Drawings of a pouch which has been removed, and of a pouch still attached to the junction of the pharynx with the oesophagus, the constant seat of this form of pouch, are contained in the paper in the journal to which allusion has been already made, so that they need not be repeated here.

REFERENCES.

¹ *Med.-Chir. Trans.*, lxxvi, p. 269. ² *BRITISH MEDICAL JOURNAL*, 1898, i, p. 8. ³ *Loc. cit.* ⁴ *BRITISH MEDICAL JOURNAL*, 1898, i, p. 944. ⁵ *Loc. cit.*

THE NATURE OF THE SYMPTOMS IN APPENDICITIS.

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In most of the medical journals at the present time articles on appendicitis are appearing. When the writers deal with the symptoms of this disease a great variety of opinion on the nature of certain signs is shown, and it is obvious there is much confusion of ideas regarding the nature of the symptoms. These contradictory views arise because the writers have not grasped the fact that the sense of localization is absent from the viscera, and that when pain arises from disease of the viscera the pain is referred not to the actual seat of disease, but to an area in the external body wall supplied by sensory nerves, which in the spinal cord have an intimate relationship with the sympathetic nerves from the viscus affected.

If a due appreciation of the manner in which sensory and other phenomena arise in visceral disease be obtained, then a whole series of symptoms can be explained in a satisfactory manner, and much help is afforded in unravelling the symptoms of the disease from those of other diseases that simulate it.

In this study the symptoms are drawn from that form of appendicitis where there have usually been recurrent attacks, and where there has been an accompanying localized peritonitis. In the cases that came to operation there have always been old adhesions between the appendix and caecum, and in a few cases there has been redness of the visceral and parietal peritoneum in the neighbourhood with numerous soft adhesions. The constitutional symptoms and the results of abscess formation are not included in this study.

The manner in which the symptoms arise in visceral disease may be explained by reference to the accompanying diagram (Fig. 1). From the viscus (V) to the spinal cord (SC) a continuous stream of energy passes by the sympathetic nerves (Sy N). In health this stream of energy flows unperceived. In disease of the viscus an increased amount of energy passes, so that when it reaches the spinal cord it affects neighbouring cells. On these cells this increased energy acts as a stimulus, and symptoms are thereby produced according to the function of the nerve cells so stimulated—sensory, motor, secretory, etc. In Fig. 1 the stimulus from the viscera is supposed to affect the spinal cord in the

Fig. 1.

shaded area. Three sets of cells are represented in this shaded area, one connected with a sensory nerve (SN), one connected with a motor nerve (MN), and a third connected with some other viscus (Bl). When the stimulus from the diseased viscus reaches the cells connected with a sensory nerve, the pain is felt in the peripheral distribution of that nerve in the external body wall. When the stimulus affects a motor nerve, contraction of the muscles supplied by that nerve results (the visceromotor reflex). When the stimulus reaches the cells that supply other organs the functions of these organs are stimulated—if secretory, then an increased flow of the secretion; if a hollow muscular organ, then contraction of the organ, or a complicated series of movements may result, as in vomiting.

In appendicitis, the inflammatory condition affects not only the appendix itself, but extends to the peritoneal covering, and a peritonitis of a greater or less extent is set up. It is impossible to separate the symptoms of the one condition from those of the other. From a study of the symptoms of appendicitis, it seems fairly certain that the portion of the cord which is in connexion with the sympathetic nerves supplying the appendix and adjacent peritoneum includes the origins of the eleventh and twelfth dorsal, first and second lumbar nerves. When an attack of appendicitis is very violent, the symptoms may affect nerves higher than the eleventh dorsal, but as a rule the symptoms can be grouped within the field supplied by the eleventh and twelfth dorsal first and second lumbar nerves. The most important nerves that arise from this portion of the cord are the sensory nerves distributed to the abdomen and adjacent portions of the thigh, the motor nerves supplying certain of the muscles of the abdomen and of the thigh, and the motor nerves supplying the bladder.

