Sometimes in a single field of view all the transitional forms of synapses could be seen ranging from argentophil swollen rings to spherical or flask-shaped structures of great size. In cases when such hypertrophied synapses lay beneath the capsule of nerve cells they exerted pressure on the body of the neurone displacing its nucleus and protoplasm towards the wall of the cellular capsule. However, by no means in all synapses within a field of view were such changes to be seen. A considerable proportion of the synapses maintained the normal form and size and differed in no way from those of healthy subjects. We must point out that in the case of all the diseases mentioned it was only the preganglionic system which was selectively affected, whereas outgrowths of the neurones maintained their normal structure.

Thus, in many chronic diseases selective damage is found to occur in the preganglionic fibers and their terminations—in the synapses in the ganglia of the solar plexus. The changes described are reactive in nature and take the form of varicose swellings along the length of the nerve fibers and of hypertrophy of the synaptic swellings on the cells of peripheral neurones. The experimental studies of A. L. Shabadash [3] have shown that the synapses are extremely labile structures which react rapidly to changes in carbohydrate metabolism.

Apparently, the morphological changes we have described are able to disturb the normal transmission of conduction through synapses of efferent impulses, an effect which must necessarily influence the function of the organs and tissues related to them.

SUMMARY

A study was made of the interneuronal synapses in the ganglia of the solar plexus of persons who had died from various diseases. The corresponding ganglia of persons who had died as a result of accident served as a control. The material was treated by silver impregnation by the method of Campos. In the controls the nerve elements and the stroma of the ganglion showed no abnormal signs; in all the pathological cases the preganglionic fibers and their terminations on the neuronal bodies and on the dendrites were selectedly affected. These changes which were of a reactive nature consisted in the appearance of varicose swellings along the course of the preganglionic fibers, and in hypertrophy of the synaptic endings. We suggest that the changes we have outlined may interfere with the transmission of impulses through the synapses, which in turn is likely to affect the activity of the structures innervated by the ganglia.

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