THE ORIGINS OF SYMPATHECTOMY

by

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> Today my experiments on the vascular and thermo-regulatory nerves have opened a new path for investigation and are the subject of numerous studies which, I hope, may some day yield really important results in physiology and pathology.[1]

BEFORE severing the cervical sympathetic nerve in the rabbit's neck, Claude Bernard had expected that the result of this operation would be a decrease in the temperature of the affected side of the head. His hypothesis was false, but the observed fact, the increase in temperature, was unmistakable. The full significance of the experiment was, to him, initially concealed. To no less extent did its therapeutic implications evade early appreciation.

One of the first to draw attention to the usefulness of interruption of the sympathetic pathways was Jaboulay[2] who, in 1899, gave an account of periarterial stripping of the femoral artery in a man afflicted with trophic lesions of the foot. The artery was exposed and cleaned in Scarpa's triangle, and, over a period of five weeks, healing of the foot lesions occurred. Jaboulay was not unaware that hospital routine might be accused of contributing to this healing, but the purpose of his assault, aimed at releasing vasoconstrictor tone, was sound. Such limitations as beset him were those of technique. We shall see that technique advanced rapidly upon the limitations of unsound theory.

Before this period Jonnesco,[3] in 1896, working in Bucharest, had resected the inferior, middle, and superior cervical ganglia for epilepsy and exophthalmic goitre. Jaboulay was another who operated on the cervical sympathetic for the latter condition in this same year. Other surgeons followed suit, extending their indications to migraine and glaucoma. The operation found favour for a multitude of affections of the head and neck, and Jonnesco[4] himself, following the suggestion of François Franck, performed the operation for angina pectoris in 1916.

René Leriche[5] followed the path of his master, Jaboulay, in advocating periarterial sympathectomy for the treatment of vascular conditions. He was, however, troubled by the observation that a unilateral periarterial sympathectomy often had a bilateral effect, indeed to the extent of vasodilatation of all four limbs. He entertained doubts as to the centrifugal nature of the fibres which he must be cutting about the femoral artery, and suspected that he might, in fact, be severing centripetal sensory fibres taking part in the maintenance of vasomotor tone. Noting the temporary hyperaemia following resection of an obliterated arterial, or even venous, trunk (in Buerger's disease), he remarked in the former, a 'hyperleucocytosis'.[6]

The histological evidence perturbed him, for no long nerve fibres were to be found about the artery, and, with the exception of the iliac and axillary arteries, the innervation of the vessels came from the adjacent nerves. These two exceptions derived their nerve supply directly from the sympathetic trunk.

Indeed, Leriche was acutely conscious of the discrepancy between his clincial findings and the evidence from animal work. Chief in this was Langley's[7] stimulation of the lumbar sympathetic chain before and after section of the femoral and sciatic nerves, showing the loss of vasoconstriction following section.

Weidkopf,[8] in man, showed that brachial plexus block produced the same changes as removal of the sympathetic chain, changes which could not be mimicked by removal of the arterial adventitia.

As operations upon the sympathetic chain later became common, Leriche was bound to observe that the changes induced by periarterial stripping were less marked than those produced by section of the former, the difference, he said, being quantitative rather than qualitative. The increasing popularity of direct attack upon the sympathetic trunk, other than the stellate ganglionectomy used for a variety of cephalic lesions and angina pectoris, owes its origin chiefly to two Australians. These gentlemen, N. D. Royle and J. I. Hunter, brought to their work such a wealth of character and ability that it is little wonder how great was their impact upon the surgical and scientific world of their day. That their initial purpose was the treatment of spastic paralysis by sympathectomy merely adds to the interest of the excitement and eventual discord which they engendered.

Royle, an orthopaedic surgeon who had been a physical training instructor before taking up the study of medicine, met John Irvine Hunter while the latter was still pursuing his spectacular career as a student of the University of Sydney Medical School. On qualifying, Hunter became an anatomy demonstrator in the department of Professor J. T. Wilson, and then Associate Professor. Soon afterwards Wilson left to become Professor of Anatomy at Cambridge. The University of Sydney decided to keep the chair vacant, and sent Hunter to England for eighteen months to work with Wilson and Grafton Elliot Smith. Returning to Sydney in 1923, he became Professor of Anatomy soon after his twenty-fifth birthday.

At this time Royle, like many orthopaedic surgeons of his day, was seeking some surgical way to the alleviation of spasticity, and his thinking had travelled along dubious lines concerning muscle innervation. Mosso,[9] in 1904, had suggested that the sympathetic nervous system subserved skeletal muscle tonus, and Langelaan,[10] working on frogs, introduced the concept of two kinds of tone, which brought to the subject of sympathetic innervation of skeletal muscle a lasting confusion. He proposed the existence of plastic tonus and contractile tonus. Plastic tonus, a term used by Sherrington[11] in connection with the lengthening and shortening reactions, was defined by Langelaan as 'that state of the muscle in which it has the properties of a plastic body'. The responsibility for this state he assigned to the sympathetic nervous system, basing this upon his rather unsatisfactory frog experiments. Contractile tonus became that property of a muscle enabling it to maintain 'a state of slight contraction' and here the somatic nervous system found itself involved. It served to explain hyperreflexia, and it might well have been given full credit for decerebrate rigidity had not Royle later claimed to have deprived the decerebrate goat of sympathetic supply, *plastic* tonus, and rigidity in the corresponding limb, in one manoeuvre. The concept of two forms of tone became the basis of a theory, and one of the greatest impediments to the acceptance of that theory.