The law regulating the distribution of pain in visceral disease is dependent on the fact that when stimulation reaches a sensory nerve (SN, Fig. 1) in any part of its course from the periphery to the brain (Br, Fig. 1), the resultant pain is always felt in the region of the peripheral distribution of the sensory nerve. In appendicitis the stimulation reaches the sensory nerves in the shaded area of the spinal cord represented in Fig. 1, which corresponds to the portion of the cord from which the eleventh and twelfth dorsal and first and second lumbar nerves arise.

The shaded area in Fig. 2 represents the field of distribu-

tion of the sensory nerves from the eleventh dorsal to the second lumbar roots. The pain may be felt in but a limited portion of the shaded area in Fig. 2. Thus it may be felt only in the lumbar region or in the iliac region, or below the crest of the ilium or in the thigh. At other times it may spread

vaguely over the whole area, and even cross over to the other side.

Hyperaesthesia.

Not only may the disturbance of these nerve cells be recognized by the presence of pain, but their excessive irritability can be demonstrated by the presence of hyperaesthesia in the tissues forming the external body wall. This hyperaesthesia may appear in an irregular patch of skin in some portion of the shaded area in Fig. 2. It is more readily demonstrated, however, in the erector spinae and muscles of the abdomen, and particularly in those over the right iliac fossa. The slightest pressure here is often felt as pain. One can readily demonstrate that the tenderness is not due to the inflamed peritoneum by slightly raising a portion of muscle away from the peritoneum before applying pressure, or, in cases where the pain and tenderness is widespread, by finding this tenderness in the muscles of the lumbar region, where pressure can be applied without the possibility of involving the peritoneum. The occurrence of this hyperaesthesia affords demonstrable evidence that the irritation has reached the sensory cells of the spinal cord, inasmuch as a stimulus applied to the skin (Sk, Fig. 1) or muscles (M, Fig. 1) which in health would give rise to the sense of touch or pressure, reaches these cells in their excitable condition by the sensory nerve (S N, Fig. 1), and gives rise in the brain to the sensation of pain. That the sensory symptoms are due to the central stimulation of nerve cells is evident from the fact that they are also present in parts remote from the seat of disease. This is evident when the pain radiates to the testicle and when that organ becomes tender to pressure, as happens in a number of cases of appendicitis. The tunica vaginalis is supplied by a branch of the first lumbar nerve, while the scrotum is supplied by the sacral nerves. The first lumbar nerve is distributed mainly over the lower part of the abdomen and upper part of the thigh, and the twig supplying the tunica vaginalis is separated widely from the rest of the distribution of this nerve. It is interesting to note also that the tunica vaginalis is the only serous membrane that is supplied by a sensory cerebro-spinal nerve, and the tunica vaginalis is the only serous membrane that is sensitive to ordinary stimulation.

In many cases of visceral disease, where there is hyperaesthesia of the skin or deeper structures of the external body wall certain spots are more tender to pressure. At these spots small sensory nerve trunks approach the surface and are readily accessible to pressure. In the case of appendicitis, small branches of the eleventh and twelfth dorsal nerves pierce the rectus muscle, and tenderness is elicited by pressure on these nerve twigs. One of them has received special attention, and is known as McBurney's point. As the sensory symptoms of appendicitis in the majority of cases are exhibited in the field of supply of the eleventh and twelfth dorsal nerves, light pressure on the small trunks elicits pain on account of the excitable state of the sensory cells in the spinal cord. When there is no tenderness over what is called McBurney's point in a case of appendicitis it will be found either that there is no hyperaesthesia of the muscles present, or that the symptoms are limited to the areas supplied by the first or second lumbar nerves.

The Viscero-muscular Reflex.

When the increased stimulus from the appendix affects the cells in the spinal centre of a motor nerve, contraction of the muscles supplied by that nerve appears—a form of reflex contraction that I have called the visceromotor reflex.

