Observations

ON

THE SYMPATHETIC NERVOUS SYSTEM.*

BY

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"He that does not go beyond the facts will seldom get as far as the facts" (Huxley). In research this axiom tells the story. Starting by deductions from facts, scientific imagination develops hypotheses, which are proved or disproved through that form of inductive philosophy which we call research. Although we desire positive results, negative results have value, and often negativity itself starts a new deduction which leads to the truth. The history of our understanding of the sympathetic nervous system well illustrates the value of both positive and negative scientific contributions.

ANATOMICAL LANDMARKS.

Petit (1724) pointed out that stimulation of cervical sympathetic nerves caused dilatation of the pupil, and Winslow (1732) deduced from measurements that the sympathetic nerves did not arise from the cranial nerves. Haller (1757-1766) first discovered the rami communicantes, which marked a great step forward in our knowledge of the sympathetic nervous system. Remak (1838) discovered that there were two types of fibre in the system, the medullated or pre-ganglionic, and the non-medullated or post-ganglionic, and Müller (1840) contributed a theory as to their respective functions. The splendid research of Gaskell, published in 1885, put our anatomical knowledge of the sympathetic nervous system on a sound basis, and Langley and Dickinson (1895) followed with new knowledge of the pelvic part of the parasympathetic system.

PHYSIOLOGICAL LANDMARKS.

For a long time Bichat's theory (1830) held the field—that is, that the cerebro-spinal system brought us into contact with the outside world, but that the sympathetic system regulated the nutrition of the body. This was finally disproved by Gaskell's demonstration of the interrelation between the two systems, aided by the method, published by Langley and Dickinson (1889), of distinguishing between pre-ganglionic and post-ganglionic fibres by the use of nicotine. Experimental work on the physiology of the sympathetic nervous system dates from 1851, when Claude Bernard discovered that when the sympathetic nerve is cut in the neck of a rabbit the blood vessels in the ear of the same side become much dilated. Since then the fundamental work of the Cambridge school of physiologists has been followed in Europe by that of Jaboulay, Leriche, Jonnesco, Daniélopou, Förster, and Bruning, in Australia by that of Hunter, Royle, and Wade, and in America by that of Kunz and Cannon. The contributions of Hunter and Royle led to the remarkable recent advance in our working knowledge of the sympathetic nervous system, the practical application of which has had most encouraging results.

AUTONOMIC NERVOUS SYSTEM AND ENDOCRINE GLANDS.

While we are thrilled with these researches, and by the surgical adventures which they have stimulated in the practical application of their results to disease, let us not lose sight of the autonomic nervous system as a whole, of which the sympathetic system is only a part. Moreover, the endocrine glands, chiefly the thyroid gland, the suprarenal glands, and the hypophysis, are in close functional association with the sympathetic nervous system, and the suprarenal glands and hypophysis contain cells derived

from the *anlage* of the nervous system. Studies of the interrelation between the central nervous system, the sympathetic nervous system, and the internal secretions, hormones, vitamins, light rays, and other biochemical phenomena which have to do with foods, are contributing new knowledge of the human economy for application in medicine and surgery. In the short time at my disposal I shall touch lightly on a few problems, the solution of which depends on a better understanding of the physiology of the autonomic system.

Thyroid Gland.

In the elucidation of the relation of iodine to disturbances of the thyroid gland we owe much to Marine and to Plummer. Plummer showed that, contrary to generally entertained views, the prescription of iodine would remove the immediate effects of the deleterious secretions of the excited thyroid gland, and would restore patients to a condition in which thyroidectomy, formerly a hazardous operation, became one of safety. Plummer also demonstrated that although iodine had this remarkable effect, the improvement was to a large extent temporary, and that this drug was in no sense curative. The surgeon no longer depends on his own clinical knowledge in the diagnosis of thyroid disease, and decides on operation only when aided by the clinician and the metabolic laboratory.

Suprarenal Glands.

