TREATMENT OF ACUTE APPENDICITIS

A STUDY OF 480 CONSECUTIVE CASES

BY

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Acute appendicitis is still a very serious problem in spite of widespread propaganda aimed at early treatment and the avoidance of purgation by well-meaning parents in cases of undiagnosed abdominal pain in children. The overall mortality appears to vary fairly widely in different clinics. Grey Turner (1943) gives his own mortality figures over a period of some years as 3.49%. The figures of Busch and Spivack (1940), Arnheim and Neuhoef (1940), and Jennings *et al.* (1942) vary between 1.8 and 2.2%. Dennis *et al.* (1942), who reviewed the reports from a number of American clinics, found that the death rate varied between 2.3 and 6.3%, with an average of 4.12%. Jennings *et al.* (1942) published tables summarizing the mortality figures from various reviews and found that they varied from Lazzarini's (1937) of 12% to their own of 1.9%.

Since the beginning of 1943 up to the present—i.e., the middle of 1945—I have personally dealt with a total of 480 cases of acute appendicitis. During 1943 the cases were treated at Glasgow Royal Infirmary and at an E.M.S. hospital. Since the beginning of 1944 the cases included have been those which came under my care in Greenock Royal Infirmary. In this consecutive series there were two deaths—an overall mortality of well under 0.5%. The series comprises patients of all ages from 4 to 72, and thus represents a very mixed collection of appendicitis cases. It is proposed to discuss briefly the treatment of these cases in an attempt to evaluate the factors responsible for this low mortality figure.

Classification and Treatment

We have divided the cases into four groups. The general methods of treatment will be discussed with each group.

1. Acute Appendicitis without Peritonitis

Into this group fell cases where the appendix was congested but showed little or no fibrinous deposition on its surface. Most of these were admitted within 24 hours of the onset of illness. Histologically there was usually ulceration of a crypt and leucocytic infiltration in the submucosa extending into the deeper parts of the muscularis. The cases were those frequently called acute catarrhal appendicitis. Of our cases 177 belonged to this group. Appendicectomy was carried out in all of them. The mortality was *nil*, and there were no post-operative complications.

2. Acute Appendicitis with Local Peritonitis

In this group the length of illness varied from 12 to 72 hours. The appendix showed the varying stages of pathology from acute suppurative or phlegmonous inflammation up to gangrene. All of them had much fibrinous deposit on the peritoneal surface, with a varying quantity of turbid or sero-purulent fluid in the abdominal cavity.

This group comprised 188 cases. Early appendicectomy was carried out in all but two of them—one an elderly woman who showed evidence of marked cardiovascular degeneration, the other a young male subject who had a tuberculous pleural effusion. They were treated by the "delayed" method, and the omental mass around the inflamed appendix slowly decreased in size and disappeared. Delayed removal was not considered advisable in these cases. Care was taken in this group to mop up most of the free fluid in the abdomen, as a positive culture was got in two-thirds of the cases tested. In most of them the organism found was coliform in type, although a streptococcus was present in two. All were closed without drainage except two in which there was a marked oozing of blood from the appendix bed. In these a little packing was inserted and brought out through the lower end of the wound. In cases in which the free fluid is frankly sero-purulent we believe it is advisable to irrigate the tissues of the abdominal wall with acriflavine solution and then dust them with sulphanilamide

powder. This should be done immediately after the peritoneum has been closed. In the more advanced cases in this group we also sprinkled sulphanilamide into the peritoneum.

In one case a residual abscess developed a week after the operation and was drained by the suprapubic route. There were 5 septic wounds, all of which cleared up without trouble. There were no deaths.

