A British Medical Association Lecture ON THE SURGICAL ASPECTS OF CERTAIN DISTURBANCES OF THE INVOLUNTARY NERVOUS SYSTEM MET WITH IN THE ALIMENTARY TRACT.*

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MR. PRESIDENT AND GENTLEMEN,—I thank you for the privilege you have afforded me in asking me to speak to you this afternoon. I am grateful to you for many reasons. I confess I enjoy a visit to London, and as I walked along Piccadilly this morning it seemed to me that George Colman's lines still hold good:

"Oh, London is a fine town,
A very famous city,
Where all the streets are paved with gold,
And all the maidens pretty."

The reputation of 1797 applies to-day, and we country mice from the provinces are enamoured of it all. As I sat just now on the edge of the fountain in the courtyard, before Professor Gask took charge of me, I felt conscious of the privilege of speaking on this historic spot, for, if the walls are modern, the spirit is as old as that of Rahere, the founder and prior of 1123.

It is my intention to speak on a subject which interests me greatly, and I would I could garb it attractively, so that you too might be interested. It is necessary that I introduce the subject with a brief reference to the physiological anatomy of the important body element—the involuntary nervous system.

FIG. 1.—Diagram showing relation between pre-ganglionic and post-ganglionic fibres. (From *Essentials of Physiology*, Bainbridge and Menzies.)

Langley in 1898 grouped together the efferent nerve fibres and ganglionic systems which control the unstriated and cardiac muscles and the glandular tissues under the name of "the autonomic nervous system," and this work, together with that of Gaskell, Bayliss, Starling, Langdon Brown, and many others, has put our knowledge of this most interesting though intricate system upon a clear basis.

A GENERAL APPRECIATION OF THE ANATOMY.

It seems to me that we get an interesting appreciation of the peculiar distinctions of the involuntary nervous system if we contrast it with the arrangements which pertain in the voluntary. In the voluntary nervous system the motor nerve cell lies in the grey matter of the anterior horn of the spinal cord, and the nerve fibre which arises from it is medullated in structure, efferent in direction, and effector in function. How different is the orientation (if I may use the term in this

FIG. 2.—The paths of the reflex. A, The path of the ordinary spinal reflex. B, The path of the sympathetic reflex. (From Langdon Brown's *The Sympathetic Nervous System in Disease*.)

sense) of the involuntary system! Here the nerve cell occupies a situation which is extracordal and usually localized in a ganglion. The cell is connected with the cord by a fibre which is medullated in structure, pre-ganglionic in position, and yet when considered on a physiological basis connector in function—a link, in other words, which con-

nects the effector cell with an intracordal station. From the ganglionic cell there passes in a peripheral direction a fibre which is non-medullated in structure, post-ganglionic in position, and effector in function. This is a contrast appreciation of the position which I have found most helpful in my own estimation of the relations of these two divisions of the nervous system.

SYMPATHETIC AND PARASYMPATHETIC DIVISIONS.

The physiologist and the anatomist have subdivided the involuntary nervous system into the *sympathetic* and the *parasympathetic* groups, and, in view of certain clinical facts which I shall discuss later, it is well that we should recognize the reasons for which the distinction has been made.

The Distinction of Position.

There is first the distinction of position. The fibres which constitute the sympathetic division leave the spinal cord over a wide level—a level which extends from the first dorsal root to the fourth lumbar root. In contrast to this the parasympathetic outflow lies in relation to the extremities of the cerebro-spinal axis, for its impulses are transmitted from the mid-brain and the medulla through the medium of the oculomotor, the chorda tympani, and the vagus, and from the sacral segments through the pelvic nerves. "Bulbo-sacral" is the term which is sometimes applied to the parasympathetic division, and the description is a convenient one so far as anatomical distribution is concerned. It will be observed that the outflow of the sympathetic nervous system is separated from the points of exit of the parasympathetic system by those areas of the spinal cord which contain the cord innervation centres for the upper and lower limbs—the cervico-dorsal enlargement separates the sympathetic from the bulbar parasympathetic while the lumbo-sacral enlargement exists between the sympathetic and the sacral parasympathetic.

In passing we may note that this orientation of the various portions of the nervous system is of great interest to the phylogenist and the morphologist, for it is in some respects an indication of the progress of evolution. The development of the extremities and the spinal nerve cell arrangements which their innervation demanded have evidently been later in their formation than the involuntary nervous system, hence the separation of the involuntary segments by the limb related enlargements of the cord.

The Distinction in Function.