Of great importance are the suprarenal glands and their different secretions from the cortex and from the medulla. The small medullated nerves which arise from the lateral horns of the spinal cord pass to sympathetic ganglions, with the single exception that certain of these nerves pass to the suprarenal glands, where they are distributed to the cells of both cortex and medulla. In the last fifteen years the growth of knowledge of the function of the suprarenal glands has come through the work of clinicians and their co-workers in laboratories. With regard to bilateral organs, if one organ is intact it is sufficient for bodily purposes, and this is true of the suprarenal glands. In a number of cases I have removed a suprarenal gland because it was involved with a diseased kidney, and in subsequent clinical observation of the case I was not able to find that this procedure had any demonstrable effect on the patient.

Vascular Type of Sympathetic Dysfunction.

These important glands, the thyroid gland and the suprarenal glands, are closely associated with the vascular phenomena of certain diseases which recently have been attacked through the sympathetic system. Thus Raynaud's disease has been definitely ameliorated by operations on the sympathetic ganglions and trunks; by the same procedure it is possible to check the progress of certain types of arthritis which lead to permanent crippling and to deformity, and of angioneurosis, which gives rise to certain forms of scleroderma of the face, neck, and extremities. Patients suffering from thrombo-angiitis of the extremities have been benefited by removal of the appropriate sympathetic ganglions and trunks. It is not possible that chronic interstitial nephritis (Bright's granular nephritis) is the end-result of the same vascular type of sympathetic dysfunction? It has been shown that excision of its sympathetic nerves appears to have a marked influence on the congenital types of dilatation of the colon which are grouped under the general heading of Hirschsprung's disease.

CONTROL OF VISCERAL FUNCTIONS.

In considering the parasympathetic system, one wonders whether the vagus nerves may sustain an unsuspected relationship between the emotions and the heart, just as one wonders about the exact relationship of Langley's pelvic nerves to certain obscure happenings in and around the bladder, the pelvic portion of the colon, and the rectum.

When one tries to visualize the various forms of local control one may postulate that smooth muscle fibre was among the very earliest of the self-controlled tissues.

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Unstriated muscle may originate its own action, and within the limits of the influences which necessitate this action it is self-sufficient. The ultimate source of this power, which carries on the vegetative functions, is molecular and colloidal energy released through enzyme action, as marvellous as the energy stored in radium. Cathcart and Benedict estimate that only 25 per cent. of the energy produced in the body can be expended by tissues under the control of the will, 75 per cent. being used by the so-called vegetative functions of the body, of which we are unconscious.

In the intramural plexuses, which to a large extent control motion in the gastro-intestinal tract, we see what might be described picturesquely as pre-sympathetic ganglions, and one might even suggest that this may be true of the sino-auricular node and the bundle of His in the heart. In the unconscious control of visceral functions through the sympathetic and parasympathetic systems, and the related glands of interaction, one might imagine that the heart is still showing the effect of an early form of control, by primitive emotional centres which existed long before the intellectual organs developed.

Psychic Influences.

A supreme relationship originated in that shadowy day when hunger and fear, and love and hate, ruled the early ancestral state. Perhaps the psychic influences of this relationship have lost none of their magic. Our emotions and our capacity for acquiring knowledge are hereditary. Emotions may be said to be the outgrowth of those experiences which we call instincts in the lower animals, reactions which existed before the development of true intellectual centres. Unstriated muscle is unconsciously controlled; striated muscle is under conscious control. But the heart is composed of a primitive type of striated muscle. Does this indicate an ancient form of control by unidentified emotional centres? Does the anatomically low origin of the vagus nerve indicate such a primitive cardiac function? Note the direct connexion of the suprarenal glands with sympathetic nerves. In other words, does stern control of the emotions throw stress on the heart, and lead to degeneration of its musculature and to coronary disease?

Do such speculations lead us to believe that by further refinements of diagnosis at the hands of physicians familiar with the electrocardiograph and with other methods of precision the surgeon will be enabled, in early cases of impending vascular disease of the heart, to relieve the strain on its muscle by division of nerve fibres or by extirpation of sympathetic ganglionic tracts? In susceptible persons, spasmodic constriction of the arteries in Raynaud's disease, scleroderma of vasospastic origin, and some types of arthritis, eventually leads to vascular obstruction. How about the heart? Is angina pectoris a similar vasospastic phenomenon, and coronary and myocardial disease its end-result? In the final analysis, heredity may be found to be a controlling factor.