So long as the irritation about the diseased appendix lasts so long will the muscles remain contracted. The muscles supplied by the nerves that concern us more particularly in this study are the erector spinae, the muscles of the anterior abdominal wall (the obliqui transversalis abdominis and rectus), and the psoas and iliacus all on the right side.

The extent of the muscular contractions varies very much. Usually it is limited to the muscles forming the wall of the right iliac fossa. As it is accompanied by more or less hyperaesthesia of the muscles, this muscular hardness is often mistaken for thickening and matting around the appendix, and surgeons sometimes express surprise at the absence of any thickening when they open the abdomen. This visceromotor reflex may be so extensive in appendicitis that it may affect not only all the muscles of the right side of the abdomen, but all the muscles of the abdominal wall. When this occurs, and when the muscles are also hyperaesthetic, the picture is then one of general peritonitis. It should be borne in mind that the extensive muscular hardness offers no

criterion of the extent of the peritonitis in any affection of the viscera.

As the acute symptoms subside in an attack of appendicitis the contracted muscles gradually relax, until, when the patient is at rest, all the symptoms may disappear. When he begins to move about before all the inflammation has quite subsided the muscles begin again to contract, and give rise to a sensation of stiffness and it may be pain when they are stimulated to contract by the movements of the body. In such cases the whole of the right rectus abdominis muscle may become very tense and sore. In the same way the psoas and iliacus muscles and other muscles that act on the hip-joint may be tonically contracted, and the patient has a difficulty in movement at the hip-joint. When this occurs, with pain in the upper part of the thigh, the picture resembles a rheumatic affection of the hip-joint. In such an instance the symptoms are mostly limited to the distribution of the first lumbar nerve, and there may in consequence be an absence of such a characteristic sign as McBurney's point.

On the subsidence of an acute attack of appendicitis the muscles may relax, except a few strands of muscle fibres here and there. As one palpates the iliac fossa a strand of fibres may produce a peculiar resemblance to an elongated narrow body in the abdomen, and hence this is often mistaken for the appendix itself. I am fairly confident that in the vast majority of cases where the appendix is supposed to be felt by the examining surgeon it is this strand of contracted muscular fibres he is feeling. I do not deny that occasionally an enlarged and thickened appendix lying against the abdominal wall may be felt, but this is a rare circumstance. As a rule, the appendix lies several inches from the abdominal wall in such a position that even when the hand is in the abdominal cavity it is difficult to feel it. If surgeons would carefully note the position of the supposed appendix before operation, and compare it with the position in which the appendix is actually found, I think they will find that I am correct in my contention. The appearance of this resisting band of muscle fibres is due to a peculiarity in the mode of contraction of the flat muscles of the abdominal wall. I have found that, in addition to the contraction of the flat muscles, as a whole, small portions of the individual muscular fibres possessed the power of independent contraction. Thus a few fibres may contract in a small part of their extent in the middle of one of the sections of the rectus abdominis muscle. To the palpating hand these hardened fibres resemble an underlying tumour. Again, a series of these fibres may contract, and their contraction may be limited to one extremity of the muscle. When this happens to the transversalis abdominis at its termination in the broad aponeurosis over the iliac fossa we feel a band which resembles an elongated body lying in the abdomen. I have on several occasions seen this band mistaken by competent surgeons for an unduly big appendix. In talking over this mode of contraction of the flat abdominal muscles with Professor Sherrington he told me that he had demonstrated this peculiar property of the flat muscles some years ago. When stimulating motor roots as they emerged from the spinal cord he found that each muscle was supplied by roots issuing from more than one spinal segment. If he stimulated one root only of a long muscle like the tibialis, the muscle contracted in its entirety. When, however, he stimulated one root of a flat abdominal muscle the fibres contracted in only a limited portion of their extent. Thus, in stimulating the nerves going to one section of the rectus of abdominis muscle one root would cause the contraction of fibres limited to one end of the muscle, another root would cause contractions limited to the other end, while a third root would cause contraction of the fibres limited to a portion of their extent midway between the ends of the muscle. It might seem, therefore, that when the band of contracted fibres persists in appendicitis the stimulation was passing out of the cord by only one nerve root.