Of greater practical importance in our subject, however, is the distinction in function which characterizes the two divisions of the involuntary nervous system. Every student of physiology knows how impressive is the distinction where the heart muscle is concerned between the action of the vagus (parasympathetic) on the one hand and the sympathetic on the other—the one inhibitory and retarding, the other accelerating. Where the enteral or alimentary system is concerned the generalization may be made that the two portions of the involuntary nervous system are to some extent antagonistic the one to the other. If the stimulus of one division results in contraction it follows almost as a matter of course that the activation of the other will induce an inhibition which is virtually a relaxation. It is true that in certain situations a single type of

FIG. 3.—The cell stations of the autonomic nervous system. (From Lyle and De Sousa's *Physiology*.)

supply, either parasympathetic or sympathetic, is provided, and in such an event it follows that both varieties of impulse are converged by the same channel. Such an arrangement probably applies in the oesophagus and cardiac portions of the stomach, where the parasympathetic is the sole source of supply, and probably in certain sections of the large intestine where the sympathetic is the sole distribution. These facts, however, do not affect the

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general consideration that the functions of the two divisions of the involuntary nervous system are antagonistic, and that in health the related exercise of the two types of function is so carefully balanced and adjusted that healthy tone results. I would add that, while the exercise of antagonistic function is general, it is exercised particularly in those regions in which special arrangements of muscular fibres exist—as, for example, in the region of the sphincters of the alimentary canal.

The Distinction of Distribution.

At first sight it would appear as though a distinction existed on the basis of the structural arrangements of the two divisions, and in certain respects this is true. The scheme of the involuntary nervous system is a medullated fibre from the cerebro-spinal axis, a relay ganglion around the cells of which the medullated fibre synapses, and a non-medullated fibre which is continued to the effector organ. The principle of this arrangement is maintained throughout the entire system, and exceptions which appear to exist are more apparent than real. It would seem as though the arrangement of such a parasympathetic nerve as the vagus differs very materially from the average sympathetic fibre, but such is not actually the case—both are arranged and distributed on a common scheme.

It is, I believe, correct to summarize the position as follows. It is characteristic of the sympathetic division to possess a short pre-ganglionic non-medullated fibre and a long post-ganglionic medullated fibre; it is typical of the parasympathetic, on the other hand, to show a long pre-ganglionic fibre and a short post-ganglionic distribution. The ganglion with its cell station is common to both; the distinction, if one may call it so, is in the respective lengths of the pre-ganglionic and post-ganglionic fibres. It is correct, however, to recognize that the effect of this arrangement results in a distinction, for the proximity of the parasympathetic cell station to its organ results in a localized response, while the stimulus of a pre-ganglionic sympathetic fibre is followed by a wide and diffuse reaction.

A Physiological Distinction.

One distinction there is, physiological in type, but a distinction which may have great importance in its influence upon certain chemical and pathological questions. I allude to the close and peculiar relation which the sympathetic division of the involuntary nervous system bears to the adrenals. Phylogenetically, embryologically, and functionally the two are in the closest relation to each other, and interaction of their respective functions must be constantly in evidence. In explanation of this point I quote the words of Gaskell:

"The evidence of embryology and comparative anatomy thus points strongly to the conclusion that the sympathetic nervous system arose from nerve cells containing adrenaline . . . and that when these cells left the central nervous system to become peripheral they left not as single cells, but as two separate cells, one of which contained all the adrenaline and formed the chromaffin system, and the other the nerve cells of the sympathetic system of the vertebrates."

In this we find the explanation of the fact that the nerves of the suprarenal are pre-ganglionic in type, and it makes clear Langley's generalization that the effect of adrenaline on a tissue is similar to a stimulation of its sympathetic nerves. As Langdon Brown expresses it, "the chromaffin cell represents the excitor element."

Psychological and Metabolic Distinctions.

There are yet further distinctions. It is possible to recognize a psychological difference, for the sympathetic is a medium by which the defence mechanism of the body is stimulated while the parasympathetic is the "lotus-eater's friend." Even on a metabolic basis a distinction may be drawn, for the sympathetic is as strongly katabolic in its effects as the parasympathetic is anabolic.

It will be agreed that the distinctions are sufficiently numerous and manifest to justify the subdivision of the involuntary nervous system into two groups—sympathetic on the one hand and parasympathetic on the other.

AN ASPECT OF THE EVOLUTION OF THE INVOLUNTARY NERVOUS SYSTEM.

I confess that it is with some measure of trepidation that I include this aspect of the subject. It may seem scarcely germane to the question under discussion, though I believe I shall be able to dissipate that attitude; my anxiety is rather in embarking upon a subject which remains so controversial. But the lessons I wish to draw are very simple; hypotheses I will undertake to avoid. The principle I desire to follow is one which I believe might well be applied in much of our work—the principle of thinking biologically and of correlating the lessons of biology to the problems of our clinical studies.

