angina; but triac may be the best thyroid hormone for treating subjects with myxoedema coma who do not give a history of angina

An E.C.G. may be taken eight hours after a dose of trial to confirm the diagnosis of hypothyroidism in young subjects

We have pleasure in acknowledging the considerable help of the sister and staff of the metabolic ward. Our thanks are due also to our colleagues who referred patients; to Miss M. Matthew, who performed some of the cholesterol determinations; and to the hospital technicians who made many of the B.M.R. and E.C.G. recordings. Dr. T. B. Binns, of Glaxo Laboratories Ltd., provided generous supplies of triac.

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MASSIVE JEJUNAL DIVERTICULOSIS WITH STEATORRHOEA AND MEGALOBLASTIC ANAEMIA IMPROVED BY EXCISION OF DIVERTICULA

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Diverticulosis of the small intestine, located largely in the jejunum, is a not uncommon pathological finding in elderly subjects, generally causing no symptoms and, incidentally, found radiologically or at necropsy. Rarely diverticula are found to induce physical disorders. Taylor (1930) described the case of a patient with pernicious anaemia and a gastro-enterostomy in which numerous diverticula of the jejunum were found at necropsy. Montuschi (1949), Zingg (1950), Spang (1954), and Krevans, Conley, and Sachs (1954) described further cases in which jejunal diverticulosis had induced a sprue-like syndrome with diarrhoea, fatty stools, and hypoproteinaemia. The triad of jejunal diverticulosis, steatorrhoea, and megaloblastic anaemia was first recognized by Baguenoch and Bedford (1954) and by Dick (1955). A review of the literature reveals that only 21 cases have as yet been described, and 17 of them showed an associated megaloblastic anaemia. It is not yet firmly established that jejunal diverticulosis may itself be the cause of an associated malabsorption syndrome, which might be a chance association with the not uncommon lesion of the small intestine.

In this paper we are reporting a further case, not only because of the rarity of the condition, but also because elective surgical removal of the diverticula has brought a prolonged improvement in the patient's condition, with correction of both anaemia and steatorrhoea.

Case Report

A man aged 64, a finisher in a dye-works, was first seen at the Leeds General Infirmary in December, 1956. For 25 years he had had attacks of upper abdominal pain occurring about twice weekly. The pain was severe and colicky, persisting a few hours, and was accompanied by nausea and vomiting; his longest remission from pain was three months. In August, 1951, a particularly severe attack of pain with vomiting and diarrhoea necessitated admission to hospital. Blood examination revealed a haemoglobin of 60% (8.9 g./100 ml.) and a red-cell count of 3,400,000. Rapid improvement followed treatment with phthalylsulphathiazole and a blood transfusion. A diagnosis of acute gastroenteritis was made. Later a barium-meal study in November, 1951, revealed multiple diverticula of the upper jejunum to be present with prolonged retention of the bowel contents in them (Fig. 1).

In December, 1953, ligation and excision of third-degree haemorrhoids was performed, and after this operation the mild diarrhoea from which the patient had suffered since

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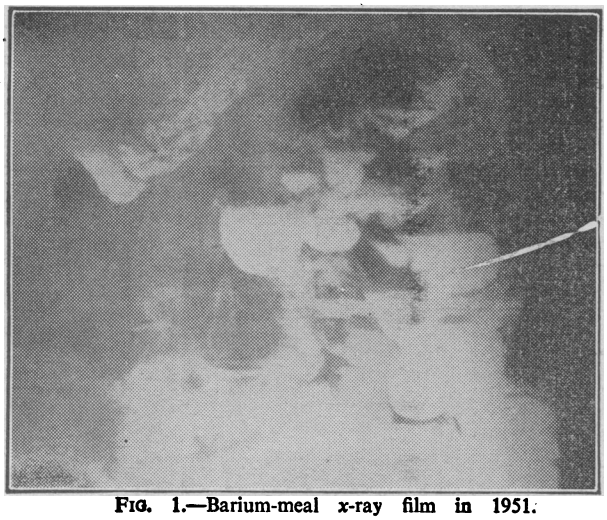

FIG. 1.—Barium-meal *x*-ray film in 1951.

1949 became persistent and severe. The bowels were opened five to six times every 24 hours, after every meal and two to three times during the night. The stools were fluid, foul, light-coloured, but not bulky, and were unaccompanied by blood and mucus. During this time increasing pallor, weakness, dyspnoea, and oedema of the legs were first noticed. Two years later (October, 1955) he collapsed while working and was not able to work thereafter, while in December exertional angina and repeated syncopal attacks developed. A weight loss of 42 lb. (19 kg.) occurred in the twelve months to December, 1956; no glossitis, dyspepsia, paraesthesiae, or ataxia had been observed.