Bladder Symptoms.

Occasionally it happens that patients' complaints are at first or after the subsidence of more severe symptoms entirely confined to symptoms of bladder irritation. This is due to a stimulus reaching the bladder (Bl, Fig. 1) from the same section of the cord by way of the hypogastric plexus of the sympathetic. The symptoms are usually of two kinds, first, simple frequency of micturition and, secondly, a frequent desire to micturate with difficulty in relaxing the sphincter. In the first class of cases the stimulus passes from the inflamed appendix to the centre for the innervation of the bladder, and the viscus is thus stimulated to contract.

The patient is made aware of this by the usual mechanism, and voids the urine without difficulty. In the second class of cases there is also an irritation of the nerve supply of the sphincter vesicae, and this results in a tonic contraction of the muscle. The result is that the patient has a difficulty in relaxing the sphincter and the opposition offered to the contracting bladder is so great that the patient may suffer grievously from the violent efforts of the bladder to overcome the resistance of the sphincter.

Appendicular Colic and other Symptoms.

A patient suffering from chronic appendicitis may suffer at times from sudden attacks of pain of extreme violence. The pain is not always easy to locate, but is felt vaguely and indefinitely over a considerable area of the abdominal surface usually somewhere near the umbilicus and on the right side. I am not quite clear as to the cause of these attacks. In two cases where this symptom was well marked there was found stenosis of the appendix near its attachment to the caecum. In one case the portion beyond the stenosis was distended with fluid, so that on cutting it open its contents squirted out with considerable force. It is a matter of observation that when non-striped muscle is stimulated to strong contraction violent pain results as in biliary and renal colic, when the bile ducts and ureter contain calculi, or when the bowel contracts behind an obstruction. Sherrington has demonstrated this experimentally by injecting fluid into the bile ducts. The contents of the appendix may stimulate its muscular coat to contract, and if the contents be not voided in consequence of the stenosis, violent spasm of the muscular wall ensues and severe pain may arise, that is, the stimulation passes by the sympathetic to the cord and then stimulates the cells of certain sensory nerves, with the result that the pain is felt over the peripheral distribution in the abdominal wall. In addition to the three centres represented in the shaded area of the cord in Fig. 1, there are doubtless other centres stimulated. The symptoms arising are as yet too obscure for me to elucidate. In one case of chronic appendicitis the patient had recurrent attacks of diarrhoea, and it is possible that this diarrhoea was a result of reflex stimulation of the intestinal glands.

Differential Diagnosis.

When only a few of the symptoms are present, appendicitis may simulate numerous other complaints. I have mistaken a commencing attack of appendicitis for lumbago because the pain and muscular tenderness were at first entirely limited to the lumbar region. I have seen another case where the medical man mistook the symptoms for a rheumatic affection of the hip-joint, because at first the symptoms were limited to a pain in the groin, with stiffness and pain on movement at the hip-joint.

It is also difficult to distinguish appendicitis from other visceral affections when the symptoms are imperfectly developed. The portion of the spinal cord affected by the sympathetic nerve supply of the appendix receives nerves also from other portions of the bowel and peritoneum, from the kidney, ureter, ovary, bladder, etc., and, in consequence, when only a few symptoms are present, appendicitis may simulate affections of these organs. I had treated one of my patients for some years for renal colic, and it was only on the supervention of other symptoms that I suspected appendicitis. On operation, only a stenosed appendix with a few old peritoneal adhesions could be found. Treves has recently written on the mimicry of gastric troubles by spinal disease. The resemblance in the symptoms of such diverse diseases is due to the fact that stimulation of the spinal cord gives rise to identical symptoms, from whatever source the stimulation proceeds, whether from visceral disease or local irritation. I have seen one case where an eminent neurologist diagnosed caries of the spine, and encased the patient in a plaster-of-paris jacket, because of the tender vertebrae and extensive hyperaesthesia and muscle tenderness, and in the necropsy there was found cancer of the stomach. It may happen, therefore, that a local affection of the cord may give rise to some symptoms resembling this complaint.

