BOWEL INFECTION AND ACUTE APPENDICITIS

BY

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This paper seeks to correct the widely held belief that a clinical or bacteriological diagnosis of infective diarrhoea excludes the presence or development of acute appendicitis.

The work that is described was stimulated by isolated incidents that occurred between 1950-1955: these are summarized in Table 1. In that period nine children had appendicectomies either when a bowel infection was present or before such an infection became manifest in the post-operative period: at operation four out of these nine cases were found to have acute appendicitis. A preliminary communication on the thesis of this paper was read at this hospital at a Summer meeting of the Paediatric Section of the Royal Society of Medicine in 1957 (Rogers, 1957).

Because of the findings shown in Table 1 an investigation was organized to inquire into the role of bowel infection as a factor in the aetiology of acute appendicitis: it was quite fortuitous that our planned project was started in January 1956, when a pandemic of Sonne dysentery in England was beginning.

Investigations

Main Investigation, 1956. In 1956 at the Children's Hospital Birmingham, there were 250 appendicectomies. The patients concerned represent 4.4% of a total of 5,730 patients admitted that year. Of these, 160 were suffering from acute appendicitis and all the appendices from them were examined, the distal two-thirds of each being sent for histological examination and the proximal one-third being used for bacteriological examination. When peritonitis was present, peritoneal pus or fluid was investigated. Examination and culture of the faeces were also performed. If no faeces was available a sheathed rectal swab was employed to obtain a true rectal specimen (Rogers, 1954). Twelve of the 160 patients were found to have *Shigella sonnei* in their appendices and it was thought that most of these patients had dysentery due to that organism as well as acute inflammation

of the appendix. Table 2 presents the main symptoms, findings at operation and bacteriological investigations of each of these 12 cases. There was, in addition, a girl (Case 13, Table 2) who developed acute appendicitis with abscess formation while she was suffering from a salmonella infection. The normal appendices removed from 20 patients, were also cultured by the same techniques and neither *Sh. sonnei* nor salmonellae were isolated.

Investigations, 1957-1960. The number of appendices which are now cultured has fallen and we appear to be having a situation comparable to that seen before the Sonne dysentery pandemic of 1956. But the bacteriological findings we have obtained have supported the evidence showing that salmonella or shigella bowel infection and acute appendicitis may be associated. The case histories of the patients in these years are summarized in Table 3.

Although the notifications of dysentery in England and Wales rose higher in 1960 than they were in 1956, the number in Birmingham did not rise. This is shown in Table 4, which presents the figures supplied by the City's Medical Officer of Health. The bacteriological findings in Birmingham are similar to those in other parts of England and Wales, where *Shigella flexneri* causes only about 2% of all the dysentery infection, the majority being caused by *Sh. sonnei*: if the *Sh. flexneri* infections of the mental hospitals are excluded, only 1% of the dysenteric infections in the general population are due to that organism (Carpenter, 1960). We were not surprised, therefore, when *Sh. sonnei* was the dysenteric organism most commonly found in the case of appendicitis.

In Glasgow dysentery infections caused by *Sh. flexneri* are not uncommon. The figures given in Table 5 are extracted from the Annual Report on the work at Ruchill Infectious Diseases Hospital, Glasgow (Annual Report on the work of the Infectious Diseases Hospital in the Western Region of Scotland, 1959). They demonstrate how, in a five-year period, the percentage of dysenteric infections

