is gained if, unfortunately, they should turn out to be sarcomatous.

It must be remembered that scurvy rickets, the result of improper feeding of children, may produce swellings of the lower end of the femur simulating sarcoma.

In my earlier cases I tried to arrest the haemorrhage by means of one of the many methods recommended for amputation at the hip-joint—the names of their originators are not quite legion: Lister, Macewen, Jordan Lloyd, McBurnie, Wyeth, Davies, Lever, and a host of others—the supposed value of these I have delighted to explain to students. They are mainly methods by the use of tourniquets, which are often unsatisfactory; in amputation at the hip-joint some of them may slip over the stump before the vessels have been secured.

I have long given up the use of tourniquets in cases of excisions, as I found that the oozing and bleeding afterwards was considerably less when the tourniquet was not used; in amputations where there is marked arterial disease, and in amputations for gangrene, a tourniquet may do a great deal of damage to the tissues and so favour sloughing of the flaps.

The method for the arrest of haemorrhage used in these cases carries out the same principle as I adopted in the inter-scapulo-thoracic amputation—that is to say, no preliminary attempt is made to control the bleeding, but the main vessels are exposed during the ordinary course of the operation, clipped with forceps, divided, and ligatured.

In ordinary amputations I had never tried this method, until Mr. J. A. Coupland, who was helping me with a supra-trochanteric amputation of the femur, suggested that I should expose and secure the femoral vessels at the point of division in forming my flap. I was a little bit afraid at first of not using some form of tourniquet as a first line of defence against haemorrhage, but was very pleased with the result. It answered admirably, the patient only losing a small quantity of blood. I think this principle should be applied to all amputations. It is not a great deal to expect of any operating surgeon that he should remember the anatomy of the main vessels. If this method is thought worthy of following, then the tourniquet will only be used for first aid.

This method has now been practised and advocated for some time by a certain number of surgeons. I believe, however, that the large majority still rely, as I had done, on the tourniquet.

I find that in a very useful and practical book (*Amputation Stumps*, Oxford War Primers, 1918) the author, Mr. C. Martin Huggins, F.R.C.S., writes (p. 114) in favour of the supra-trochanteric operation in certain cases; the method is also commented on favourably in the *Manual of Surgery*, by Thomson and Miles, 1920, p. 539.

A Post-Graduate Lecture
ON
CLINICAL ASPECTS OF ABDOMINAL TUBERCULOSIS.*

BY
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THE great frequency with which tuberculosis attacks the abdomen in childhood, the wide variations in its manifestations, and the grave results to which it often leads, all combine to make it a disease of prime importance in the abdominal surgery of the first two or three decades of life. My purpose in the following remarks is to approach the subject from the point of view of clinical diagnosis, and to state the conclusions to which my own experience has led me on the subject of the appropriate surgical treatment.

Tuberculosis of the Intestine.

Tuberculous ulceration of the intestine in its early stages is a problem for the physician, and rarely, if ever, requires surgical intervention. A history of diarrhoea, accompanied by the passage of some blood and mucus per rectum, is not uncommon in all classes of abdominal tuberculosis, and such a feature in the history gives us evidence of some value, as suggesting earlier tuberculous ulceration of the bowel. It is only when ulceration has gone on to cicatrization, with stenosis of the intestinal lumen, that the need for surgery arises. Tuberculous ulcers of the bowel commence, as is well known, in the lymphoid tissue of the mucosa, either in the larger collections known as Peyer's patches, or in the solitary follicles, and such ulcers are accordingly commoner in the lower end of the ileum and near the ileo-caecal valve. Two forms of intestinal stenosis are met with in these old tuberculous cases—in one the ulcer, which tends to spread in a circular direction round the lumen of the bowel, gives rise in the process of healing to an annular cicatricial diaphragm. There may be many such stenoses in the small intestine, but not uncommonly they are single. In the second form there is a massive formation of fibrous tissue, which gives rise to a gross thickening of the intestinal wall, as well as a narrowing of its lumen. I will illustrate these types by two cases:

CASE I.