THE WAR AGAINST MOSQUITOS IN AMERICA.—The Brookline Board of Health has renewed the war of extermination against mosquitos successfully carried on during the preceding two summers. A systematic attempt is to be made this year to treat catch basins and stagnant pools with crude oil. The grant required for this purpose is estimated at about £200.

ON THE OCCURRENCE OF VOMITING DURING RECTAL ALIMENTATION.

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In a number of patients with gastric ulcer treated by rectal enemata, we have been struck by the fact that several of them have vomited up material from the stomach other than blood, in spite of the fact that they were having absolutely nothing by the mouth at the time. With the object of determining the frequency of this event, and, if possible, of finding some explanation for its occurrence, we have collected and analysed 171 consecutive cases of gastric ulcer treated in St. George's Hospital during the past two and a half years, 154 of them occurring in women and 17 in men. Of these cases, 75 were fed from the first either by the mouth alone or by the mouth and rectum together, and may be dismissed from further consideration after mentioning the fact that vomiting occurred in 41, or 54.6 per cent. The remaining 96 cases were fed per rectum alone for periods varying from two to fourteen days, usually for rather less than a week, and 26, among whom there were 4 males, or 27 per cent. of these cases, vomited on one or more occasions, although they had received no food at all by the mouth for a period of thirty-six hours or more before the vomiting occurred. Of these 26 cases, however, 8 were given medicine—bismuth, an opiate, or hydrocyanic acid—by the mouth, with or without a mouth-wash, and 7 were having a mouth-wash alone; the remaining 11 received nothing of any kind by the mouth. It is clear that in the 8 patients who took medicine by the mouth, the subsequent vomiting may have been due to peristaltic contraction of the stomach set up by the introduction of fluid into that organ. It is possible that the 7 patients whose mouths were washed out with a solution of listerine may have swallowed some of that antiseptic lotion, and that vomiting was thus accounted for. The remaining 11 cases can have swallowed nothing but their own buccal secretions; oral sepsis may have been an important factor in causing some of the vomiting here, for in 6 of the 11 the teeth were "bad" or "very bad," and the patients doubtless swallowed with their saliva a quantity of offensive purulent material derived from the carious teeth and stumps. The fact that in 2 cases under our own care persistent vomiting only stopped after extraction of decayed teeth, points to oral sepsis as a definite causal factor in some cases. But the teeth were noted as "good" or "very fair" in the other 5 cases, so that in these some other reason for the vomiting must be sought. Two of the 11 cases were menstruating while vomiting continued, but both of these fall into the category of "bad teeth." As showing that the nervous perturbation associated with menstruation is not a cause of vomiting, it may be added that 4 out of 70 patients who did not vomit, while being fed by the rectum alone, were menstruating.

We have been unable to trace any connexion between the nature of the food given by the rectum and the occurrence of vomiting. In the 26 cases that did vomit, the nutrient enemata were variously composed of water alone or of mixtures of water, beef tea, peptonized milk, eggs, coffee, and nutrient suppositories with, in a few cases, small quantities of common salt, which has been shown experimentally to set up anti-peristalsis; but identically constituted enemata were given in the 70 other cases that did not vomit while on rectal feeding. Still, there does seem to be a certain connexion between the administration of enemata and the occurrence of nausea or vomiting; no exact figures can be given, but retching is provoked by enemata in quite a fair proportion of rectally fed patients, and in a few of them goes on to actual vomiting.

Little information can be gathered by the examination of the vomited material; as a rule it is greenish or "bilious," mucous, and acid to litmus paper, and in some cases it contains free hydrochloric acid. The presence of bile shows that reversed peristalsis has occurred, and proves that relaxation of the pyloric sphincter can take place in spite of the gastric irritation which must result from the ulceration of the stomach wall. The explanation of this relaxation of the pyloric sphincter and of anti-peristalsis is not clear; but it is not unreasonable to suppose that when an irritable stomach