TABLE 1

Date	Sex and Age (years)	Days Before Admission		Operative Findings	Bacteriology
		Diarrhoea	Pain		
May, 1950	M/4	0	1	Normal appendix; appendicec-tomy	<i>Salm. enteritidis</i> two days after appendicectomy when diarrhoea developed
June, 1950	M/5	3	1	Gangrenous appendix with abscess	No culture of pus from abscess; <i>Sh. sonnei</i> from faeces
January, 1951	M/7	0	4	Normal appendix; appendicec-tomy	<i>Sh. sonnei</i> from faeces two days after operation
March, 1951	M/4	1	1	Acute appendicitis, appendix adherent to liver; appendicec-tomy	No culture of appendix; diarrhoea developed six days post operatively; wound suppuration, <i>Sh. sonnei</i> cultured from wound pus and from faeces
May, 1951	M/12	1	4	Normal appendix; appendicec-tomy	Diarrhoea occurred three days post operatively; <i>Sh. sonnei</i> cultured from faeces
July, 1952	M/10	0	1	'Congested appendix'; appendicectomy	Diarrhoea two days post operatively; <i>Salm. typhimurium</i> cultured from faeces
January, 1953	M/12	0	4	Normal appendix; appendicec-tomy	Diarrhoea two days post operatively; <i>Salm. typhimurium</i> cultured from faeces
March, 1953	M/5	0	Few hours	Acute appendicitis with general peritonitis; appendicectomy	No culture of peritoneal pus or appendix; 'routine' faeces on admission grew <i>Sh. sonnei</i>
September, 1953	F/1	7	7	Normal appendix; appendicec-tomy	One day post operatively <i>Sh. sonnei</i> cultured from faeces
February, 1954	F/4	0	3	Appendix very inflamed; pus in peritoneal cavity	Peritoneal pus grew <i>Sh. sonnei</i>
February, 1954	M/11	Three attacks of diarrhoea and vomiting in two weeks		Adherent and inflamed appendix	No culture of appendix; <i>Sh. sonnei</i> in faeces two days post operatively
December, 1955	M/8	1	0	Appendix very inflamed; peri-toneal toilet necessary	<i>Sh. sonnei</i> in faeces post operatively
December, 1955	M/5	Con-stipated	2	Perforated appendix; appendix abscess	<i>Salm. derby</i> from peritoneal pus and post operatively from faeces

TABLE 2

Case No.	Date	Sex and Age (years)	Days Before Admission		Contact	Tem-perature (° F.) on Admission	Operative Findings*	Bacteriology
			Diarrhoea	Pain				
1	January, 1956	M/6	3	3	Mother and father had diarrhoea and vomiting three weeks before	103	General peritonitis	<i>Sh. sonnei</i> from appendix and sheath swab, not from peritoneal pus
2	February, 1956	M/6	3	$\frac{1}{2}$	None	100	Local peri-tonitis	<i>Sh. sonnei</i> from appendix and sheath swab
3	February, 1956	M/9	$\frac{1}{2}$	$\frac{1}{2}$	None	99	Local peri-tonitis	<i>Sh. sonnei</i> from appendix and sheath swab
4	February, 1956	M/5	14 intermittent	1	None	101	Local peri-tonitis	<i>Sh. sonnei</i> from sheath swab, not from appendix
5	March, 1956	M/8	1	2	None	103	General peri-tonitis	<i>Sh. sonnei</i> from appendix and sheath swab, not from peritoneal pus
6	March, 1956	F/5	5 intermittent	5	None	100.6	Local peri-tonitis	<i>Sh. sonnei</i> from appendix and sheath swab
7	April, 1956	M/5	2	2	None	100	General peri-tonitis	<i>Sh. sonnei</i> from appendix and sheath swab, but not from peritoneal pus
8	April, 1956	M/8	4	2	7 siblings, 2 recently had diarrhoea and vomiting	100	General peri-tonitis	<i>Sh. sonnei</i> from appendix only; not from peritoneal pus or sheath swab
9	April, 1956	M/12	2	2	None	100	Local peri-tonitis	<i>Sh. sonnei</i> from appendix and sheath swab
10	May, 1956	F/2	4 at onset	4	Mother had diar-rhoea one week before	100	General peri-tonitis	<i>Sh. sonnei</i> from appendix only, not from sheath swab or peritoneal pus
11	May, 1956	M/8	5	1	None	99	Local peri-tonitis	<i>Sh. sonnei</i> from appendix only, not from sheath swab
12	June, 1956	M/9	2	2	Sister had diarrhoea and vomiting one week before	103	General peri-tonitis	<i>Sh. sonnei</i> from appendix and sheath swab only, not from peritoneal pus
13	August, 1956	F 17 mths	3 (vomiting only); diarrhoea occurred three days after operation	3	None	100	Retrocaecal abscess	<i>Salm. heidelberg</i> from appen-dix and sheath swab

Eleven of the 12 strains of *Sh. sonnei* were identified on the primary cultures and one was only isolated by selenite enrichment.