Hunter, while in London, saw what he believed to be histological evidence for two such mechanisms in some preparations of python muscle made by Kulchitsky. Identifying non-medullation with sympathetic origin, Hunter was not alone in believing these preparations to confirm the sympathetic innervation of skeletal muscle. During the previous century these fibres had been described by other workers, amongst whom there was a difference of opinion as to their nature. Kulchitsky,[12] whose preparations of python muscle Hunter saw in 1922, believed that unmedullated fibres supplied only the thin striated muscle fibres, and that medullated fibres supplied only the thicker muscle fibres. This was disputed by other histologists, but to Hunter it provided a mechanism for two kinds of tone. Upon this foundation of the dual innervation of muscle he and Royle constructed an edifice of new surgical technique and physiological explanation.

If the sympathetic system were responsible for plastic tone it must be possible to destroy plastic tone by the removal of sympathetic influence. If spasticity could be reduced, such cortical control mechanisms as were available could break through to afford purposive movement. The assumption was made that spasticity was a major factor in paralysis by providing the barrier of rigidity behind which lay the remnants of volition. Spasticity must consist of a combination of plastic and contractile tone, in varying proportions, and the greatest benefits of sympathectomy would fall to those whose spasticity was chiefly of plastic tone.

Hunter devised the technique of sympathetic ramisection which Royle performed on goats and practised on cadavers. Sympathetic ramisection was carried out on goats which were decerebrated many days later. Before decerebration Royle[13] satisfied himself that there were already muscle changes in the sympathectomized limb. After decerebration typical rigidity did not develop in the limbs which had lost their sympathetic supply.

Royle went on to apply his technique of ramisection to humans. With his physical training background he provided excellent physiotherapy for his patients, and there was always belief that much of the improvement which they showed was due to this. The results of this surgery, when demonstrated in Sydney and Melbourne in 1923, were acclaimed, and Hunter and Royle were invited jointly to give the Dr. John B. Murphy Oration in Surgery of the American College of Surgeons in New York the following year. The interest aroused by their work was immense.

While in Boston, Royle, who had done many demonstration operations in the U.S.A., developed symptoms of what was thought to be influenza. Further cerebral symptoms appeared, and his malady turned out to be encephalitis lethargica. In later years he was to develop Parkinsonism.

Hunter came to England from the U.S.A. to see his old friends Professors Wilson and Grafton Elliot Smith, and to tell of the work of Royle and himself. He became ill, and died of enteric fever in University College Hospital in December 1924. This tragic blow shook the Sydney Medical School to its foundations. It was almost unbelievable that the journey which the two men had made to spread the fame of the School should have produced so much misfortune.

Royle, after recovery, continued his work, and surgeons in the U.S.A. and England tried ramisection, as taught by him, for spasticity. Slowly and sadly it became apparent

that the early successes in Sydney were not being repeated elsewhere, whether operated on by Royle, during his visits, or by the local surgeons. Meanwhile the theoretical basis of such surgery was being examined by many workers. In Melbourne, Tiegs and Coates,[9] after a very full investigation, found themselves opposed to Hunter's theory both physiologically and histologically. In Hunter's own laboratories Wilkinson[14] found no histological evidence for the sympathetic innervation of skeletal muscle fibres. Phillips,[15] set to work by Royle, found no evidence of a loss of postural tonus following sympathectomy in the decerebrate cat.

Enthusiasm for sympathectomy as a treatment for spastic paralysis declined rapidly, more through the poor clinical results than through the lack of a sound theoretical basis. Not all its results were, however, disappointing. Royle had noticed in his first patient that, within six hours of operation, the leg on the operated side felt warmer, and was a deeper pink than its fellow. In subsequent patients the flushed appearance was more striking. Some of the patients were aware of a feeling of increased warmth in the limb. Will Mayo, visiting Australia in 1924, also observed the vascular changes in the feet and legs of these patients, and, conscious of their possible usefulness, took word of them back to the Mayo Clinic.[16]

In 1923 Brüning[17] in Berlin had removed the cervico-thoracic ganglia for Raynaud's disease and scleroderma. His results proved encouraging. He had, in fact, compared the results of this operation on one side with those of periarterial sympathectomy on the other. A year later Royle modified Jonnesco's anterior approach to this region for the treatment of spastic paralysis of the upper limb.

Adson and Brown,[18] at the Mayo Clinic, carried out lumbar sympathetic ganglionectomies on five spastic patients, beginning in May 1924, and carefully observed the changes in limb temperature, colour, and sweat gland function. Impressed by these results they then began to apply sympathectomy to patients with vascular disturbances,[19] commendably selecting suitable cases by the degree of vasodilatation produced on body heating by the injection of a foreign protein, typhoid vaccine. They used for the upper limb, a posterior approach to enable them to reach and remove the second thoracic ganglion which Kuntz had shown to contribute to the brachial plexus.

Davis and Kanavel[20] reported a similar series of cases in the same year, approaching the cervical chain anteriorly, and being satisfied with the removal of the stellate ganglion. On the whole the results in vasospastic disease were encouraging, and sympathectomy was assured of continuing popularity. With minor modifications of technique, a better experience of results, and, in consequence, the indications for the operation, sympathectomy became, from these beginnings, an established routine procedure.

The discredit which Royle suffered regarding his and Hunter's theory of spastic paralysis, did not alter his beliefs as to the efficacy of the treatment, though he was prepared to provide other theories. The importance of his contribution in developing the surgery of the sympathetic nervous system was not always fully appreciated in his lifetime. That he did not pursue his technique along the channels, chiefly vascular, of others may be attributed, in large part, to his aims as an orthopaedic surgeon. It was left to those who learned from him to achieve the results foreshadowed by the rabbit's ear, and desired by Jaboulay.

Referring to this same topic Bernard[1] wrote, 'To sum up, even mistaken hypotheses and theories are of use in leading to discoveries.'

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