In a general sense it is true to state that our nervous system is composed of three elements—receptor, effector, and that important link which connects the two and in one sense makes life possible, the adjustor or connector fibre. The complexity of this arrangement is the result of a long process of evolution, and it is the phases of this process and the lessons I would draw from it that I desire to present.

Let us consider the nervous mechanism of such a simple organism as the sea sponge. A single sponge is a goblet-shaped or finger-shaped animal attached by its base to the sea bed. The ordinary bath sponge is an example of the principle which Fabre has so vividly described, the "community" grouping of the simple types of the natural world, for it is composed of a number of individual finger sponges fused together; it is, in fact, a communistic or gregarious production. The outer surface of the creature is perforated by a series of pores which lead into a system of canals each lined by "lash" cells, the function of which is to propel the water through the canals into a large space in the centre of the sponge, from which the fluid ultimately escapes by a single large opening at the unattached end of the animal. From the current of fluid in circulation the creature extracts the necessary nourishment, and the production and the control of this current are the essential features of its existence. The direction and the degree of the current are controlled by such simple arrangements as a slight contraction and bending of the body as a whole, by the formation of protoplasmic membranes which temporarily close the openings, and by the action of layers of simple muscle cells which surround the pores and the exit openings.

The mechanism is simple, but is none the less vital to the well-being and existence of the individual, and we naturally ask ourselves how it is induced and controlled. The experimental and biological knowledge which we possess has failed to reveal any evidence of nerve mechanism or transmission. The responses are put into operation by direct stimulation without any associated nervous impulse; in fact, the life of the creature is maintained by structures which respond only to direct stimulation, a local response to a local stimulus.

Let us pass higher in the scale of animal life and consider the arrangements which exist in the sea-anemone (*Actinia mesembryanthemum*). The appearance of this creature is well known. The sac-like body is attached by means of the "pedal disc" to rock or stone; the large central cavity, surrounded by its fringe of tentacles, is the space in which digestion proceeds and from which undigested residue is discharged to the exterior. When an expanded sea-anemone is stimulated by contact it responds by a general contraction of its body musculature, and the response follows a stimulus applied to any portion of the body wall. A general and collective response succeeds a local stimulus, a result which is ensured through the medium of a nerve net spreading throughout the body substance, bringing any and every portion of its body surface into association with its entire musculature. The arrangement is an example of direct transference from receptor to effector through the medium of a nerve net, the control organ or adjustor being absent.

It is in the earthworms (Annelida) that the first evidence of an adjustor mechanism becomes apparent. In the anterior extremity of the creature on the dorsal aspect there is a small collection of nervous matter which may be termed a brain, while connected with this and extending along the ventral mid-line is a segmented chain of ganglionic enlargements. Primitive in its arrangement such a central nervous system may be, and yet a very real advance

in the evolutionary trail, for it contains the internuncial neurones which constitute the beginnings of the adjustor or connector mechanism.

In the scheme of evolution muscle first functioned as an independent effector; receptors or triggers for activating the muscles were afterwards developed, the diffuse nerve net acting as the organ of transmission and intercommunication; and finally a central nervous organ was evolved at the site of the adjustor or connector mechanism, a tissue or group of tissues which eventually adopted the function of modifying responses in relation to past influences until it has become a storehouse of experience and the centre of the intellectual life (Parker).

The evolutionary picture which I have drawn would indicate that the involuntary nervous system, and particularly that portion which is grouped as the sympathetic system, is the persistence of an earlier type. The involuntary muscle of the intestine responds to direct stimulus, as does the tissue of the sponge; many of the hollow viscera possess a nerve net which functions as does the parallel system of the sea-anemone, while the nervous system of the earthworm is arranged on a plan strikingly similar to that found in the ganglionic cord of the sympathetic nervous system of man.

If it is correct to consider the sympathetic portion of the involuntary nervous system as the oldest from the phylogenic point of view, it follows that the parasympathetic is a later acquisition, and this would seem to be indicated for several reasons: (1) from its position in relation to the extremities of the cerebro-spinal axis; (2) from its relation, in part at least, to that portion of the cerebro-spinal axis which has been a late acquisition in the phylogenic tree, the mid-brain and medulla; (3) from its great length of medullated nerve structure.

The Acquisition of Contraction and Inhibition.