* All had acute appendicitis.

TABLE 3

Date	Sex and Age (years)	Days Before Admission		Operative Findings	Bacteriology
		Diarrhoea	Pains		
April, 1957	M/11	0	1	Ileo-ileal intussusception; 'injected' appendix; reduction of intussusception and appendicectomy	Appendix yielded <i>Sh. sonnei</i> by selenite enrichment only
April, 1957	M/8	0	1	Acute appendicitis; local peritonitis; appendicectomy	Appendix yielded <i>Sh. sonnei</i> on direct culture
October, 1958	M/5	5 hours	5 hours	Appendicectomy; appendix showed 'acute focal infiltration of all layers'	Both appendix and faeces grew <i>Salm. typhimurium</i>
April, 1959	F/6	1	1	General peritonitis; appendix gangrenous and perforated; partly 'walled off' by omentum	Mixed growth with <i>Sh. sonnei</i> on direct culture
July, 1959	M/4	7	1-2	Gangrenous perforated retrocaecal appendix lying in an abscess with faecolith	Mixed growth with a few <i>Sh. sonnei</i> on direct culture
August, 1959	F/7	6 ceased at 2	?	General peritonitis; gangrenous perforated appendix, partly 'walled off' by omentum	Rectal swab, peritoneal pus and appendix all yielded <i>Sh. sonnei</i> on direct culture
June, 1960	M/ $\frac{1}{2}$	For 7 days, 14 days before admission	1	Ileo-ileal intussusception requiring resection of non-viable gut; appendix nearly involved in intussusception, so removed	<i>Sh. sonnei</i> grown from appendix whose histology showed oedema and some polymorph infiltration only

TABLE 4

NOTIFICATIONS OF DYSENTERY IN THE CITY OF BIRMINGHAM IN THE FIRST TWO QUARTERS, 1956-1960

Year	First Quarter					Second Quarter				
	Total Notified	No. Investigated	Organisms Identified			Total Notified	No. Investigated	Organisms Identified		
			<i>Sh. sonnei</i>	<i>Sh. flexneri</i>	None			<i>Sh. sonnei</i>	<i>Sh. flexneri</i>	None
1956	744	431	372	0	59	305	267	112	4	51
1957	250	207	87	56	64	143	104	62	6	36
1958	209	163	93	0	70	118	73	48	1	24
1959	194	60	49	1	10	284	45	29	1	15
1960	171	46	30	1	15	181	55	36	2	17

TABLE 5

DYSENTERY IN RUCHILL HOSPITAL, GLASGOW

Organism	1955		1956		1957		1958		1959	
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>Sh. sonnei</i>	408	56	485	86	326	87	328	75	278	57
<i>Sh. flexneri</i>	323	44	78	14	48	13	107	25	206	43
Total	731		563		374		435		484	

due to *Sh. flexneri* was very much higher than is usual in England and Wales. In February 1959, a girl of 15, who had had diarrhoea for one day was admitted to the Royal Infirmary, Glasgow; *Sh. flexneri* was isolated from her faeces, but her abdominal pain increased and appendicectomy was performed. At operation an inflamed appendix was found, without any pus formation or peritonitis (Patrick, 1959).

Diagnosis

The differential diagnosis of acute appendicitis in children has been discussed at length by Williams (1947) and Brown (1956). Both these authors draw attention to the fact that the 'difficult case' is the patient who does not have abdominal pain as

the presenting and predominating symptom; they point out that diarrhoea, contrary to time-honoured orthodox surgical teaching, is a very common alternative manner of presentation. This diarrhoea, associated with vomiting, may precede or concur with the abdominal pain.

