BRITISH MEDICAL JOURNAL

LONDON: SATURDAY, FEBRUARY 2nd, 1935

ABDOMINAL SURGERY IN CHILDREN *

BY

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The subject of my address has interested me for many years, and I have been brought into contact with it for a quarter of a century in the Belfast Hospital for Sick Children. In this hospital one had the opportunity of learning surgery from Robert Campbell—a pioneer in general surgery with a very special interest in children—and, looking back over the twenty-five years, we appear to have made very little progress. Possibly our results are slightly better, but this is due to improved anaesthesia and diagnosis and to a more enlightened community.

The child's abdomen is not the place for heroic surgery, and, indeed, most of it is of the "chicken-hearted" variety. It consists of the removal of an appendix, the reduction of an intussusception, pyloroplasty, a very occasional gastro-enterostomy, the removal of a Meckel's diverticulum, the division of a peritoneal band, and the radical cure of a hernia. This is the routine work of a children's hospital. It saves a large number of lives at a low rate of mortality. Most of our surgical deaths are due to irreducible intussusceptions, unrecognized hypertrophic stenoses of the pylorus, and neglected cases of appendicitis—that is, to delay in recognizing the true condition. Preventive medicine should pay more attention to the needs of surgery. The American press is in advance of us in this matter. It keeps the American public right concerning teeth, eyes, dandruff, athlete's foot, halitosis, and body odour; more recently it has directed attention to the dangers of the thyroid and the appendix.

Anaesthesia

Avertin is one of the main advances in the past five years. It has abolished the sound of crying; the child knows nothing of the operation; post-operative lung trouble is much diminished; and subsequent vomiting is slight or absent. The drug is not without danger in young infants, and we do not use it for hare-lip, hypertrophic stenoses, or intussusceptions. It is always combined with local anaesthesia, since the dose of avertin used is not sufficient to abolish cutaneous sensibility. Our anaesthetist, Dr. Boyd, who has an experience of over 600 cases of avertin in children, recommends the following dose: 0.175 gram per kilogram of body weight accompanied by 1/150 grain of atropine, and morphine according to age—that is, 2 to 5 years, 1/20 grain; 5 to 9 years, 1/12 grain; and 9 to 13 years, 1/8 grain.

The Appendix

I have no hesitation in saying that appendicectomy is the most important operation in the child's abdomen. It saves more lives and improves the health of more

children than any other operation. If it were always done in the quiescent stage the mortality should be *nil*. Nearly all the deaths occur in perforations with general peritonitis, and it is my belief that if the obstructed appendix could be recognized and removed before the onset of acute symptoms a large number of lives would be saved.

There are different schools of thought on the incision, pathology, time of operation, and the limits between the normal and the abnormal. I prefer the gridiron incision, through which any appendix can be removed. It has a great advantage over the paramedian when a retrocolic appendix is being dealt with: it is well away from the small intestine area, and should adhesions form they will tend to be caecal. As regards the time of operation, I remove the acute appendix as soon as it is diagnosed, operate immediately when in doubt, remove the chronic or recurrent appendix as soon as convenient, and in certain cases I am content to drain.

PATHOLOGY OF THE APPENDIX

We must admit, I think, that the last word on appendicular pathology has not yet been written and that there are still many gaps in our knowledge. Krecke,¹ after a very complete and up-to-date account of the causes of appendicitis, summarizes his conclusions as follows:

"The real cause of appendicitis is not yet clear. One may accept that there is a bowel-borne infection. Mechanical obstruction plays an important role. Neuro-angiospasm may be a factor and may account for those cases attacking several members of a family."

One tends, with the progress of years, to place more appendices in the pathological class, and to recognize that an opinion cannot be given on the macroscopic condition until the appendix has been removed and opened. The histologist would appear to be still more exacting, since he occasionally places in the pathological class appendices which show no naked-eye pathology. The surgeon is in the most favourable position to record the naked-eye pathology because some of this may be obliterated by the appendicectomy. For example, kinks, U-shaped bends, corkscrew or spiral twists, and atypical peritoneal relations may be destroyed by the removal of the appendix. The surgeon himself may find considerable difficulty in visualizing the pre-operative position of the viscera after he has pulled the caecum out of the abdomen, and with a certain arrangement of peritoneum this manoeuvre will convert a hairpin bend into a straight appendix. This happens, for instance, where the proximal part of the appendix ascends and is adherent to the posterior aspect of the caecum while the distal part descends and is mobile. The pathologist labours under

* Presidential address to the Northern Ireland Branch of the British Medical Association, delivered at the Whitla Medical Institute, Belfast, November 22nd, 1934.

the disadvantage of seeing the appendix in his laboratory for the first time and of having no opportunity of correlating his findings with the living anatomy or with the results of operation.