A woman, aged 36, on whom I had operated eighteen months before for tuberculous wrist with a very satisfactory result, returned to hospital complaining that for the past twelve months she had suffered from intermittent attacks of acute pain in the left of the epigastrium. These attacks had occurred with increasing frequency, until they came on every week, and were accompanied by vomiting. There was no history of jaundice. On examination the upper abdomen was somewhat fuller than normal, but no palpable mass could be detected, and there was no visible peristalsis. There was no localized tenderness in any part of the abdomen, and *x*-ray examination was negative. In view of the nature of the attacks and the previous tuberculous lesion, the provisional diagnosis of tuberculous stricture of the intestine was made, and exploratory laparotomy undertaken. On examining the small intestine systematically a single annular, fibrous constriction was found in the jejunum some two feet below the duodeno-jejunal flexure. On the peritoneal coat of the bowel there were several small grey tubercles, and there was some enlargement of the mesenteric glands in the neighbourhood. The bowel above the stricture was somewhat hypertrophied and distended as compared with that below. Four inches of jejunum were excised, including the stricture, and lateral anastomosis performed. The patient made a rapid recovery, had no more attacks of pain, and when last heard of was in good health. Histological examination confirmed the diagnosis of tuberculous ulceration.

CASE II.

A woman, aged 29, had for five years been suffering from attacks of pain in the right iliac fossa, associated with local tenderness, vomiting, and increasing constipation. Her general health was poor, and she had lost a good deal of weight. On examination the right iliac fossa was found to contain a firm, palpable mobile mass, somewhat tender on pressure. There was no general abdominal distension. The diagnosis lay between ileo-caecal tuberculosis and carcinoma of the ileo-caecal valve. On exploring the abdomen the lower eight inches of the ileum, the ileo-caecal valve, and the caecum were found to be involved in a uniform hard and massive thickening, which strongly resembled a carcinomatous growth. On the peritoneal aspect, however, numerous small white tubercles could be made out. Lateral anastomosis between the normal ileum above and the transverse colon, combined with resection of the diseased area of bowel, brought speedy relief to her symptoms, and when seen recently, five years after the operation, she was in good health.

When such cases of hyperplastic ileo-caecal tuberculosis are met with in young children, they must be diagnosed from chronic intussusception or appendicitis with abscess formation. In chronic intussusception the attacks of pain are much more frequent and urgent, there is usually some passage of blood-stained mucus, and the illness is rarely of more than a few weeks' duration. In acute appendicitis with abscess formation there is again a much shorter history, with a typical sudden onset, and the mass is firmly fixed and not movable as in the case under discussion.

In older patients the diagnosis from carcinoma is a matter of extreme difficulty on account of the similarity of symptoms. In some cases the presence of subperitoneal tubercles will determine the diagnosis at operation, though even these may not be distinguishable from secondary carcinomatous nodules, and it may sometimes happen that the diagnosis between hypertrophic tubercle and carcinoma of the ileo-caecal valve remains in doubt until the specimen has been submitted to microscopical examination.

Tuberculosis of the Appendix.

Tuberculosis of the appendix, as an isolated lesion, is an occurrence of some rarity. The majority of recorded cases of tuberculous appendicitis have occurred in combination with hyperplastic ileo-caecal tuberculosis, and in such cases implication of the appendix in the tuberculous process must be regarded as a comparatively unimportant detail. The following case of primary tuberculosis of the appendix is the only one that has come under my care.

* Delivered at St. Mary's Hospital, Manchester.

CASE III.

A boy, aged 7, had had a brief attack of abdominal pain and pyrexia two years before he was brought to me with a history of two days' pain that began in the umbilical region and had settled in the right iliac fossa. He had not vomited, and his temperature and pulse were normal. On examination the boy did not look ill, but on palpation in the right iliac fossa there was a definite hard, tender mass, which felt much like an acutely swollen appendix with surrounding omental adhesions. The mass was, however, better defined and more mobile than usual, and there was little muscular rigidity.

A diagnosis of acute appendicitis was made, and laparotomy disclosed a hard, elongated mass lying below and to the inner side of the caecum. The mass was 4 in. long and 1 in. in diameter, and the omentum was adherent to its lower extremity. It was readily delivered through the abdominal wound, and proved to be an appendix, enormously distended and congested and twisted somewhat on its origin from the caecum. The adherent omentum was ligatured off and divided, without stripping it from the appendix; the appendix was removed by dividing it across at the healthy base, and the stump invaginated in the usual way. Examination of the specimen showed that the distal half was involved in typical hyperplastic tuberculosis, with areas of caseation here and there. The lumen of this distal half was reduced in size, but the proximal half, with thin and non-tuberculous wall, was distended with blood and pus, and the outlet into the caecum was blocked by a hard concretion. It was evidently, therefore, a case of acute obstructive inflammation of the appendix, superimposed on a chronic tuberculosis, which had given rise to no symptoms. The ileo-caecal region and adjacent glands were not tuberculous. The boy made an uneventful recovery, and is now, five years after the operation, in good health.