Campbell and McPhail (1958) noted that 16% of 450 adult cases with acute appendicitis had a history of diarrhoea, whilst Brown (1956) found this symptom in 12% of 1,148 children suffering from appendicitis. Zachary Cope (1957) draws attention to the fact that appendicitis in children may be heralded by the passage of loose stools. While it is recognized that diarrhoea may occur late in the disease, indicating the presence of a pelvic abscess, little attention has been paid to the significance of

diarrhoea as an early symptom. In the 160 cases studied in 1956, diarrhoea was an early symptom in 28 (17.5%). Amongst these 28 cases, were the 12 who were subsequently found to be suffering from Sonne dysentery. In four of these 12 children with shigella infections, diarrhoea preceded the abdominal pain: in seven, abdominal pain occurred at the same time as the diarrhoea and in one the diarrhoea started after the pain. The child with salmonellosis was constipated until three days after operation, when diarrhoea developed.

Vomiting occurred as an early symptom in 118 of the 160 patients studied (73.3%) and in 10 of the 12 patients with Sonne dysentery.

The physical signs we have used in the diagnosis of acute appendicitis in our children have been essentially those evaluated and found reliable in adults by Campbell and McPhail (1958); moreover, we have not found that they differ when there is concomitant dysenteric infection.

All our patients were pyrexial, but their fever showed no unusual features. Those patients with localized infection had temperatures of 100° F. or below: those patients with general peritonitis had temperatures of 101° to 103° F.

When allowance is made for the natural apprehension of the very young, and if gentleness is used and care taken not to alarm a frightened child, the signs of tenderness, guarding and release pain, in the right lower quadrant of the abdomen, are as valid in children as in adults, and the same applies to rectal tenderness.

In some patients the diagnosis of appendicitis was delayed because of the clinical picture of infective diarrhoea, and it is noteworthy that six of the 12 cases with Sonne dysentery had general peritonitis.

Treatment

In the 160 cases described in this study, appendicectomy was performed with or without drainage. Patients with general peritonitis received intravenous therapy and gastrointestinal suction. The dysenteric infection was treated in 11 cases with oral streptomycin 0.5 g. b.d. for seven days. One child received oral phthalyl sulphathiazole 1 g. q.d.s. for seven days. The children were considered free of infection after specimens of faeces obtained on three consecutive days had been examined and found to be free from the presence of *Sh. sonnei* (Rogers, 1954).

Bacteriological Techniques

The fragment of appendix sent for a cultural examination was placed in a sterile 1-oz. screw-

topped bottle: in the laboratory this was cultured as if it was pus (Rogers, Zinnemann and Foster, 1960), and also as if it was faeces (Rogers, 1954). Strains of *Sh. sonnei* and salmonellae were first identified by slide agglutination and then this identity was confirmed by tube agglutination using a centrifuge, a method which provides a quick confirmation of the slide agglutination result (Rogers, Dowse and Hall, 1959). Other routine confirmatory tests were made and the *in vitro* antibiotic sensitivity reactions of each strain were examined, but no attempt was made to phage or colicine type them during 1956. Some of the strains isolated in 1959-60 have been colicine typed, but no single type was found to be associated with appendicitis.

Discussion

Several authors described how either *Salm. typhi* or *Salm. paratyphi B* were isolated from the appendix or the peritoneal pus removed from patients with acute appendicitis (Mackenzie, 1903; Wilde, 1930; Hawkes, 1939; Storey, 1954), Rubenstein and Johnson (1945) reviewed the literature on the subject and reported that a boy of 14, who had been under their care, developed appendicitis whilst suffering from salmonellosis due to *Salm. newport*, and that a 42-year-old man had a gangrenous appendix removed when he had salmonellosis due to *Salm. oranienberg*. There have been fewer reports in which the association of shigellosis and acute appendicitis has been proved. Graham (1944) reported that amongst 550 American troops, with dysentery due to *Sh. newcastle*, four also suffered from acute appendicitis, the appendices showing catarrhal changes.

Rose (1945) described how a man of 30, who had clinical dysentery due to *Sh. flexneri*, developed appendicitis two weeks later: no dysentery organisms were isolated from the foul pus found at operation: another man of 29 had mild clinical dysentery and acute appendicitis, but at no time were shigellae isolated from his faeces: *Sh. shigae* were isolated from the pus found at operation. Cowan (1958) reported 10 cases of acute appendicitis occurring amongst 345 patients with mild clinical dysentery: no bacteriological investigations were made.

