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Sympathetic Ganglion Cells in Ventral Nerve Roots. Their Relation to Sympathectomy

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Surgical procedures designed to bring about sympathetic denervation of a part of the body have been based on the assumption that all peripheral sympathetic conduction pathways traverse the sympathetic trunks. If this assumption were correct, sympathetic trunk extirpation or section of the corresponding white communicating rami would result in interruption of all sympathetic pathways in the affected area, and insure its complete sympathetic denervation.

Failures to achieve complete sympathetic denervation, particularly of the extremities, by extirpation of the appropriate segments of the sympathetic trunks or by section of the white communicating rami in the appropriate segments have suggested the possible existence of peripheral sympathetic conduction pathways which do not traverse the sympathetic trunk. Such pathways could be postulated on the assumption that some embryonic nerve cells, in their displacement from the neural tube, have failed to reach the primordia of the sympathetic trunks and have been differentiated into ganglion cells in the ventral nerve roots, or adjacent to them, where they have become synaptically connected with preganglionic fibers which either do not extend into the sympathetic trunk or give off collaterals to the ganglion cells in question.

Small ganglia located in communicating rami in the lumbar (*1, 2, 7*), the cervical, and the upper thoracic segments (*5*) have been described. Most of them appear to be located in gray communicating rami. Occasional ones have been described as located adjacent to a ventral nerve root, probably in a white communicating ramus. Wrete (*7*) and Skoog (*5*) have suggested the possibility that such ganglia may be a factor in the residual activity following sympathectomy in some cases.

In examining a series of human bodies, we have observed small ganglia imbedded in ventral nerve roots or adjacent to them, usually at the site of origin of a white communicating ramus, particularly in the first and second thoracic and the first and second lumbar segments. Small ganglia have also been observed in communicating rami, particularly gray rami. In the present report only those in ventral nerve roots or adjacent to them will be considered. Most of them are small. Among the larger ones, an individual ganglion may comprise in excess of 20,000 ganglion cells. In appropriate histologic sections, fibers of the ventral nerve root may be traced into the ganglion. Fibers may also be traced distalward from it in the spinal nerve. The possibility that the axons of some ganglion cells in such ganglia extend into the sympathetic trunk is not precluded, but most of them appear to extend distalward in the spinal nerve without traversing the sympathetic trunk. A nerve with sympathetic ganglion cells located in its ventral root or adjacent to it, therefore, includes direct sympathetic conduction pathways which are independent of the sympathetic trunk and which, consequently, are not interrupted by extirpation of the corresponding sympathetic trunk or section of the white communicating rami which join them.

The anatomic demonstration of sympathetic conduction pathways which involve synaptic connections in ventral nerve roots, and which do not traverse the sympathetic trunk, affords a more satisfactory explanation than has been possible hitherto for most of the failures to achieve complete sympathetic denervation by sympathectomy, in the absence of faulty operative technic. The frequency with which direct sympathetic pathways occur is indicated by the frequency with which residual sympathetic activity can be demonstrated following interruption of all the pathways which traverse the sympathetic trunk. In an extensive series of patients who had been subjected to extirpation of the sympathetic trunk from the eighth thoracic to the third lumbar segments inclusive, Ray and Console (*4*) demonstrated sympathetic activity, particularly in the twelfth thoracic and the upper three lumbar dermatomes, in every case.

Resection of the ventral roots of the second and third thoracic nerves has been carried out, particularly by Smithwick (*6*), in preganglionic sympathectomies of the upper extremities. The advantage of this procedure probably depends on interruption of direct sympathetic pathways in which the ganglion cells are located in relation to the ventral root of the second thoracic nerve. Since the ganglion cells associated with the ventral roots of lumbar nerves appear to be located mainly in the first and the second lumbar segments, section of the ventral roots of the first and second lumbar nerves, in addition to extirpation of the lower two thoracic and the upper three lumbar segments of the sympathetic trunk, probably would insure complete sympathetic denervation of the lower extremity in most cases.

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