Tuberculosis of the Liver.

Tuberculosis of the liver is also a rare occurrence in surgical practice. Setting aside the cases in which the liver is involved in general miliary tuberculosis, tuberculous peritonitis, or multiple small tuberculous abscesses, cases are occasionally met with in which a solitary tuberculous mass is found in the liver and can be removed by operation. That the diagnosis of such a tuberculoma of the liver is by no means simple is illustrated by the following case.

CASE IV.

A boy of 13, who had been operated on a year previously for "tuberculous glands of the neck," came to hospital complaining of abdominal pain. On palpation a rounded, hard lump, about one inch in diameter, could be felt, and indeed seen, in the right epigastrium. It was evidently in the right lobe of the liver, and in view of his previous history the diagnosis of tuberculosis of the liver was made.

On opening the abdomen a solid yellow mass was found on the anterior aspect of the right lobe, with a smaller adjacent mass of a similar character. Both these masses were enucleated with ease, but it was noticed that instead of presenting the homogeneous appearance of caseating tubercles, they were somewhat lamellated and the appearance suggested gumma.

A Wassermann reaction taken after the operation was strongly positive, and histological examination of some of the excised tissue confirmed the diagnosis of gumma. It is quite possible that the supposed tuberculous glands that had been previously dealt with had, in reality, been the result of congenital syphilis.

Tuberculosis of the Mesenteric Glands.

I now pass to the consideration of the commonest form of abdominal tuberculosis—namely, tuberculosis of the mesenteric glands, and in this group of cases I do not include those with general tuberculous peritonitis in addition. The diagnosis of tuberculous mesenteric glands in children is by no means difficult, for it may be laid down as a broad general rule to which there are few exceptions, that wherever a child presents a firm, rounded, mobile lump in the umbilical or right iliac zones of the abdomen, unassociated with intestinal obstruction, the case is one of tuberculous adenitis. Surgical interference is necessarily limited to those cases in which the glandular implication is not too extensive. Where the whole chain of mesenteric glands is grossly enlarged and caseous, any attempt to excise them would endanger the blood supply of the bowel, to say nothing of the risk of lighting up tuberculous peritonitis. There is, however, a very common type of case in which one or two glands, lying along the ileo-colic vessels in the angle between the lower ileum and the ascending colon, are enlarged and caseous. These glands receive the efferent lymphatics from the appendix and ileo-caecal valve, and their infection with tuberculosis is closely analogous to the common tuberculous adenitis of the upper deep cervical glands which receive the drainage of the tonsils. I have frequently removed the appendix and the glands in such cases, but have never yet, on microscopical examination, found any evidence of tuberculous disease of the appendix, though typical tubercle formation can usually be found in the glands. In the case of tonsils which are removed in association with tuberculous cervical glands, we know that under 5 per cent. of such tonsils show tuberculous lesions. I believe that in the appendix, as in the tonsil, a chronic catarrhal inflammation of the lymphoid tissue, of a non-specific nature, acts as a predisposing cause to tuberculosis of the glands, and that the tubercle bacillus can be absorbed through the mucosa of either a normal or chronically inflamed appendix and give rise to no specific lesion until it reaches the nearest lymph glands.

What, then, are the indications for surgical interference in these cases? I believe operation should be undertaken if, after a few weeks' constitutional treatment, the glands do not disappear, provided that the glandular swellings are not too extensive. I believe further that if recurrent attacks of colicky pain are associated with glandular enlargement operation should be advised in any case, for such pains signify some mechanical interference, by kinking or adhesions, or perhaps by an associated stenosis, with the peristaltic movement of the bowel.

CASE V.

A girl, aged 7, was brought to hospital with a history of repeated attacks of abdominal pain, accompanied by vomiting, during the previous six months. The child was thin, and the abdomen somewhat distended; on the left of the umbilicus an indefinite hard mass could be made out on palpation. Laparotomy disclosed a mass of caseous glands in the upper mesentery adherent to the transverse colon and kinking it somewhat acutely. The glands were freed from the colon and excised, and an omental graft placed over the area of colon denuded of peritoneum. Since this operation was performed, nearly a year ago, the child has been free from the attacks of pain, and has put on weight.

Occasionally, as is well known, such isolated tuberculous glands will produce a kink of the adherent bowel sufficiently grave to cause acute intestinal obstruction, and I have records of one case in which gangrene of the apex of an adherent intestinal loop had resulted, and necessitated resection of the bowel. The cord-like adhesions so prone to result from tuberculous mesenteric glands in childhood are, of course, one of the commonest causes of acute intestinal obstruction in adult life.