On examination (December, 1956) nutrition was poor (weight, 116 lb—52.6 kg.), and there was marked pallor of skin and mucous membranes, with gross pitting oedema of the legs up to the knees. The tongue was clean and smooth but not reddened. There were no positive physical or abnormal neurological signs. The urine was free from albumin and sugar. Urgent admission to St. James's Hospital, Leeds, was arranged on December 8.

Blood examination revealed a severe macrocytic anaemia. The haemoglobin was 44% (6.51 g./100 ml.), red-cell count 1,600,000, and colour index 1.2. The M.C.V. and M.C.H.C. were both increased at 143 cubic microns and 32.5% respectively. Macrocytosis, anisocytosis, and poikilocytosis were present on the stained film. The platelets appeared to be reduced in number, and a mild leucopenia with a relative lymphocytosis was present—total white count 3,000 (polymorphs 40%, lymphocytes 60%). A sternal marrow examination on December 14 showed marked megaloblastic erythropoiesis. These findings, in conjunction with histamine-fast achlorhydria with a greatly reduced serum cyanocobalmin level (20 $\mu\mu$g./ml.*), suggested that either pernicious anaemia or a megaloblastic anaemia due to malabsorption complicating jejunal diverticulosis was present. Liver-function tests were normal except for a severe hypoproteinaemia—total proteins 4.3 g. (albumin 2.5 g., globulin 1.8 g.). The macroscopic appearances of the stools strongly suggested steatorrhoea, and this was confirmed biochemically later. There was no evidence of osteomalacia initially either radiologically or biochemically (calcium 9.1 mg./100 ml., phosphorous 3.5 mg./100 ml., serum alkaline phosphatase 9.7 units). Subsequently the serum calcium fell to 8.2–8.8 mg./100 ml., and the alkaline phosphatase rose to values between 22 and 30 units.

*Cyanocobalamin was assayed by the method of Hutner, Bach, and Ross (1956). In our hands the normal range is from 180 to 700 $\mu\mu$g./ml. Cases with pernicious anaemia usually fall in the low range below 110 $\mu\mu$g./ml. (Dossett and Droller, 1959).