It is a necessary preliminary for the thesis which I am about to present that I answer a question which may be of great importance in relation to certain pathological features. The question is: "Does the acquisition of the function of motor activity (contraction and relaxation) precede the acquisition of the function of inhibition, or is there a coincident development of both functions?" The answer I venture to give is suggested to me by the results of a simple experiment on the sea-anemone.

When the creature is fed with small particles of meat the food is collected by the tentacles and passed into the central cavity, where it is ultimately digested. If fragments of filter paper soaked in meat juice are alternated with the meat both materials are accepted indiscriminately—but not for long! After some eight or ten experiences the meat is accepted while the filter paper is rejected. Inhibition has been excited, but only as a secondary and subsidiary function. The experiment affords information which enables me to answer the question, for the evidence I have quoted suggests to me that the acquisition of motor activity precedes the acquisition of the function of inhibition.

The information is important for the substantiation of my hypothesis, but for the present it is sufficient to state my belief that in the involuntary nervous system the acquisition of contractive function precedes the inhibitory; in fact it may well be that the exercise of inhibition is at first experimental and selective, and only later becomes a regularized part of the nervous mechanism.

FIG. 4.—The distribution of the parasympathetic or bulbo-sacral (enteral) system. (From Pottenger's *Symptoms of Visceral Disease*.)

inhibitory on the other, I believe that the motor is the more primitive, and that in the growth and progress of any individual, the motor function takes precedence in its time of acquisition of the more selective inhibitory function.

THE DISTRIBUTION OF THE SYMPATHETIC AND PARASYMPATHETIC NERVOUS SYSTEMS IN RELATION TO FUNCTION.

Authorities differ a good deal in their descriptions of the

distribution of the involuntary nerve supply to the respective portions of the alimentary tract, but certain general considerations are accepted (Fig. 5). The oesophagus and the cardiac portion of the stomach are supplied by the parasympathetic, both motor and inhibitory impulses being conveyed along this channel. In the pyloric half of the stomach the sympathetic first becomes evident, and from this point onwards as far as the ileo-caecal region there is a combined distribution of sympathetic and parasympathetic elements, the former motor, the latter inhibitory in its effects. The large intestine as far as the lower end of the pelvic colon is evidently the site of a pure sympathetic distribution, motor and inhibitory functions being distributed along this channel. The remaining portion of the large intestine and the rectum combine a sympathetic and a parasympathetic supply, the former being inhibitory and the latter motor. Particularly important in view of the pathology presently to be discussed are those areas where the

FIG. 5.—Schematic illustration of the double innervation of the enteral system. (Modified from Pottenger's *Symptoms of Visceral Disease*.)

various types of supply meet or overlap—the pylorus, the ileo-caecal junction, and the lower reaches of the large intestine.

A PATHOLOGICAL APPRECIATION.

Each system has its peculiar pathology, and in common with others there is a pathology of the involuntary nervous system—a state of affairs which differs from the normal,

and by doing so results in the various symptoms and physical signs of a clinical picture.

The evolution of clinical knowledge has been, and will continue to be, along certain well defined lines. Anatomy introduces the field, experimental physiology elucidates its functions, symptoms and physical signs denote derangement of these functions, and the picture is completed by the correlation of signs and symptoms with a characteristic pathology. Where the involuntary nervous system is concerned the usual path is being followed, and we are at present in a phase where, thanks to the work of the anatomist and the physiologist, a clinical picture is shaping itself and a pathology is being sought.

That disorders of the involuntary nervous system occur is beyond dispute. In relation to the hollow viscera of the abdomen such disorders may be made manifest at the sphincters or throughout the continuity of the canal. On a hypothetical basis it is possible to conceive four types of derangement:

- (a) Abnormal stimulus of contraction (spasm).
- (b) Persistence of contraction effects (achalasia).
- (c) Persistence of inhibitory effects (atony).
- (d) Irregularity of the normal peristaltic waves (arrhythmia).

It is when we attempt to speak of the pathology that we are met by the difficulty of ignorance. I can tell you the changes which result from the derangements I have outlined (a secondary pathology if you like), but there must be something deeper—original, primary, whatever you care to call it—and it is there that my difficulty lies, because as yet we do not know with any certainty in what this primary change consists, whether it be central, ganglionic, endocrine, or peripheral.

A CLINICAL PATHOLOGY.

As a primary pathology has yet to be discovered, I am driven to consider an aspect which may be described as a clinical pathology—the evidences of disease, the various disorders of the hollow alimentary viscera which in our conception proceed from derangements of the involuntary nervous system. I search through the span of life, I pick out those conditions which at one time or another with a sufficiency of reason have been ascribed to a derangement of the involuntary nervous mechanism, and I plot out in a simple fashion the age periods at which such disturbances occur. The result is interesting.