Tuberculous Peritonitis.

In considering the subject of tuberculous peritonitis I would first remark that whereas, according to *post-mortem* statistics, this disease is most common between the ages of 30 and 40 years, according to my clinical experience it is most usually met with between the third and twelfth years of age. We can distinguish broadly two main clinical groups of tuberculous peritonitis:

1. The *ascitic* type, in which the whole peritoneum is dusted over with innumerable tubercles, varying in size from the finest grey granules to discrete yellow nodules almost as large as a pea. In this type adhesions, if present at all, are unimportant in number and extent, and a massive ascites dominates the clinical picture.

2. The *plastic* type, with a large, doughy abdomen, in which tympanites is more evident than ascitic fluid. In this second form there are often localized pockets of clear fluid, but the outstanding feature is universal adhesions, fibrous in character, which often obliterate the peritoneal cavity almost completely. In the graver cases of this group large caseating tubercles are found between adjacent and adherent coils of intestine, and in some, though this is infrequent, definite abscess formation occurs.

These two clinical groups have this in common, that the child's abdomen swells, and at the same time there is wasting of the limbs and face and marked failing in energy; but, whereas in the ascitic type there is shifting dullness in the flanks and a fluid thrill, in the plastic form these latter signs are absent, and there are commonly palpable masses of adherent, infiltrated omentum, with considerable enlargement of the mesenteric glands. Symptoms of associated tuberculous ulceration of the intestine are uncommon in each type in my experience, though there is not infrequently a previous history of blood-stained diarrhoea. Pain is unusual in the ascitic form, and may or may not be present in the plastic.

It has long been recognized that laparotomy gives the most satisfactory results in the ascitic form. To what mechanism we should attribute the remarkable improvement that occurs in most of these cases from the day of operation is a problem on which many theories have been

elaborated, and concerning which little definite is known, but this improvement is an undoubted clinical fact. It is not to be denied, of course, that certain of these cases make a complete recovery under medical treatment without surgical assistance, but the change in their condition after laparotomy and evacuation of the ascitic fluid is so rapid and so striking that there is, I think, no doubt that operation has a most definite influence on the course of the disease.

CASE VI.

A girl of 14, who had had no previous ill health, was playing hockey for her school team when she noticed an unwonted shortness of breath. Seven days later, when I saw her, there was a large collection of ascitic fluid, without any pain, and her limbs were already wasting. Operation, performed three days later, showed tubercles so profusely scattered all through the peritoneal cavity as to be confluent, with great thickening of the peritoneum itself, but no adhesions. When seen eight months after the operation she had put on over 28 lb. in weight, the abdomen was normal, and she appeared to be in every respect a healthy girl.

The abdominal incision should always be sutured in layers without drainage, on account of the danger of mixed infection and the greatest care should be taken to prevent tuberculous infection of the abdominal wall—a not uncommon complication which is a cause of serious delay in convalescence.

The prognosis after laparotomy in the plastic type of tuberculous peritonitis is generally considered to be poor, and it is undoubtedly a fact that the percentage of recoveries is smaller in this than in the ascitic type, whether treated by medical or surgical measures. There is the further consideration that laparotomy in these cases is by no means devoid of risk, since the intestines are firmly adherent to the abdominal wall and to adjacent coils, and unless the greatest care is exercised by the surgeon, a faecal fistula may readily be produced, with disastrous results. I was somewhat surprised to find, however, on tracing a series of eight of these cases in which I had operated as a last resort, that five of them, in spite of the very grave prognosis that I had given on the strength of the operative findings, were in good health after four, seven, one, two and a half, and two years respectively, and all dated improvement from the operation. One patient had made such a rapid and complete recovery as to be on active service in Mesopotamia for two years without any ill health. Of the remaining three cases, one improved for a time, but died of bronchopneumonia one year after operation, one is suffering from pulmonary phthisis and still has abdominal pains and distension, and one developed a faecal fistula shortly after the operation and died in about three weeks. The series is, of course, too small for any wide conclusions, but it does at least suggest that there is something to be gained in these cases by surgical measures when medical treatment has failed.

CONCLUSIONS.

I would sum up the general indications for operation in the various types of abdominal tuberculosis as follows:

Pain, when it occurs in recurrent, well-defined, colicky attacks, especially if they return with regular periodicity and sharp intensity, signifies a mechanical interference with intestinal peristalsis, and this can only be relieved by operative measures.