From the Royal Victoria Hospital in Manchester attention has been called to the fact that a common cause of death among surgeons is disease of the heart, especially coronary stenosis, coming on in the latter part of the sixth and the early part of the seventh decade of life. In all other respects the surgeon maintains his general health equal to others, and often post-mortem examination does not show evidence of other serious disease. The tendency to death from heart disease is not confined to surgeons, but is common to all men who live lives of stress, in which stern control of the emotions is necessary. It is true that much of the disability among surgeons is due to the fact that surgery is to a certain extent a handicraft, and that age and anxiety produce reduction in skill; but, after all, that is not the most serious consideration. The keen clinician, as he grows in experience, becomes more and more valuable as age advances. He is not exposed to those malign influences of anxiety and responsibility to the same extent as is the surgeon. One might say that the clinician sees his patient drowning and throws him the best means of relief he has, but that the surgeon, in order to give relief, jeopardizes the patient anew.

THE CLINICAL RESULTS FOLLOWING THE OPERATION OF SYMPATHETIC RAMISECTION.*

BY

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SYMPATHETIC ramisection was introduced by me in October, 1923, for the treatment of spastic paralysis. It followed upon experiments carried out to investigate the apparent failure of reciprocal innervation in spastic conditions. The results of these experiments are recorded elsewhere.¹

De Boer had previously found that the normal tonus of the hind limb of the frog and the cat disappeared when the rami communicantes of the sympathetic ganglion were cut. Other investigators obtained similar results, but I was unaware of these when I carried out my experiments.

DISCUSSION OF TONE.

When the limb was deprived of its sympathetic nerve supply it behaved differently to a normal limb in that it showed a loss of resistance to passive movements; in addition, it exhibited an inability to oppose gravity in the decerebrate, anaesthetized, and normal passive animal—that is, there was a loss of the posture-maintaining mechanism. The different behaviour of a limb deprived of its sympathetic nerve supply was attributed to a loss of tone.

There is considerable controversy about the exact nature of tone, and a definition is difficult to give, but the definition that I use is that tone is the expression of a proprioceptive mechanism subserving posture, and is present in muscles which have been stretched or are being stretched—that is to say, it is not exhibited to any extent by muscles at rest.

Over this mechanism of tone we have no conscious control except as a concomitant to active contraction. There is a small amount of tone in a normal muscle which is overcome by the contraction of the opposing group, but is not directly inhibited. Though I do not subscribe to the idea of co-contraction, tone is certainly induced by stretching the opposing group in any movement.

The upper eyelid maintains a definite posture in the waking stage in response to the stretching imposed by gravity. We cannot voluntarily make this posture any more fixed or any less fixed, but the tone is not sufficient to impede movement in changing the position of the lids. If through some pathological change tone becomes abnormally increased, as it does in spastic paralysis, it not only increases the tendency to maintain posture, as is shown by the persistent attitudes of spastic hemiplegia, or by the inability to balance in spastic paraplegia on account of rigid limbs, but it also forms an obstruction to movement. There is an apparent failure of reciprocal innervation due to an increase in tone in opposing groups of muscles. For example, the excessive tone of the flexors of the elbow or knee induced by stretching cannot be inhibited when the extensors are contracting. Although this may not appear in the laboratory animal, it does in the intact human subject.

The chief indication for the operation of sympathetic ramisection is the failure of inhibition in voluntary muscles. This is expressed by delayed relaxation time in reflexes, as in the knee-jerk, and by the inability to relax the muscles quickly. There must also be present definite cortical control over the muscle group for the operation to be effective. The essential change following a ramisection is that the patient no longer has to inhibit the excessive tone of his formerly contracted hypertonic muscles if cortical control is present. Sympathetic ramisection does not remove contractures of fibrous tissue, nor does it restore cerebro-spinal pathways. It decreases tone, and thus enables patients to move smoothly and more rapidly. Movements are gained or regained as a result of operative treatment, as in the intrinsic muscles of the hand or the common extensors of the fingers, because the patient is

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