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Rôle of Preganglionic Fibers of First Thoracic Nerve in Sympathetic Innervation of Upper Extremity

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Telford[1] and Smithwick[2] have described operative procedures for sympathetic denervation of the upper extremity by means of which the preganglionic fibers in question from the second thoracic nerve downward are interrupted but the inferior cervical and upper thoracic sympathetic ganglia are left *in situ* and the preganglionic fibers of the first thoracic nerve and the gray communicating rami joining the nerves of the brachial plexus are left intact. The advantages claimed for these procedures are avoidance of the unwanted effects of extirpation of the inferior cervical and upper thoracic sympathetic ganglia, particularly Horner's syndrome and sensitization of the vascular musculature in the affected area to adrenin.

The assumption that preganglionic components of the first thoracic nerve play no part in the sympathetic innervation of the upper extremity, although in accord with certain early experimental data recorded by Langley,[3] is not supported by certain more recent experimental and clinical observations. In view of the importance of complete functional sympathetic denervation of the upper extremity in the treatment of peripheral vascular disease it has seemed desirable to obtain additional data regarding the distribution of the preganglionic components of the upper thoracic nerves by means of anatomical and physiological experimentation. The anatomical experiments have been carried out on cats; the physiological experiments on both cats and dogs.

In the anatomical experiments, some cats were subjected to unilateral section of the roots of the second and third thoracic nerves proximal to the communicating rami and division of the sympathetic trunk below the level of the third thoracic nerve; others were subjected to unilateral section of the roots of the first thoracic nerve, leaving the sympathetic trunk intact. Preparations of the inferior cervical ganglia, taken after degeneration of the divided fibers, in the first series, showed extensive degeneration of the intercellular

1 Telford, E. D., *Br. J. Surg.*, 1935, **23**, 448.

2 Smithwick, R. H., *Ann. Surg.*, 1936, **104**, 339.

3 Langley, J. N., *Erg. d. Physiol.*, 1903, **2**, 818.

axon complexes except in the area adjacent to the white communicating ramus of the first thoracic nerve. Preparations of the inferior cervical ganglia, in the second series, showed complete degeneration of the major portion of the intercellular axon complexes in the area adjacent to the white communicating ramus of the first thoracic nerve and relatively little degeneration in other parts of the ganglion. The distribution within the ganglia of the axons arising from ganglion cells in the portion adjacent to the white communicating ramus of the first thoracic nerve also indicates that many of them enter gray rami which join constituent nerves of the brachial plexus.

In the physiological experiments the effects on the blood vessels and sweat glands of the upper extremity produced by direct stimulation of the preganglionic fibers of the upper thoracic nerves by means of an induced current were observed. The electrode was applied to the white communicating ramus of the first, second and third thoracic nerves separately, and, in a few instances, to the cut surface of the ventral root of the first thoracic nerve.

Stimulation of the preganglionic fibers of either the first, the second or the third thoracic nerve consistently resulted in activation of the sweat glands in the paw pads and constriction of cutaneous vessels of the foot. The exact distribution of the sweat glands and cutaneous vessels affected by stimulation of the preganglionic components of each nerve separately has not been determined. It is significant, however, that stimulation of the preganglionic fibers of the first thoracic nerve elicited sweating on all parts of the paw pads.

These experimental data indicate clearly that preganglionic components of the first thoracic nerve play a significant rôle in the sympathetic innervation of the forelimbs in the animals used. Comparative anatomical and physiological data furthermore indicate a close correspondence in the distribution of the preganglionic components of the thoracic nerves in the carnivora and man; consequently, complete sympathetic denervation of the upper extremity in man obviously cannot be accomplished by any operative procedure which leaves intact the first thoracic nerve with its communicating ramus and the inferior cervical sympathetic ganglion with the gray rami which connect it with the constituent nerves of the brachial plexus.