3. Acute Appendicitis with Spreading Peritonitis

In all but four of the 52 cases included in this group the appendix was ruptured. In every one of them there was evidence of spreading peritoneal inflammation at a distance from the appendix, with diffuse fibrinous deposition and pus formation. Mere reddening of the peritoneum was not by itself taken as indicative of peritonitis, as this was found in many of the cases included in the previous group. In 27 of the cases the patient was classified as "desperately ill" and the condition was accompanied by marked toxicity and some degree of paralytic ileus. Early rather than urgent operation was carried out in all these cases except one, which was treated by the "delayed" method. In the very ill cases intravenous therapy was started—at once in the case of adults, and during the operation in children, who were otherwise more readily upset by the procedure. In all these ill patients it was found that a few hours in the Fowler position and the parenteral administration of sulphanilamide not only made them more fit for operation but caused the inflammatory products to gather in the lower abdomen, from which they could be more readily removed. In four of the cases an immediate enterostomy was carried out because of advanced paralytic ileus. In a fifth this was required six days after the primary operation. The fistula closed in all these cases but one, in which it eventually closed after five months.

Gastric suction was used in all the cases in which post-operative vomiting and distension became pronounced. When this happened a Ryle tube was passed by the nasal route and aspiration carried out by a syringe every half-hour.

Sulphanilamide was freely used in this group, particularly locally, and will be discussed later in this article. All the cases but four were drained. In one of the latter a large abscess developed in the abdominal wound two weeks after the operation.

The only patient treated by the real "delayed" method was a young seaman who had been operated upon in mid-Atlantic. The ship's medical officer had failed to find the appendix, and closed the abdomen without drainage. When seen by us some days later the patient had a diffuse peritonitis. He was treated in the Fowler position, with sips of water and intramuscular sulphonamide. The tenderness slowly decreased and finally faded off into the right lower abdomen after five days.

In many of the cases in this group the patient had a few days of grave illness, during which great emphasis was placed upon intravenous sulphonamide therapy. After this a steady recovery was made. The mortality rate was *nil* in this group.

4. Appendiceal Abscess

In most cases the abscess lay in the pelvis or behind the caecum. In a few it was retro-ileal, and in one it lay completely enclosed in omentum, forming a mass which was freely movable in the abdomen. There were 63 cases in this group. All but five of them were operated upon at once, and of the latter two were drained after a few days because of signs of extension of the inflammatory process. Thus, only three were treated by the real "delayed" method. In all but four of the cases the appendix was removed at the time of operation. We agree with Arnheim and Neuhoef (1940), who pointed out that it is preferable to remove the appendix in these cases, not only because it may remain a potentially infected focus in the abdomen but also because other abscesses may lie behind it and be opened only after it has been detached. When the pus had been swabbed from the cavity sulphanilamide powder was liberally shaken into it and a drainage tube left in position.

The patients in this group were on the whole not nearly so ill as in Group 3, and intravenous therapy was required much less often. The only two deaths in the whole series of cases occurred in this group. One was that of a child who died suddenly, a few hours after operation, of what looked like an

acute oedema of the lungs. A necropsy was not allowed. The other was that of a man aged 35 who died of a recurrent pelvic abscess eight days after the original operation. This case and the mistake which led to this complication will be referred to later.

Special Points in Treatment

Before beginning the present series of cases I attempted to formulate the most frequent causes of death in acute appendicitis. The most early important cause appeared to be the practice of operating at once on very ill patients "as a last resort." Another, particularly in children, was post-operative bronchopneumonia, and this seemed to be at least partly attributable to the anaesthetic. After some days cellulitis of the abdominal wall and residual abscess became important causes of morbidity and mortality. It was then decided to pay particular attention to means which might conduce to the prevention of these complications. The following points in technique appeared to be of importance.