The Age Incidence.

Within a few weeks or months after birth we meet with certain disturbances which, in the opinion of many, should be included under this heading: hypertrophies of obscure origin affecting local segments of the alimentary canal; hypertrophies occurring with unfailing regularity at the sphincteric regions of the gut (the pylorus, the ileo-caecal sphincter, and the pelvi-rectal or O'Beirne's sphincter)—conditions to which there is no parallel in the later years of life; I allude to congenital hypertrophy of the pylorus, congenital hypertrophy of the ileum, and Hirschsprung's disease. These conditions possess characteristics which justify their inclusion in a special class, and as such they are representative of the early months of life.

The second group of cases which may be considered as being related in their origin to disturbance of the involuntary nervous system appear in the period of infancy. They are distinguished by irregular and abnormal peristaltic rhythms, arrhythmias, exaggerations of a physiological action which by reason of special mechanical conditions gives rise to serious pathological pictures; I allude to the intussusceptions, conditions which Neulinger once described as "uneducated and misguided types of peristalsis," clinical entities of a peculiar type and sufficiently distinctive of a definite age period in the span of life—the period of infancy.

Then follows a phase which extends from the end of infancy to puberty and into the age of adolescence, a phase of life which is remarkably free from the disturbances we have under consideration. Hypertrophies are unknown, the arrhythmias of intussusception are so rare as to be negligible events, and the atonies, the spasms, and the achalasia of which I shall speak in a moment have not as yet become manifest. In figurative language it is a period of calm, and, I may add, a calm which precedes the storm, for from

the passing of puberty and the early years of the twenties up to middle life, and particularly the menopause of the female, the incidence of what one may call functional disturbances of the hollow viscera—the spasms, atonies, and achalasia—are unusually frequent. It is a period of functional disturbances, of errors which are rarely serious unless it be from a functional or mental point of view, of disturbances in which a primary pathology is difficult to demonstrate, yet in which a real symptomatology is manifest. In contrast, the later decades of life are remarkably free from disturbances, and so the story ends.

The periodicity of events is surely not without significance: the hypertrophies which distinguish the early months, the arrhythmias, the uneducated functions of the early years, the period of calm as though the lesson had been learnt and an adjustment secured, the functional derangement which succeeds adolescence, the freedom from symptoms of the later years.

Let me now consider in a more individual sense the various disturbances which may reasonably be ascribed to influences exerted by the involuntary nervous system. I shall express as far as I am able the impressions which I have of the origin and nature of the various diseases, always in the light of what I have already somewhat generally described.

THE HYPERTROPHIES OF INFANCY.

Congenital Hypertrophy of the Pylorus.

The distinctive features of this condition are well known. The essential lesion is a hypertrophy of the muscular coats of the pyloric canal and antrum and to a slight degree the distal portion of the body of the stomach. The circular fibres of the pyloric sphincter are not affected, and it is a correct summary of the affected area to say that it involves that portion of the stomach musculature which is concerned with the expulsion of contents. Such changes as dilatation of the stomach, catarrh of its mucous lining, and body wasting are obviously secondary features.

The abnormality in function of an organ so affected becomes apparent on x-ray examination. There is an ill timed and abnormal, yet forcible and prolonged, contraction of the stomach muscle, and, because of the very inopportune of the function, contents are prevented from leaving the stomach.

The problem has been to account for the muscular hypertrophy. The theory of the congenital redundancy of growth, as suggested by Hirschsprung, Cantley, and others, finds few supporters, and the view which Thomson first enunciated, "that the muscle is hypertrophied because from an early period in its development it has been worried into overgrowth by constantly recurring overaction such as would result from even a slight degree of habitual inco-ordination," is now in favour. It is apparent that a demonstration of the origin of the disease is, and is likely to remain, a matter of great difficulty, but there are certain facts which help us. We must bear in mind the observation so frequently made that if the body strength can be maintained these cases pass to a natural cure by a disappearance of the hypertrophy. We have the knowledge which John Hunter first gave us, and a knowledge repeatedly confirmed, that the tendency to hypertrophy as the result of repeated forcible contractions is peculiarly well marked in involuntary muscle. We have the observation, which I believe Cameron first made, that the hypertrophy does not affect the circular fibres of the true pyloric sphincter. There is no actual obstruction—a truth which may be confirmed at operation—and it is probably significant that the change occurs at a situation in which a pure parasympathetic nerve supply merges into an area in which a mixed sympathetic and parasympathetic supply exists. Such a combination of events and related conditions suggests a persistence of motor function without the beneficial influence of inhibition, with, it may be, an achalasia or want of relaxation of the circular tissue of the pyloric ring. But my case is not yet complete.