Glandular masses in the mesentery, if not too extensive, and if they do not yield rapidly to constitutional treatment, should be excised, and this is particularly urgent when they are associated with colicky attacks of pain.

Palpable masses in the ileo-caecal region associated with signs of chronic intestinal obstruction are an emphatic indication for laparotomy and resection of the tuberculous ileo-caecal region should such be found.

The ascitic form of tuberculous peritonitis is essentially a disease for surgical treatment. The operation is free from danger, and its beneficial results are usually dramatic. I need hardly labour the point that the utmost care in the medical or constitutional treatment is of great importance in the cure, but I wish to emphasize the view that operation is almost equally essential.

Finally, in the plastic type of tuberculous peritonitis, if the trouble does not yield to the ordinary medical measures, operation may be undertaken with a fair degree of safety, provided that no extensive attempt is made to separate adhesions, and there is some ground for hoping that even these apparently desperate cases may make a complete recovery.

OBSERVATIONS ON THE RESTING METABOLISM OF CHILDREN AND ADULTS IN SWITZERLAND.

BY

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With the Co-operation of

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WE have carried out observations at the English sanatorium in Montana, in November and December, where the patients are under the supervision of Dr. B. Hudson, and where a laboratory and every assistance in our work was given us. We also made observations at the Belgian children's clinic under Dr. Chassot, and the Geneva sanatorium under Dr. Betchow, and we are greatly indebted to these physicians for the facilities they afforded us.

In October the sunshine at Montana averaged over eight hours a day, and during the last three weeks of November the sun shone every day, while the air was calm and frosty; the thermometer, while showing from 5° to 20° F. of frost at night, rose at midday in front of the sanatorium to some 50° F. dry bulb and 35° F. wet bulb. Montana is at an altitude over 5,000 ft., and the midday winter sun piercing the clear atmosphere was so warm that it raised the surface temperature of a dark fur or wool coat to 100° or 120° F., and a shade became necessary for the head.

While the sunlight absorbed by the clothes and skin warms those parts of the body exposed to it, the shaded parts of the body are actively and pleasantly cooled by the cool dry air, and the heat production of the body is thus stimulated. In the shade, or before the rising and after the setting of the sun, the cold dry air stimulates the body heat production far more powerfully. Patients can sit or lie out of doors in the sun in comfort, even without overcoats, after 9 a.m., when the temperature of the air is scarcely above the freezing point. In sheltered sun-boxes, open only to the south, they can comfortably expose themselves nude to the sun. Such exposure has, of course, to be gradually inducted, and, while suitable for surgical tuberculosis, is considered unsuitable for phthisis. We suggest that, given a sufficiently high cooling power of the air, insolation might be borne by such cases when not febrile. Such is the experience of Rollier at Leysin. It is obviously unwise to produce tissue cell degradation in the skin or blood by exposure to the sun when the body is dealing with an active tuberculous process and is febrile.

At an altitude of 5,000 ft. the greater tenuity of the air not only stimulates red blood formation, but the breathing, and the greater volume breathed of dry cool air acts with advantage on the respiratory membrane, for the amount of water vapour evaporated daily from this membrane may be some three times greater in patients taking exercise in the Alpine winter climate than in people living a sedentary life in England indoors, where the water vapour tension is much higher. Saturated air at 0° C. holds some 5 grams of water vapour per cubic metre, while air saturated at almost body temperature holds some 40 grams. The dry cool air as breathed in is warmed up to almost body temperature and saturated with water evaporated at this temperature from the breathing passages. The greater evaporation of water entails a greater flow of arterial blood and lymph through the respiratory membrane, and this helps to keep up its health and immunity to disease.

The cooling power which the Alpine air exerts out of doors on a dry surface at body temperature, as measured by the kata-thermometer, is some three times greater than in ordinary conditions indoors, and the evaporative power twice as great. The heat production of the resting subject, stimulated by this cooling power, is put up, above that taken indoors in London, some 40 to 50 per cent. in the case of clothed adults, and 60 to 90 per cent. in the case of children exposed more or less nude to the sunny, calm Alpine winter atmosphere. A cold wind and cloudy sky may raise the breathing metabolism of clothed children over 200 per cent. Increased appetite, better digestion, and more active breathing and circulation of the blood result from this increased heat production. Owing to the climatic conditions the growth of muscular tissue is enhanced and fatness and flabbiness opposed. For early cases of phthisis and all cases of surgical tuberculosis, then, the Alpine winter climate offers great advantages.