(a) Anaesthetic

Well over 80% of the anaesthetics given to the cases of this series were administered by house-surgeons. We believe that there is nothing more injurious to a seriously ill patient than a raw house-surgeon attempting to use one of the complicated series of tubes and dials which constitute a modern anaesthetic apparatus. My house-surgeons are therefore instructed in the method of giving open ether without chloroform, and this is the anaesthetic always used in cases of acute appendicitis. Recently the induction has been made more rapid and comfortable for the patient by the use of vinesthene mixture. In extremely ill cases nitrous oxide with light ether has been given. In ill patients ether tends to stimulate the heart, and, in children particularly, there is a stage immediately after the completion of the operation when this stimulant effect wears off and the tendency to cardiac collapse becomes marked. This is minimized by having the intravenous drip started before completing the operation and by administering enough plasma to keep the circulatory volume up to normal. A mild post-operative bronchitis has been common, and in some cases a basal pulmonary collapse has occurred. These chest complications were not serious, and in regard to the death already mentioned as being due to pulmonary oedema there was doubt whether this was primarily due to the heart or to the lungs. Immediately after the operation patients are instructed in deep-breathing exercises and in many cases are made to inhale carbogen frequently. It is our impression that this has definitely reduced chest complications.

(b) Fluid and Chloride Replacement

In all very ill patients an intravenous drip was set up—in adults at once and in young children while under the anaesthetic—and saline, glucose, and plasma were administered. In most of the cases the lower end of the internal saphenous vein was found to be the best site of administration, and, particularly in restless children, the application of a light plaster to the foot and ankle will allow the intravenous therapy to be continued for days on end. Where the patient is very collapsed it is often exceedingly difficult to run fluid into the saphenous, and in such a case a vein of the antecubital space is more suitable. The speed of administration is regulated according to the needs of the patient and the effect on his pulse. The danger of overloading the right heart appears to us to be much less in the shocked and dehydrated patient than is usually suggested; and it is very gratifying to bring a patient literally back to life by running one or two pints of fluid into his circulation at a fairly rapid rate. We cannot overstress the importance of intravenous therapy in these very ill cases of peritonitis, and we feel that this has played a most important part in the low mortality figures.

(c) Time of Operation

The "delayed" or Ochsner-Sherren method of treatment in the advanced but localized appendiceal inflammatory process is too well known to require elaboration. It is in the treatment of diffuse peritonitis that there is some difference of opinion. It is interesting to note in passing, as has been pointed out by Guerry and McCutchen (1942), that it was really with reference to this type of case that Ochsner's (1934) original description

of the "delayed" treatment was given. To quote from his article on appendicitis:

"The temperature was 104° F., the pulse 140, the abdomen enormously distended, and the features pinched. My experience with this and other similar cases has taught me that whenever I operated upon patients approximately in this condition the patient invariably died. Some years ago . . . I frequently operated upon patients in this condition as a last resort, thinking that this gave them the last chance of recovery. The majority of these patients recover if the delayed treatment is followed."

There has been abundant evidence of the truth of Ochsner's observation, although most authors do not differentiate very well between the localized and the diffuse type of peritoneal involvement. Coller and Potter (1934) reduced their mortality from 52 to 8.6% by the "delayed" treatment in this type of case. Davis and McLaughlin (1940) reduced theirs from 60 to 14%, and Guerry and McCutchen (1942) reported a mortality rate of 10.6% in 96 cases treated by immediate operation and one of only 1.4% in 139 cases treated by expectant means.

Where there is pus, free and unlocalized, in the peritoneal cavity it is surely a fundamental surgical principle that it should be mopped up as soon as possible and the suppurating focus dealt with. Thus we have preferred early operation in these cases but have waited for some hours with the patient in the Fowler position in order to allow the inflammatory products to settle in the pelvic region and the initiation of intravenous therapy. Our results have been very satisfactory, all of our 52 cases making uninterrupted recoveries. We must remember, however, that the use of sulphanilamide may have played an important part in the recovery of this type of case, as we shall see later.

(d) Abdominal Incision

We now use Battle's incision in all our appendicectomy cases. Our only exception to this rule has been where the gridiron approach has been more directly over an abscess. We have had no example of sepsis spreading up the rectus sheath, nor have we seen an incisional hernia follow its use. The abdominal contents can be better visualized and a "difficult" appendix removed more easily and with less tendency to break down protective adhesions than with any other incision we know. As it is unnecessary to tear through muscular strata, and as the approach is a more direct one, there is less tendency to "pocketing" of pus in the abdominal wall than with the gridiron incision.