Hypertrophic Iliac Obstruction.

During the thirteen years I was privileged to act as a member of the staff of the Edinburgh Royal Hospital for Sick Children I operated on three obscure and interesting

cases of intestinal obstruction in babies. The history in each case was somewhat similar. At birth the child appeared to be well and meconium was passed, but at a period which varied from four days to three weeks after birth signs of obstruction developed. There was vomiting of bile-stained fluid; the bowels, which had always been constipated, now ceased to act, and the abdomen became distended, a ladder pattern of small intestine being apparent. Repeated enemas usually succeeded in evacuating small amounts of bile-stained faecal matter of a somewhat inspissated type.

Laparotomy showed coils of dilated small intestine, but the lower six inches or thereabouts of the ileum was the site of a most marked hypertrophy, so marked, indeed, that in the first case I saw I mistook the condition for a hypertrophic type of small intestine tuberculosis, though I confess I was at a loss to explain how the infection could have arisen in a child of such tender age. In the two subsequent cases I recognized that the condition was a muscular hypertrophy proceeding from some obscure cause.

In the first case an ileostomy was done—unfortunately, as I now recognize, for the child succumbed—while in the other instances the abdomen was closed and recovery ultimately ensued, though constipation remained a difficulty.

I believe that these cases were examples of a disease similar in pathology and in origin to congenital hypertrophy of the pylorus. Again, it is significant that the lesion occurred where the parasympathetic nerve distribution probably ends and a pure sympathetic supply is continued; as in the pylorus, the segment affected is that immediately proximal to the actual sphincters, and there is the same tendency towards spontaneous recovery. The evidence suggests that we are dealing with the result of a neuro-muscular error, an hypertrophy which has proceeded from uncontrolled contractive impulses in a segment of bowel the muscle of which has not yet acquired the function of inhibition.

Congenital Hypertrophy and Dilatation of the Colon.

Ammon first described the condition in 1842, but the classical account which Hirschsprung gave in 1886 has led us to associate his name with the disease. Its characteristics are dilatation of the colon, most marked at the distal portion and diminishing as the gut is traced centrally, hypertrophy of the muscular coats, both circular and longitudinal, and of the muscularis mucosae. The peritoneum and mesocolon are thickened, and the associated blood vessels, lymphatics, and lymphatic glands are enlarged, and in a well established case the mucous membrane is thickened and often ulcerated. Many of these appearances, however, are secondary in their incidence, and those who have had an opportunity of seeing such cases in babies in the early stages of their development agree that hypertrophy of the muscular coat and dilatation of the colon canal are the original and the primary features. The lower limit of the change is usually at the junction of pelvic colon and rectum (O'Beirne's sphincter), but in a few instances the hypertrophy and dilatation extend downwards to the level of the anal sphincter.

I believe that the condition is of a similar nature to those I have already mentioned. Occurring at a situation where a sympathetic nerve supply comes into contact with a muscular tissue provided with parasympathetic innervation, affecting a segment of gut on the proximal side of a sphincter, associated with hypertrophy of the muscular fibres (though in this instance the gas content of the large bowel produces a coincident dilatation), the disease first becoming evident in the weeks which immediately succeed birth, this combination of circumstances suggests an etiology similar to that of congenital hypertrophy of the pylorus and congenital hypertrophy of the ileum—an uncontrolled contractive function, a delay in the acquisition of the power of inhibition, combined, it may be, with achalasia, an insufficient relaxation of the associated sphincters.

There remains yet another example of an hypertrophy of the alimentary tract ascribable to the influence of the involuntary nervous system—the condition of cardiospasm,

a dilatation of the lower end of the oesophagus with hypertrophy of its walls. I believe that this disease might with reason be included. Fleiner¹ has described examples occurring so early in life that he classified them as congenital, hypertrophy and dilatation characterizing the local pathology, and it may be that one of the nerve junctions which distinguish the disorders I have already described exists here also, for our knowledge of the nerve distribution of the oesophagus is by no means exact. There are, however, aspects in which cardiospasm differs from the aforementioned hypertrophies and dilatations, and therefore I provisionally exclude it. In relation to the other conditions, however, the point I wish to make is that in the early weeks and months of life we find highly distinctive derangements of the non-striped muscle of the alimentary tract, which are characterized by hypertrophy, which occur in situations where different types of nerve supply intermingle, which under certain conditions eventually undergo restoration to normal, and which are without parallel in the later years of life. It has seemed to me that the process which explains these errors is one which in its beginnings is functional, a delay in the acquisition of the power of inhibition by certain segments of the alimentary canal, segments which are proximal to sphincters and which correspond to areas of different nerve type junction.