Most writers agree that mechanical obstruction plays an important part and that the infection is bowel-borne. Aschoff, maintains that the inflammation is due to a microbe which normally dwells in the appendix lumen and requires an increased virulence to enable it to attack the mucous membrane with success. Obstruction, by preventing the free entrance of caecal contents with their peculiar micro-organisms or by preventing the free escape of appendicular secretions, is a potent factor in bringing about this increased virulence.

Surgeons usually have a creed with regard to appendicitis, and my own is as follows: (1) The lumen of an appendix may be obstructed by its peritoneal relations, its vascular connexions, changes in its wall, or by its contents (mass of faeces, intestinal salts, or swallowed material). (2) Such an obstruction renders an appendix more liable to inflammation and accelerates the stages of inflammation. (3) An inflamed appendix may recover or may pass on to the stages of ulceration, empyema, perforation, or gangrene. (4) The exact number of days required for an appendix to pass through this cycle of changes varies, and important factors in control are the existence of previous attacks and the degree of obstruction. (5) Venous congestion, arterial spasm, and thrombosis of vessels may enter into the pathological picture, but their position in the sequence of events is not yet clear. (6) The part played by gas-gangrene bacilli is a matter for further investigation. (7) The normal mucous membrane of the appendix is a pale yellow colour, and alterations in this colour are the earliest naked-eye signs of a pathological condition. These colour changes are often sharply limited to one segment of the tube, and take the form of a red blush, a purple ring, or bluish-red petechiae. They may be accompanied by free blood in the lumen.

THE CHRONIC APPENDIX

The term "chronic appendix" is very widely used, and would appear to apply to all those appendicular conditions which are not disclosing themselves at the moment by acute symptoms. It includes recurrent appendicitis, recurrent mild attacks of appendicitis, the obstructed appendix, and the various mucous membrane changes. The chronic appendix may lie dormant for fifty or sixty years; it may react on the stomach or duodenum, or it may produce attacks of abdominal pain which may be accompanied by vomiting, pyrexia, or tenderness. The recognition of this condition is a diagnostic triumph, since the removal of such an appendix should be attended with no mortality and may prevent a subsequent catastrophe.

The living pathology of the chronic appendix includes obstructions and mucous membrane changes. There may be obstruction of the lumen by a coprolith or by a localized thickening of the wall; or there may be obstruction by any one of the following conditions: the spiral twist, the corkscrew, the angular kink, or the U-shaped bend. These various conditions are produced mainly by peritoneal attachments. The mucous membrane changes have already been described. Often they accompany and lie distal to a kink, but they may be present in the absence of any obstruction. Some of these colour changes fade rapidly and are best seen immediately after removal.

DIAGNOSIS

The classical textbook signs and symptoms may be present in the acute appendix, but if these are insisted upon many serious appendicular lesions will be missed.

Rigidity and changes in pulse or temperature may be absent, and one occasionally operates when the only signs are colic, vomiting, and tenderness. If there is a history of a previous attack the case for operation is greatly strengthened. It is, I believe, a mistake to await the appearance of more definite signs or to make repeated examinations in the hope of diagnosing the exact pathological condition. As soon as the appendix is suspected it should be removed. If the surgeon is wrong and finds that he has removed a normal appendix the mortality should be *nil*. If there is any appendicular pathology present then he is justified, but he cannot be sure of the appendix until it has been removed and opened.

In the chronic appendix, as a rule, the history and the examination of the patient can only suggest the probability or possibility of some appendicular pathology. The problem is much simpler in children than in adults. In the former, diseases of the stomach, duodenum, gall-bladder, and female genitals are exceedingly rare. Cancer of the bowel is not likely to complicate the picture, and renal calculus or hydronephrosis must be excluded. The common errors in diagnosis are produced by constipation, mesenteric glands, adhesions, tuberculous peritonitis, cyclic vomiting, and acidosis.

Opaque meal examination is at times a valuable aid by revealing gastric retention or a deformed appendix. One encounters cases of gastric retention which are entirely relieved by removal of a chronic appendix. The appendix may be visualized seven hours after the meal, but it is more frequently seen at the end of thirty-one hours. Complete absence of any appendicular shadow may mean obstruction at the base or blotting out by the colon shadow. Mere breaks in shadow continuity are of no importance. Persistence of the appendix shadow after the caecum has been emptied, according to some observers, indicates disease or deformity. Tenderness over the appendix shadow falls into a similar category.