(e) Use of Sulphonamides

There is now much experimental and clinical work which proves the value of the sulphonamide group of drugs in the treatment and prevention of peritoneal infection. McGehee (1941) reported 401 cases of appendiceal perforation in which sulphanilamide had been used, with the low mortality figure of 6.2%. By the use of sulphonamides in the post-operative treatment of acute appendicitis in children Wattenberg and Heinbecker (1942) were able to reduce their mortality rate from 7.89 to 2.2%. Favourable results have also been reported by Thompson *et al.* (1941) and Stafford (1942).

The experimental work of Rosenberg and Wall (1941) and of Epps *et al.* (1942) in rats and dogs demonstrated that the mortality rate of peritonitis in these animals fell rapidly when sulphonamides were used. There is still some speculation as to which is the best individual sulphonamide compound to employ in peritonitis. Sulphanilamide powder appears to be the most popular local application, although sulphathiazole is preferred by many because of its greater potency in the usual peritoneal infections. Sutton (1942) has, however, reported adhesions following the use of this drug, a secondary intestinal obstruction actually developing in one case. This might be avoided by the suggestion of Epps *et al.* (1942) that a suspension of the drug would be more readily disseminated throughout the peritoneal cavity. Ambrose and Griswold (1942) found that sulphadiazine is absorbed from the peritoneum more slowly than either sulphanilamide or sulphathiazole, and Lyons and Burbank (1942) showed that sulphapyridine and sulphadiazine remained longer *in situ* than any of the other compounds. Gardiner (1944) obtained satisfactory results by using a suspension of sulphapyridine in saline, the rate of absorption from the peritoneum being very slow, and the drug still being present in the blood up to a week later.

Again, there is no unanimity as to the safe intraperitoneal dosage of the sulphonamides. Jackson and Collier (1942) found that after implanting 5 g. of sulphanilamide powder in the peritoneum the maximum blood concentration of nearly 10 mg. per 100 c.cm. was reached in about two hours. At 24 hours the level was less than 2 mg. per 100 c.cm. Hudson and Smith (1942), using an average of 15 g., found the peak concentration in the blood stream in about 12 hours, the figure falling to zero in 36 to 48 hours. Tashiro *et al.* (1942) pointed out that a blood concentration of 1 mg. per 100 c.cm. could be expected for every gramme of sulphanilamide placed in the peritoneum. Waugh *et al.* (1943) calculated that the systemic administration of the drug should be started 24 to 48 hours after the intraperitoneal administration of sulphanilamide and 3 to 4 days after sulphathiazole.

In our series the sulphonamides were considered to be unnecessary in the ordinary case of uncomplicated acute appendicitis. In the late suppurative stage they were sometimes used, and in the cases complicated by abscess or diffuse peritonitis their use was extensive. Sulphanilamide powder was employed. The powder is put up in double packets, each containing 5 g. and already sterilized, so that the surgeon has merely to lift out the inner packet after the nurse has torn off the top of the outer envelope. The dose varied between 5 and 10 g., depending upon the severity of the illness and the age of the patient. About two-thirds of the amount used was placed inside the abdomen and the remaining third in the tissues of the wound. After the pus had been swabbed from the abdomen the powder was simply "dumped" into the peritoneum, no great effort being made to disseminate it. Care was taken, however, to rub it evenly into all the corners of the wound. Particular care was taken to smear it abundantly round the track of the rubber drain, and it also seemed advisable to close the tissues snugly round the tube to minimize the escape of pus into the abdominal wall for at least the first few critical post-operative days until the raw tissues had acquired some immunity to infection. We also found it useful to spray the powder on to the stitched surface of the wound in order to protect it from escaping pus. In the very ill cases parenteral sulphonamide was started about 40 hours later, soluble sulphapyridine being given intravenously or sulphathiazole orally. The dosage was 1 g. four-hourly.