As I have recalled in the simple experiment of feeding the sea-anemone, the acquisition of inhibition lags behind the functions of contraction and relaxation, and in the disease which we have under review it may well be that an undue delay in the appearance of the function of inhibition will explain the peculiar pathology, an hypertrophy which results from an uncontrolled contraction and relaxation. With the acquisition of the function of inhibition the stimulus is controlled and the hypertrophy disappears.

THE ARRHYTHMIAS OF EARLY CHILDHOOD.

While the distinctive feature of involuntary nerve errors of the early weeks and months of life is localized hypertrophy, the derangements of a later period are characterized by an exaggeration of the normal functions of the muscular coats—the function of peristalsis—and as a result we find that during a period which extends roughly from the sixth month to the end of the second year, intussusceptions, the results of an excessive and misguided peristalsis, are met with. In the last 300 cases of intussusception operated on in the Edinburgh Children's Hospital 295 had their beginnings in the small intestine, in the lower end of the ileum, where after reduction the original point of invagination remained apparent. Now the muscle of the small intestine demonstrates three varieties of activity:

(a) *A Segmentation Movement.*—An example of a local response to stretching by contents, and one independent of the myenteric reflex. The aim of this movement is to break up masses of food and to bring the nutritive material into close association with the absorptive mucosa of the gut. Because of it food passes up and down the gut for a few centimetres only.

(b) *True Peristalsis (Diastalsis).*—In this instance the stimulus is chemical rather than mechanical, and a wave of inhibition always precedes the contraction, which moreover invariably progresses in the distal direction. This movement depends upon the integrity of the nerve net, for, if repeated encircling incisions be made through the musculature of the small intestine so as to interfere with the function of the myenteric nerve plexus lying between the muscular coats, the movement is abolished. The function of this type of peristalsis is to pass the nutritive material on for some considerable distance in order that fresh areas of absorption and digestion may be reached.

(c) *The Peristaltic Rush.*—Under certain conditions the true peristaltic wave may advance at a very rapid rate. This is called "the peristaltic rush," and it is evidently in this way that intussusception is induced. It is a swift wave of peristalsis, which may sweep over the entire length of the small intestine in about one minute, and it was first observed by Van Braam-Houckgeest in rabbits killed by asphyxia. The confused squirming of the coils as the contraction rushes along has caused the phenomenon to be designated the "Rollbewegung," or the vermicular wave.

That the rushing wave is actually peristaltic in character was proved by the observations of Snelitzer and Auer. They showed that it consists of a contraction preceded by a completely relaxed section of the gut, and they were able to evoke the phenomenon in rabbits by intravenous injection of a combination of substances designed to

produce simultaneously stimulation and inhibition of intestinal activity. The most effective pair was ergot (stimulant) and calcium chloride (depressant).

When the phenomenon occurs in man the wave is carried with some degree of violence throughout the length of the small intestine. As long as inhibition precedes contraction no harm results, but when the wave reaches the lower end of the ileum, an area in which a new type of nerve supply is encountered, under certain conditions the preceding phase of inhibition is not transmitted, with the result that the strong contraction of the "peristaltic rush" carries a circular area of the gut into the distal segment as an invagination, and the intussusception has begun. I said that the event was likely to occur only under certain conditions, for every child who evidences the "peristaltic rush" does not develop intussusception; a developmental anomaly is the predisposing feature, for, if the ileo-caecal segment has failed to complete its fixation to the posterior abdominal wall, if, in other words, the third stage of intestinal rotation has not been completed, and the ileo-caecal segment is provided with a loose mesenteric attachment, the occurrence of a peristaltic rush is likely to be followed by the development of intussusception. Why this should be is difficult to explain. The laxity of the attachment offers a mechanical explanation of the migration of the intussuscepting segment, but in all likelihood there is a further influence which concerns the nerve supply of the bowel, and it may be the nodal tissue in the ileo-caecal segment.

It is natural that we should inquire about the origin of the peristaltic rush. In view of the experimental work of Snetzler and Auer we are tempted to imagine that some dietetic error which combines the depressant and the stimulant factors may be the source, but, even so, the original stimulus, whatever it may be, is acting upon an intestine which in some way is predisposed to disturbance of this nature, a bowel the functional education of which is not yet adjusted and stabilized.

The period of the intussusceptions is followed by an interval which is largely free from involuntary nerve disturbance of the alimentary tract. It would seem as though the lesson had been learnt, adjustments made when necessary, and the functional education completed.