OPERATION

In the presence of pus how far should one go in the attempt to remove the appendix; and is there any danger in leaving the appendix or part of the appendix in the abdomen? It is impossible to lay down any rules on this subject. The condition of the patient, the accessibility of the appendix, the presence of an adhesion barrier, the mobility of the caecum, and the state of the caecal wall are all factors to be considered. It is quite certain that the gangrenous portion of an appendix can be entirely destroyed or absorbed by the omentum, and probably the retrocolic tissues can perform a similar function. If, therefore, the proximal portion can be removed and a good stump infold secured the sloughed tip will probably disappear. Inefficient closure of the stump occasionally leads to slight faecal leakage, but in my experience this is only temporary. With good light, free exposure, and gentle mopping away of the pus it should be a very unusual occurrence not to see the base of the appendix.

If one fails to remove the appendix no second operation should be undertaken unless symptoms develop. The probability is that a large part of the appendix will be absorbed and that the proximal part will remain as an unobstructed abbreviated appendix with a new tip. Occasionally faecal concretions may be found lying free in the peritoneal cavity, either seen or palpated; they should, of course, be removed.

The most important thing to avoid is the tearing of the caecal wall. Occasionally the inflammation spreads on to the wall, and rough handling of this friable structure may lead to a caecal fistula. In such a case it may be advisable to remove the appendix in the abdomen or to cease to search for it.

OPERATION RESULTS

In the past six years I have had 140 cases of acute appendicitis in the Children's Hospital with eight deaths, a mortality of 5.5 per cent. One patient died of lung trouble thirteen days after operation, and the remaining five died on the day following operation. In all five the peritoneal cavity was very seriously affected; in two of them the operation was merely one of drainage. Here are the short pathology notes of the five.

Case 1.—History of two days. Much thin purulent fluid in peritoneal cavity; appendix inflamed and perforated at tip.

Case 2.—No history. Thick pus; intestines matted. Long gangrenous appendix removed.

Case 3.—History of appendix trouble for eight days. Large right ilio-lumbar abscess; small bowel distended; drainage only.

Case 4.—History of appendix trouble for seven days. Free pus in peritoneal cavity; drainage; appendix not sought.

Case 5.—Child, aged 2 years, with history of appendix trouble for six days. Pus in region of appendix; blood in peritoneal cavity; ileum distended and blue; appendix crossed the ileum, which it may have restricted; appendix perforated at its mid-point. Appendicectomy and drainage.

During the same period eighty-seven cases of chronic appendix have been operated on with no deaths. A follow-up has been attempted in many of these, but owing to the roving population for which our hospital caters it has been impossible to obtain complete returns. Six months should elapse before the inquiry is made, but by this time the family may have migrated.

Out of fifty-eight cases of so-called chronic appendix which have been investigated thirty-nine patients have been relieved of their symptoms, ten have not been relieved, and nine gave no reply.

Of the ten unrelieved patients, one was subsequently found to have a stone in the kidney, three had a normal appendix, two were much improved, and the other four still have their colic. The symptoms of the chronic appendix were: attacks of abdominal pain, sometimes right-sided; abdominal pain and vomiting; typical recurrent attacks of appendicitis.

Out of sixty-six of these chronic cases with pathological notes fifty-nine showed living pathology and seven showed nothing abnormal. The pathological conditions were mucous membrane changes, stricture, and various forms of kinks.

CASE REPORTS

Case 1.—A boy, aged 14, had had a gland removed from the neck several years ago. His only sister had died some years previously after an operation for alleged appendicitis. Her appendix was found to be normal, but there was some mesenteric adenitis. In August, 1933, my patient was in bed for two days with abdominal colic and sickness, and in the following November he had a similar attack. Boils appeared on the neck and on the left ear. At Christmas of that year and in April, 1934, there was bilateral deafness. The left drum was incised in May; the tympanic membrane was like oil-silk and there was free sterile fluid in the middle ear. The following month the right drum was incised, and the right middle ear was found to be in a similar condition. On September 23rd there was abdominal pain and vomiting, which continued until I saw the patient the next day.

Examination revealed absolute flaccidity of the abdominal wall and some suprapubic tenderness. The pulse was 92, and the temperature 99.5° F. I advised operation, but every effort was made to divert me from this. The boy's own history and that of his sister were related. At operation, two hours later, the appendix was found rigid and distended with pus; there was a caeco-appendicular kink. Convalescence was normal, but most interesting in the subsequent history was the marked improvement in the ears.

Three points emerge from this case: (1) there may be serious appendicular trouble without any rigidity; (2)

history may lead one astray; and (3) chronic middle-ear disease may be connected with the appendix.