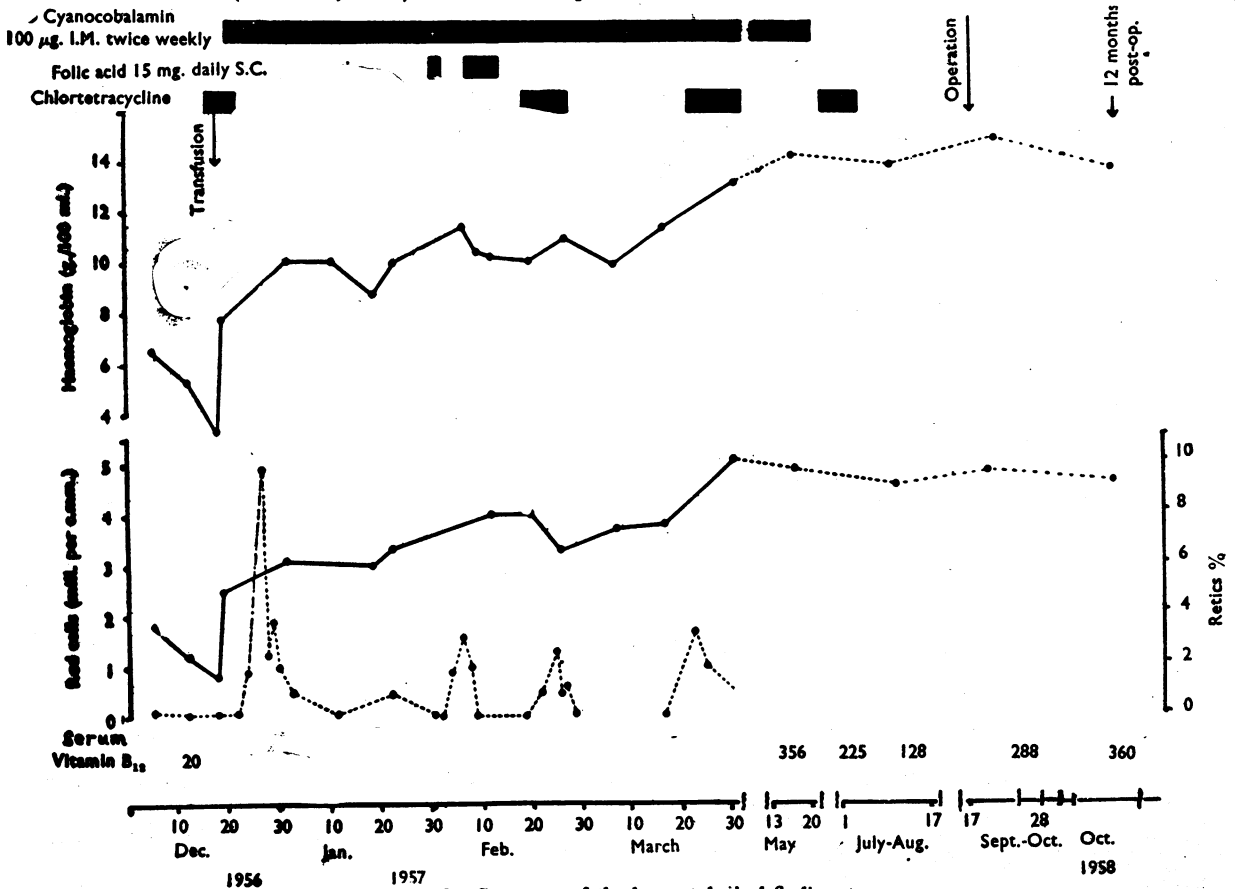

FIG. 2.—Summary of the haematological findings.

Progress and Treatment

By December 18 the patient's anaemia and general condition were much worse, his haemoglobin having fallen to 22% (3.3 g./100 ml.) and the red-cell count to 1,100,000 (Fig. 2). A transfusion effected a temporary improvement, but as there was a possibility that he might have pernicious anaemia, complicated incidentally by jejunal diverticulosis, treatment with cyanocobalamin injections had to be started on December 20, in a dose of 100 μg. twice weekly. At the same time a course of chlortetracycline, 1 g. daily, was given for five days because of intercurrent chest infection. A reticulocyte response of 9.8% on the seventh day followed this therapy, and by the 11th day the haemoglobin concentration had risen to 71% (10.5 g./100 ml.) and the red-cell count to 3,100,000. This response was suboptimal as judged by the severity of his anaemia. Continued cyanocobalamin therapy for the next month failed to raise the haemoglobin above 71% (10.52 g./100 ml.) or the red-cell count above 3,000,000.

The possibility of folic acid deficiency was considered and folic acid absorption and utilization studies were performed (Girdwood, 1953). These showed neither tissue depletion nor defective absorption to be present. However, as a minimal reticulocyte response (3.2%) had followed the oral and subcutaneous administration of 5 mg. of folic acid given for the test, more intensive therapy seemed desirable. Accordingly 15 mg. was injected daily for 10 days by subcutaneous injection, without improvement. Courses of chlortetracycline, given on two occasions, in each instance coincided with a slight reticulocyte response and produced improvement in the haematological picture (Fig. 2).

Further attempts at differential diagnosis were now made. Gastric juice removed after bethanecol chloride and alcohol stimulation contained neither acid nor pepsin, and uropepsin could not be detected in the urine. Gastroscopy (G. W.) showed a normal mucosa with a few areas of patchy gastric atrophy, far less than is usually present in pernicious anaemia, and a normal rugal pattern. Simultaneous gastric biopsy specimens obtained from the body and fundus of the stomach showed no mucosal atrophy. Gastric pits with well-formed mucous neck cells, few zymogenic cells, but no oxyntic cells were seen. The pathologist's opinion on these sections was that owing to the variability of the gastric histology in pernicious anaemia they could not be used to support or refute a diagnosis of pernicious anaemia. This view has been supported by the findings of Magnus (1958).

Throughout his stay in hospital, diarrhoea with bulky stools persisted, and steatorrhoea was demonstrated biochemically on several occasions. Hypoproteinaemia, which was present initially, showed a gradual improvement under treatment, total protein levels rising from 3.6 g. in December, 1956, to 5.1 g. in March, 1957. Plasma albumin levels rose from 2.2 to 3.2 g. over the same period.