The changes in the pattern of Sonne dysentery, which have occurred since 1947, have been discussed by Taylor (1957): it is possible that this change might be due to new strains brought to England in the post-war years by returning troops and transient foreign visitors (*Lancet*, 1956), but this increasing frequency of Sonne dysentery makes it important for the association of dysentery and appendicitis to be appreciated in Great Britain.

Rendle Short (1935) wrote: 'Pain associated with diarrhoea . . . is unlikely to have surgical significance'. Burrill Crohn (1945) stated: 'Diarrhoea and appendicitis rarely concur and it is a safe rule that fever, tenderness, and even rebound tenderness, in the presence of diarrhoea are almost invariably due to an acute gastro-enteritis or ileitis', but he admitted that if there were conditions of epidemic or endemic dysentery, a diagnosis of acute appendicitis could be seriously considered.

Several writers (Kross and Schiff, 1940; Keeling, 1942; Rose, 1945; Keyes and Cook, 1946), have emphasized how difficult it is to differentiate between appendicitis and dysentery. Rubenstein and Johnson (1945) showed how the white cell count was of no value in making this differential diagnosis; we agree that there is often a polymorphonuclear leucocytosis in a patient who is dehydrated, which can easily occur when a child has dysentery.

Many authors recorded that faecoliths were present or there was evidence of previous damage to the appendix in the patients who had this dual pathology. Perry and Tidy (1918) suggested that the intestinal disturbance of dysentery was liable to cause irritation of a previously diseased appendix, and Rose (1945) noted the presence of a faecolith in both his patients who had acute appendicitis due to shigellosis, as did Widal (1913) in the appendix abscess of his patient who had paratyphoid fever. Macroscopic and microscopic examinations of the appendix of each of our cases showed acute suppurative inflammation, progressing in some cases to gangrene and perforation, and no evidence was found which did not support the view of Wangenstein and Bowers (1937) and Bowers (1939) that obstruction was the exciting factor in the development of acute appendicitis.

It was our opinion that mucosal oedema was the precipitating factor in the development of the *acute appendicitis*, as a partial obstruction then became complete. Enterogenous infection of the appendix by bacteria, which may be recognized pathogens, may account for a larger number of cases of acute appendicitis than we had hitherto believed, especially those in which diarrhoea is an early symptom. Such a theory might revive the 50-year-old beliefs of Aschoff that the exciting cause of acute appendicitis was mucosal infection (Aschoff, 1932).

The awareness of the association of infective diarrhoea and acute appendicitis, which we have in fact shown to exist, is essential if a correct diagnosis is not to be delayed. The risk of hospital cross-infections will be reduced if patients with acute appendicitis, who might also have dysentery,

are admitted to isolation wards or barrier nursed, until the bacteriological investigations are completed. In this hospital any non-lactose fermenting enterobacteriaceae is examined to ensure that salmonellae and shigellae are always identified: we are not the first to consider this logical, for in 1945 Rubenstein and Johnson advocated that appendices should be cultured on selective media to allow salmonellae or shigellae to be isolated, and the interesting report of Hormaeche, Surraco, Peluffo and Aleppo (1943) make it obvious that this is also the rule in their laboratory.

Summary

The evidence collected in a children's hospital over a period of 10 years has shown that acute appendicitis may be precipitated by a bowel infection. Symptoms and signs suggestive of acute appendicitis demand operation, even though a bowel infection may be known to be present. It is considered that an appreciation of this possible dual pathology will help to prevent hospital cross-infection due to salmonellae and shigellae. Previously published literature on the subject has been reviewed and discussed.