Case 2.—Five years ago a girl, aged 9 years and 6 months, was admitted to the Belfast Hospital for Sick Children with alleged appendicitis. She was discharged without operation, and for five years was treated for a tuberculous abdomen. A month ago she had an attack of pain in the right side with vomiting; subsequently she had several similar attacks. When she was admitted to hospital on November 21st, 1934, her pulse and temperature were normal; there was no rigidity, but a slight tenderness in the right iliac fossa.

At operation the appendix showed a moderate kink at the junction of the distal and middle thirds. This kink was due to a short band of meso-appendix which anchored the appendix to the adjacent caecum and posterior abdominal wall. On pulling on the distal third it became blue in colour as if it were being strangulated. Internally the mucous membrane of the distal third was dark red and overlaid by some blood. There was a narrow coprolith in the region of the kink. There was no sign of tuberculous disease.

This was a typical chronic appendix. Such cases should always be investigated by operation.

Congenital Hypertrophic Stenosis of the Pylorus

The diagnosis and treatment of this condition has improved enormously during the past twenty years. I have no recollection of ever seeing it during my first ten years at the Children's Hospital; during the next ten years I saw about one case per annum, and now I am operating on one case per month. The condition is not, I think, increasing in incidence, but is being more frequently recognized.

The main diagnostic feature is visible gastric peristalsis; there is also projectile vomiting, and loss of or failure to gain weight. The following figures are quoted from a recent communication: average age of onset of projectile vomiting, 3 weeks; average age at time of operation, 5½ weeks; average weight at operation, 7 lb; range of onset, birth to eleven weeks. The presence of a palpable tumour depends much on the imagination and touch of the examiner, and is not really an essential test in the presence of visible gastric peristalsis, which is best seen immediately after a feed.

Pre-operative treatment consists of lavage and glucose saline per rectum.

OPERATION AND ITS MORTALITY

The child is fixed on a padded cross, and a high right paramedian incision is made under gas and oxygen with local anaesthesia. The stomach is withdrawn with forceps, and the pylorus is fixed in position by an assistant. Any large pyloric vessel which might interfere with the incision is underrun with a needle and ligatured. A longitudinal incision is made over the tumour at the junction of the upper and middle thirds anterior pyloric wall; this incision divides only the peritoneum and superficial muscle fibres. The edges of the incision are retracted by small lung forceps, and the deeper muscle fibres, which are now on the stretch, are divided by blunt dissection and the mucous membrane exposed. The mucous coat appears as a white or yellowish-white layer, and should be exposed in the whole length of the pyloric canal. Great care must be taken not to perforate this mucous membrane coat, and the danger zone is near the duodenum. The stomach is then returned to the abdomen and the abdominal wall closed.

After operation saline is administered per rectum, four-hourly, and feeds are given by the mouth as soon as the child can swallow. Many of the cases show a sharp post-operative pyrexia: 102°, 103°, and 104° are not uncommon readings on the day after operation.

The mortality of the operation varies much in different clinics. At one time the British mortality was around

50 per cent., but a recent communication reports 25 per cent. Wallace and Wevill report only 4 per cent. of deaths in 145 cases. My own figures are twenty-four cases with five deaths, a mortality of 20.8 per cent. Statistics are not very reliable, since uniformly good results may be secured by avoiding the bad cases, and bad returns will be obtained by operating on all and sundry. In my own series I have never refused to operate on any case sent forward by the physician.

A common diagnostic error is to confuse this condition with congenital atresia of the duodenum. As a rule the error is only discovered at operation, but in congenital atresia there will be no tumour, and jaundice may be present if the atresia is distal to the common-duct opening.

Duodenal Ulcer

Duodenal ulcer is by no means uncommon in children, and four distinct groups can be recognized according to age: *Group 1.*—Ulcer of the newly born, which makes its presence known by melaena neonatorum. *Group 2.*—Ulcers in children from a few weeks to 1 year old; these are acute and probably of an infectious nature. *Group 3.*—Ulcers in children from 1 to 9 years; these are chronic, and fail to give rise to any suggestive symptoms. *Group 4.*—Ulcers in children from 9 onwards; these give symptoms similar to adult duodenal ulcer, and may be treated similarly.

I met a case from Group 4 in February, 1934. A child, aged 10, gave a six-months history of stomach pain which was present in the morning, and was relieved by a hot drink. X-ray examination showed a well-marked seven-hour gastric retention and no visualization of the first part of the duodenum. At operation a large visible and palpable duodenal ulcer was found. The appendix was normal externally, but the mucous membrane of the tip was bluish-red. The appendix was removed and a gastro-enterostomy performed. Since operation the child has been free from symptoms.