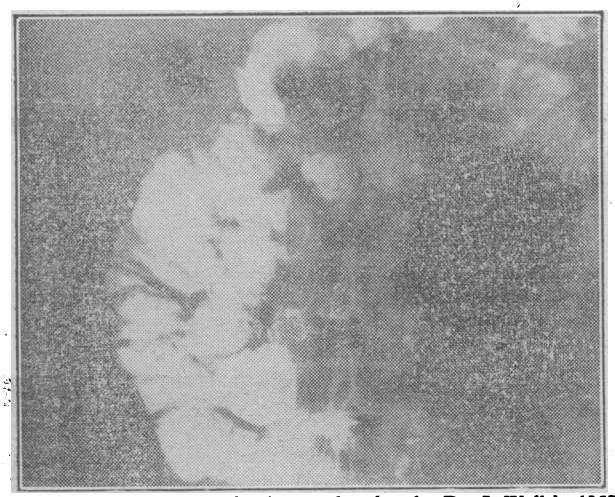

FIG. 3.—Further examination, undertaken by Dr. J. Wall in 1957. (D. B. F.) massive diverticulosis localized to the proximal

After chlortetracycline therapy the stools would become formed and less numerous for a few days, but would relapse again towards the end of the week's course. The patient was discharged on March 28, his anaemia corrected, hypoproteinaemia improved, but diarrhoea persisting.

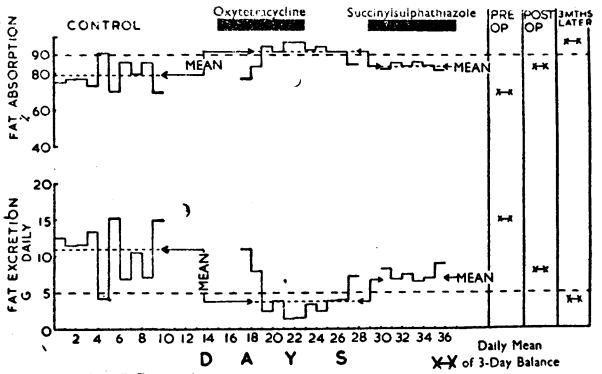

FIG. 4.—Effect of chemotherapy and partial enterectomy on steatorrhoea associated with jejunal diverticulosis.

Ankle oedema recurred shortly after discharge and diarrhoea again became severe, necessitating readmissions to hospital in May and in July, 1957. Improvement followed a high-protein low-salt diet and the use of mersalyl injections twice weekly. The oedema could not be wholly attributed to hypoproteinaemia as plasma protein levels had continued to improve and the blood count remained satisfactory; bilateral varicose veins probably contributed to this condition. He was again discharged, to continue diet, diuretics, and injections of cyanocobalamin at home.

By May, 1957, although the patient was much improved, his diarrhoea remained uncontrolled and a definite diagnosis had not been established. Pernicious anaemia was suggested from the haematological findings, low serum cyanocobalamin levels, achlorhydria, and the apparent response to cyanocobalamin injections. Against the diagnosis were the presence of the diverticula with steatorrhoea, the gastroscopic findings, and the fact that minimal haematological improvement followed chlortetracycline therapy The possibility of surgical excision of the diverticula was now considered. It was felt that excision would be an easy and reasonable procedure as both the diarrhoea and the haematological state appeared to improve when the diverticula were sterilized, and as they appeared to arise high in the jejunum comparatively close together (Fig. 3).

Pre-operative Assessments

It was first established that chemotherapy would temporarily control the steatorrhoea (Fig. 4). On a 50 g. fat diet, the daily fat content of the patient's stool was estimated over a control period of 10 days and averaged 10.5 g., representing a true steatorrhoea (79% absorption). After a week's course of oxytetracycline, 1 g. daily, fat excretion fell to an average of 1.4 g. daily but rose again as oxytetracycline was discontinued. Succinylsulphathiazole in doses of 4 g. daily for 10 days did not abolish steatorrhoea, for in this period his stools contained on an average 7.5 g. daily (85% absorption). Immediately before operation, in September, 1957, fat absorption over a three-day period was 70%.

In an attempt to distinguish Addisonian anaemia and malabsorption clearly, and also to assess the effect of operation on the haematological picture, cyanocobalamin therapy was suspended in May, 1957, when the haemoglobin was 97% (14.3 g./100 ml.) and the red-cell count 4,900,000. At this time the serum cyanocobalamin level was 356 $\mu\mu$g./ml.; two months later this had fallen to 225 $\mu\mu$g./ml., and in August, 1957, to 128 $\mu\mu$g./ml., with slight deterioration in the haematological picture (haemoglobin, 80% (11.8 g./100 ml.), red-cell count 4,300,000). At laparotomy

3 ft. (90 cm.) of the jejunum was found extending from the duodeno-jejunal flexure downwards. Resection was easily accomplished and end-to-end anastomosis performed.

The pathological specimen removed (shown in Fig. 5) was described as follows (J. A. D.). "A loop of small intestine 70 cm. long. On the mesenteric border numerous diverticula are present, and project into the mesentery so that they bulge between the vessels of the mesenteric arcade. The diverticula measure from a minute dimension up to 5 cm. in diameter and communicate with the small bowel via a large orifice up to 2 cm. in diameter. *Histology:* These diverticula are lined with glandular epithelium of the small intestinal type and there is muscle in the wall corresponding to the various coats of the small intestine. The nerve plexuses are present. The only point of distinction is that the mucosa is smoothly applied around the diverticulum and is not thrown into folds as in the small bowel."