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REFERENCES

- Annual Report on the work of the Infectious Diseases Hospital in the Western Region of Scotland, 1959.
- Aschoff, L. (1932). *Appendicitis: its Aetiology and Pathology*. Translated by G. C. Pether. Constable, London. (First published, 1912.)
- Bowers, W. F. (1939). 'Appendicitis' with especial reference to pathogenesis, bacteriology and healing. *Arch. Surg. (Chicago)*, 39, 362.
- Brown, J. J. Mason (1956). Acute appendicitis in infancy and childhood. *J. roy. Coll. Surg. Edinb.*, 1, 268.
- Campbell, J. A. and McPhail, D. C. (1958). Acute appendicitis. *Brit. med. J.*, 1, 852.
- Carpenter, K. P. (1960). Personal communication.
- Cope, Z. (1957). *The Early Diagnosis of the Acute Abdomen*. Oxford University Press, London.
- Cowan, D. J. (1958). Appendicitis and acute terminal ileitis during an outbreak of gastro-enteritis among British troops in Port Said. *Brit. med. J.*, 1, 438.
- Crohn, B. B. (1945). Acute appendicitis and diarrhea. *Gastroenterology*, 4, 511.
- Graham, W. H. (1944). Diagnosis of appendicitis with gastro-enteritis. *Milit. Surg.*, 95, 296.
- Hawkes, S. Z. (1939). Paratyphoid fever complicated by ruptured appendicitis. *Ann. Surg.*, 110, 466.
- Hormaeche, E., Surraco, N. L., Peluffo, C. A. and Aleppo, P. L. (1943). Causes of infantile summer diarrhea. *Amer. J. Dis. Child.*, 66, 539.
- Keeling, J. (1942). Salmonella septicaemia. A report of seven cases. *N.Z. med. J.*, 41, 254.
- Keyes, E. L. and Cook, M. M. (1946). Diagnosis of acute appendicitis in the presence of diarrhea. *Arch. Surg. (Chicago)*, 52, 429.

- Kross, I. and Schiff, F. (1940). Pseudosurgical syndromes produced by salmonella organisms. *Amer. J. dig. Dis.*, 7, 176.
- Lancet* (1956). Leading article. 'More dysentery.' 2, 878.
- Mackenzie, H. W. G. (1903). Perforation in typhoid fever. *Lancet*, 2, 863.
- Patrick, W. (1959). Personal communication.
- Perry, H. M. and Tidy, H. L. (1918). A report on the investigation of an epidemic caused by bacillus aertryche. *Spec. Rep. Ser. med. Res. Comm.*, No. 24.
- Rendle Short, A. (1935). Abdominal pain in children. *Brit. med. J.*, 1, 1157.
- Rogers, K. B. (1954). Clinical pathology in general practice. Examination of faeces for infection and infestation. *Ibid.*, 1, 147.
- (1957). The association of acute appendicitis with infective diarrhoea. *Proc. roy. Soc. Med.*, 50, 1025.
- , Dowse, J. E. and Hall, J. T. (1959). Techniques used in the routine examination of specimens for the specific serological types of *Escherichia coli*. *J. clin. Path.*, 12, 191.
- , Zinnemann, K. and Foster, W. P. (1960). The isolation and identification of *Haemophilus* spp. from unusual lesions in children. *Ibid.*, 13, 519.
- Rose, T. F. (1945). The clinical differentiation of appendicitis and the dysenteries. *Med. J. Aust.*, 2, 72.
- Rubenstein, A. D. and Johnson, B. B. (1945). Salmonella appendicitis. *Amer. J. med. Sci.*, 210, 517.
- Storey, G. W. (1954). The pathology of salmonella food poisoning. M.D. Thesis, Liverpool University.
- Taylor, I. (1957). The changing epidemiology of Sonne dysentery. *Proc. roy. Soc. Med.*, 50, 31.
- Wangensteen, O. H. and Bowers, W. F. (1937). Significance of the obstructive factor in the genesis of acute appendicitis: an experimental study. *Arch. Surg. (Chicago)*, 34, 496.
- Widal, F. (1913). Rapport sur un travail de M. Walther concernant un cas d'appendicite paratyphique. *Bull. Acad. Méd. (Paris)*, 69, 283.
- Wilde, J. F. (1930). Acute appendicitis complicated with paratyphoid fever. *Brit. med. J.*, 1, 16.
- Williams, H. (1947). Appendicitis in the young child. *Ibid.*, 2, 730.