THE DISORDERS OF ADULT LIFE.

With the passing of puberty, however, or later it may be, in certain individuals there is another breakdown in the neuro-muscular alimentary arrangements, not immediately serious as are the hypertrophies of the early months and the arrhythmias of the early years, yet ultimately of great importance from various points of view, psychological, diagnostic, and toxæmic. The disturbances of these later years are most elusive in both their etiology and their pathology. In view of the time period of their manifestation and the response which many cases show to glandular therapy it may well be that a derangement of the glands of the internal secretories is the origin of the nervous disturbance. From what I have seen I am convinced that an imperfect attachment of the caecum and ascending colon to the posterior abdominal wall is a frequent, in fact I would say a constant, accompaniment of the functional disorders—that, in other words, an abnormal type of intestinal arrangement exists to make such disturbance possible. But we must confess that our knowledge of the etiology remains largely hypothetical.

The pathology is as difficult of demonstration as the etiology. Spasms of achalasia or want of relaxation and atonies express the changes which give rise to symptoms, yet, except in the case of the atonies, many of them are as transient as the morning mist; they vanish during anaesthesia and operation, and when life has fled they too have vanished.

But it is in respect of diagnosis that a great interest lies. During six months' work in the Edinburgh Royal Infirmary I have kept a careful record of fifty-eight cases sent to hospital with the diagnosis of appendicitis. Twenty-four of these showed pathological conditions of the appendix, thirty-four were examples of ileo-caecal pain certainly, but the explanation was not an inflammatory lesion of the appendix, but a spasm of the caecum and the

related colon. There was a diagnostic error which exceeded 50 per cent.

I can produce similar figures in relation to the stomach, where gastric and pyloric spasm and achalasia of the pyloric sphincters have closely simulated stomach and duodenal disease. It is true that many of these disturbances are reflex, and in some instances the association is obvious, but in many it is impossible to discover the source from which the derangement is proceeding. Pain and functional derangements are the usual symptomatic evidences of the spasms and the achalias. Gastric spasm and achalasia of the pylorus may closely simulate the symptomatology of serious stomach disease. I have alluded to the frequency with which ileo-caecal and ileo-colic spasm are confused with appendicitis. I have seen a spasmodic contraction of the colon so closely simulate organic colon obstruction that only a laparotomy made the diagnosis clear. In fact, we can rarely afford to neglect the possibility of a functional disorder of the involuntary nervous system simulating the more serious organic lesion.

The atonies constitute a surgical problem of great difficulty, whether they affect stomach, small intestine, or colon. It is unusual to find associated pain, though a painful spasm may occasionally be superadded to the existing atony. It is rather in the functional derangement that the seriousness lies, for it is inevitable that there is delay in the passage of contents, and the results of toxic absorption are therefore superadded to complicate and obscure the original picture.

It is with a purpose that I have avoided any reference to problems of treatment; it has rather been my intention to present to you a general aspect of the disorders of the involuntary nervous system as met with in the intestinal tract, and to attempt to trace what may be described as an evolutionary picture of disease.

REFERENCE.

¹ Fleiner: *Munch. med. Woch.*, 1910, p. 982.

RADIO-DIATHERMY IN THE TREATMENT OF INOPERABLE MALIGNANT DISEASE OF THE UPPER AIR AND FOOD PASSAGES.*

BY

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THE early recognition of malignant disease and its immediate removal by the knife is a counsel of perfection not always attainable. Procrastination is unfortunately inherent in human nature, while other factors, such as fear of operation and the dread of being informed of what actually is wrong, act as deterrents in preventing many patients from seeking advice at that stage when a cancerous growth or ulcer is a strictly localized process and therefore curable.

In my opinion the dissemination of knowledge amongst the public concerning the early symptoms of malignant disease is long overdue, even if it be given at the risk of causing unnecessary alarm to a limited section of the population. The good of the majority should be considered rather than the fears and prejudices of the minority. Educational propaganda would undoubtedly serve a useful purpose, more especially in drawing attention to the possibility of something serious being wrong, and so in gaining that all-important factor—time.

In the fourth quarterly report of the Cancer Survey of San Francisco, Hoffman draws attention to the fact that of 255 deaths of women suffering from cancer of the breast 107 were not operated upon, owing, in all probability, to their having gone to hospital too late, while of 319 deaths from cancer of the uterus 156 were deemed inoperable for similar reasons. The view, so widespread and deep-rooted, that cancer is a disease of later life is mischievous and erroneous, as out of 493 deaths from cancer of the stomach

* A paper read before the Nottingham Medico-Chirurgical Society, January 21st, 1926.