There was one important point in after-treatment which bitter experience taught us. In our earlier cases it was found that local application of the drug appeared in many cases to only temporarily subdue the infection which sometimes flared up into activity after four to six days. We thus learned to leave the drain in position longer than usual, and now allow it to be only very slowly shortened, so that it is not completely removed until the fifth or sixth day. We have already noted that one of our deaths was due to a residual pelvic abscess which flared up into activity a week after the primary operation. In this case the drain had been completely removed on the third day. Such a case is, of course, also an argument for the post-operative use of parenteral sulphonamide in all such conditions.

(f) Drainage of the Peritoneum

When a young surgeon removes a suppurating appendix and finds the peritoneum containing an abundant quantity of turbid almost frankly purulent fluid, his first inclination, on general surgical principles, is to drain the abdomen. To do this in such a case would be to disregard the excellent protective and reparative properties of the peritoneum. A very instructive experiment can be carried out by injecting a suspension of staphylococci into the peritoneum of a rabbit. Periodic examination of the peritoneal contents shows that there is an immediate phagocytic response, and within a few hours most of the organisms have been ingested by emigrating polymorphonuclear cells, the latter being afterwards phagocytosed by macrophages derived mainly from the serous lining. This suggests that where a peritoneal infection is not too overwhelming, and the focus of infection has been removed, the peritoneum may be allowed to look after itself. If we may be permitted to quote from Hilton's (1930) famous book, "Nature has a constant tendency to repair the injuries to which her structures have been subjected, whether these injuries be the result of fatigue or exhaustion, of inflammation or accident. Also

this reparative power becomes at once most conspicuous when the disturbing cause has been removed."

Buchbinder *et al.* (1931) showed experimentally the fallacy of peritoneal drainage. They produced peritonitis in dogs by opening a loop of gut and leaving it for 24 hours. They then reopened the abdomen and closed the bowel. In the cases in which the abdomen was then drained the mortality was 100%. When closure was effected without drainage the mortality fell to 57.5%. Haggard and Kirtley (1940) quote Giertz, who found that, in cases of appendiceal peritonitis operated upon in the first 48 hours of illness, he was able to reduce the mortality from 22.2 to 3.5% by primary closure of the peritoneum.

In our series of cases, wherever possible, we refrained from draining the abdomen. We have followed the general principle that drainage is unnecessary when the appendix is unruptured, unless the peritonitis is obviously of advanced degree. The examination of peritoneal smears demonstrated the truth of this. In the early unperforated case the turbid fluid shows many polymorphonuclear leucocytes, some of which contain engulfed bacteria; only very occasionally are free bacteria found. In such a case it is obviously best to leave the peritoneum to combat the infection. As the condition progresses, however, the polymorphs become more degenerate and poorly stained, and the free bacteria more abundant. In frankly spreading peritonitis bacteria are abundant, most of the polymorphs are degenerating, and a piece of excised omentum shows stagnant and dilated blood vessels, many of which contain hyaline thrombi, and most of the lymphatic pathways are obviously blocked by fibrin thrombi. In such a one-sided struggle it is obviously safer to drain—not only to remove the products of bacterial activity but also to avoid abscess formation. In our past experience the main danger of peritoneal drainage has been the tendency to infection of the abdominal wall setting up a cellulitis. In the present series this danger appears to have been reduced to negligible proportions by the local use of sulphanilamide.

Conclusion

It is very difficult for any surgeon to evaluate properly the factors responsible for a decreasing morbidity and fatality rate in a series of cases such as this, particularly when this is a natural sequel to an increasing experience. In our series, however, the most important factors appear to have been the prompt use of intravenous therapy to restore fluid balance, and the intraperitoneal use of sulphanilamide powder.

Summary

A consecutive series of 480 cases of acute appendicitis with a mortality of under 0.5% is described. The main reasons for this low mortality are discussed.

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