Intestinal Obstruction

Strangulated hernia, ileus following appendicitis, a band, a kink, Meckel's diverticulum, congenital defects, and tuberculous peritonitis are the common causes of intestinal obstruction. The following are brief notes of two recent cases.

CASE 1

A boy was admitted to hospital with a five-days history of appendix trouble and signs of an acute appendix. The appendix, which was removed on the day of admission, lay postero-lateral to the ascending colon; it was surrounded by omentum, was swollen and inflamed, contained pus and two coproliths, and showed gangrenous mucous membrane in its distal half. After operation nothing was passed by the bowel, and enemata returned unchanged. The abdomen became distended and ladder-like. There was vomiting, which subsequently was faecal. Medical measures were without avail, but gastric lavage gave temporary relief.

Nine days after operation death was imminent, and as a last resource a right rectus incision was made under novocain. A presenting loop of distended bowel was sutured to the parietal peritoneum and the bowel opened. The following day the boy was sitting up and playing with his toys. All vomiting ceased and the distension disappeared. Seven days after the ileostomy enemata showed a result, and twenty-four days later semproline produced a natural motion. The boy left hospital, and is now attending the out-patient department. The appendix incision is soundly healed, but there is a slight purulent discharge from the ileostomy wound.

CASE 2

A girl was admitted to hospital on April 30th, 1933, with a history of vague abdominal pain for one year. Recently the attacks had been more severe and had been accompanied by vomiting. On admission the abdomen was distended and showed the ladder-like appearance of obstructed small bowel.

The temperature was 100° and the pulse 140. In a few days with enemata the distension subsided, and the patient appeared normal on May 10th. Opaque meal and opaque enema examination disclosed transposition of viscera but no sign of obstruction. She was discharged on May 16th.

She remained well until September 9th, when abdominal pain returned and her doctor diagnosed appendicitis. She was readmitted on September 11th with a temperature of 102°. Treatment with enemata was repeated, but after one week the abdomen was opened. There were enlarged mesenteric glands and the ileum was found to be constricted by a band the thickness of the little finger. The band was divided and the patient was discharged well on September 30th. Six days later she was readmitted with abdominal pain, vomiting, and distension. Olive oil enemata were given, and she was well in four days. She was detained in hospital for three weeks' observation, but since then has remained well.

Meckel's Diverticulum

One out of every fifty people has a Meckel's diverticulum, but, of course, only a small proportion of these ever give rise to any symptoms. I can recollect only three such diverticula in the last twenty-five years. Two of them opened at the umbilicus and were seen in infancy; one was inflamed and simulated appendicitis. In the two former cases there was a red polyp-like structure at the umbilicus on the surface of which was an aperture leading into the abdomen. At operation in one of these the diverticulum was found to be connected with the appendix joining the antimesenteric border about the mid-point. The specimen now reposes in the Hunterian Museum in London, and is the only one of its kind. There was the usual attachment to the ileum in the second case. Operative procedure consisted in circumcising the navel and suturing the skin over the fistula. Gloves, instruments, and towels were then changed and the abdomen was opened. In the one case the appendix was removed with its attached diverticulum, whilst in the other the diverticulum was clamped at its base, removed, and the ileal opening closed, transversely to the long axis of the bowel, by two rows of suturing. A blind diverticulum fixed to the umbilicus is very prone to give rise to intestinal obstruction, and must always be considered as a possible aetiological factor.

Intussusception

I have had nineteen cases of intussusception during the past six years, with two deaths. The deaths were in irreducible cases in which resection was necessary. The diagnosis is always somewhat worrying. An enteritis may produce blood in the stools, but in enteritis the blood is mixed with bowel contents. Purpura is another condition with which it may be confused. A palpable tumour makes the diagnosis easy, but it is often wise to operate in the absence of any palpable tumour. I like the high gridiron incision, since it is very easily closed and there is not the same tendency for the small bowel to escape as with the paramedian.

Two points in the pathology which have impressed me are: (1) that the starting-point in a very large number of cases is a lateral dimple in the ileum, which point is possibly a swollen mass of lymphoid tissue; (2) that most intussusceptions are found in children who have a mobile ascending colon.

Operation within the first twenty-four hours will almost always give a good result, but even after five days it may be possible to effect a reduction. In doubtful cases an opaque enema may determine the diagnosis. I have never seen an intussusception recur, so that I do not think it is necessary to take any steps to prevent recurrence.

REFERENCE

¹ Knocke: *Munch. med. Woch.*, February 23th, 1933.