SYMPATHECTOMY OF THE UPPER EXTREMIT Y
EVALUATION OF SURGICAL METHODS*
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The failure to obtain consistently good results in sympathectomy of the upper extremity and more particularly of the hand has been the cause for much speculation for over twenty years. A variety of factors, anatomical, physiological and pathological, have been highlighted from time to time and have resulted in changing modes of surgical operations. In view of accumulating evidence that some of the past reasoning regarding the anatomy and physiology of the sympathetic nervous system must be abandoned it is appropriate now to take stock of our surgical methods.

Three principles have long been mentioned as necessary in evaluating an operation on the sympathetic nervous system: (1) The operation must be anatomically complete, leaving no sympathetic nerves to supply the part to be denervated; (2) it must be extensive enough or performed in such a way that regeneration of sympathetic nerves to the part is obviated; and (3) it should be preganglionic, thus leaving intact the postganglionic supply to the part. A considerable bulk of the literature on the subject has to do with affirming the merits of one type of operation over another in meeting these proclaimed principles. While there is no fault to find in the principles, the interpretation of each of them has changed considerably. They will be considered in reverse order.

SENSITIVITY OF DENERVATED ARTERIOLES

Sensitization or supersensitivity of denervated tissue to circulating hormonal substances after sympathectomy was first described by Meltzer and Auer\textsuperscript{30} and later supported by Cannon and co-workers,\textsuperscript{8,9} who demonstrated that adrenin was the substance in question. Additional evidence of the overresponse of sympathectomized blood vessels to epinephrine was produced by experiments in man by Freeman, Smithwick and White\textsuperscript{12} which led to the proposal that sensitization was one cause of failure of sympathetic operations for Raynaud’s disease.\textsuperscript{31}

From animal experimentation, Hampel\textsuperscript{14} concluded that smooth muscle was less sensitive to chemical stimuli after preganglionic as opposed to post-ganglionic sympathectomy. The clinical evidence of the superiority of preganglionic sympathectomy in man seemed to exist in the fact that the results

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of the standard lumbar sympathectomy, which is a preganglionic operation, usually produced an effect in the lower extremity which was relatively better than that usually obtained in the upper extremity following the standard cervicothoracic or stellate ganglionectomy, which is a postganglionic operation. In further support of this deduction Ascroft showed in laboratory animals that by converting a preganglionic to a postganglionic sympathectomy in the lower extremity the reaction of blood vessels to adrenalin was increased.

Telford in 1935 devised a technique for producing a preganglionic denervation of the upper extremity in man. His operation was performed through a supraclavicular incision with division of the clavicular head of the sternocleidomastoid and the anterior scalenus muscles. The rami of the 2nd thoracic ganglion were severed and the paravertebral chain was divided below the ganglion. The rostral end of the divided chain was then anchored in the cervical muscles to prevent regeneration of fibers that might bridge the gap between the ends of the divided chain. Later he extended the operation to include the 3rd thoracic ganglion.

Smithwick (1936) independently developed a preganglionic sympathectomy comparable to Telford's but performed through a posterior rib resection. Smithwick's operation entailed division of the rami of the 2nd and 3rd thoracic ganglia and division of the chain below the 3rd ganglion. The rostral end of the divided chain was swung out of the thoracic cavity and sutured into the paravertebral muscles; the distal end was ligated. In addition, segments of the 2nd and 3rd intercostal nerves and their intradural roots were resected to prevent regeneration from this source. As a later addition to the operation, capping of the cut ends of the chain was proposed further to minimize the possibility of regeneration. A still later addition has extended the operation to include the 4th thoracic ganglion and intercostal nerve.

Thus the principle of the advantage of the preganglionic over the postganglionic sympathectomy and the development of Telford's and Smithwick's operations more or less guided thinking and surgical methods for some years thereafter, and corroboration was forthcoming from many sources, as Learmonth, de Takáts and associates and Atlas, to name but a few.

But there were at least two studies made during this period that questioned the importance of a difference between preganglionic and postganglionic sympathectomy in man. Simmons and Sheehan, in exploring the cause of relapse following sympathectomy of the hand, reviewed 38 ganglionectomies and 29 preganglionic sections in Telford's clinic. They did not find any significant difference in the number of relapses following the two types of operation and concluded that regeneration of vasoconstrictor fibers is the probable cause of relapse after either type of sympathectomy.

The other study was by Fatherree, Adson and Allen on the vasoconstrictor action of epinephrine on the digital arterioles of man before and