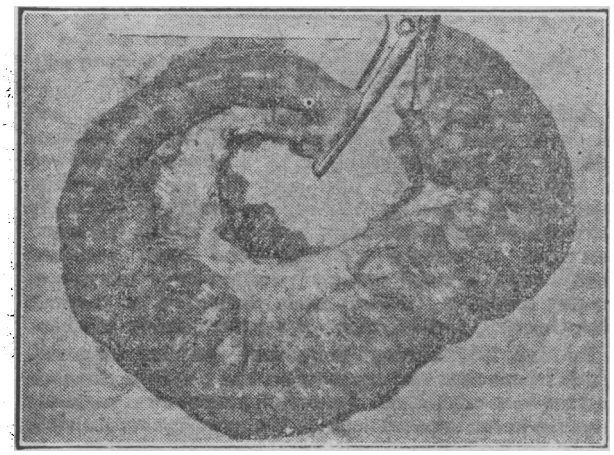

FIG. 5.—Operative specimen of a loop of small intestine.

Although organisms resembling normal intestinal flora were cultured from the diverticula, experiments to establish their nature and ability to utilize cyanocobalamin proved inconclusive.

Effects of Operation

The patient stood the operation well, transfusion was not required, and post-operative complications did not occur. After the operation his stools became formed for the first time in five years and have remained so, two stools being passed daily. He was immensely satisfied with the operative outcome. It was thought desirable that a full year should elapse before results of the operation were assessed to confirm that the initial favourable effects would be lasting.

The haematological effects are summarized in Fig. 2. As already stated, after the suspension of cyanocobalamin injections the serum levels of the vitamin fell, reaching 128 $\mu\mu$g./ml., the haemoglobin from 97% (14.3 g./100 ml.) to 80% (11.8 g./100 ml.), and the red-cell count from 4,900,000 to 4,300,000 in the same period. After excision of the diverticula the serum cyanocobalamin level rose spontaneously without haematinics to 288 $\mu\mu$g./ml. and 12 months after operation had reached 360 $\mu\mu$g./ml. All these are within the normal range, and this fact provides evidence that the diverticula had in some way interfered with absorption of the vitamin. After an initial dramatic improvement in haemoglobin and red-cell counts a month after operation to 98.5% (14.6 g./100 ml.) and 4,900,000 respectively, the long-term effects have been less well sustained, the haemoglobin varying between 78% and 86% (11.5 and 12.7 g./100 ml.) and the red-cell count between 4,200,000 and 4,600,000. Although initially a histamine-fast achlorhydria had been demonstrated without pepsin secretion, repeat analysis four months after operation revealed normal acidity and adequate peptic activity: an example of reversible achlorhydria complicating anaemia (Watkinson, 1959).

The effects of operation on the steatorrhoea are shown in Fig. 4: immediately before operation a three-day fat balance had shown only 70% absorption of the 50 g. fat diet given. After operation the stools became formed and diarrhoea had not recurred in the succeeding 12 months. However, one month after operation balance studies showed that, although fat absorption had been improved to 86%, steatorrhoea had not been completely abolished. A further balance performed three months after operation showed fat absorption to be now normal at 96% of the administered fat; a smaller improvement in folic acid absorption had also occurred.

Discussion

The syndrome of jejunal diverticulosis with steatorrhoea and a megaloblastic anaemia is rare. Only 16 patients with the complete syndrome have been reported in the literature, but a further five patients without anaemia are also recorded. In five instances complications of previous operative procedures, such as gastrectomy, fistulae, and blind loop and intestinal resection, might have contributed towards the production of macrocytic anaemia or steatorrhoea. Bone-marrow studies were performed in 17 patients and found to be megaloblastic in 16. Subacute combined degeneration, histamine-fast achlorhydria, and jaundice had been reported to complicate the syndrome, while liver extract or cyanocobalamin administered parenterally proved effective in most instances.

The similarity of the anaemia complicating jejunal diverticulosis to Addisonian anaemia raises the diagnostic problem, as in our patient, of whether coincident pernicious anaemia is present in a patient with diverticulosis. Such an association can usually be excluded by the demonstration of free hydrochloric acid on gastric analysis, acid being present in 11 of 17 reported so examined. In two of the six with achlorhydria coincident pernicious anaemia could not be positively excluded (Taylor, 1930; Townsend and Cameron, 1957), differentiation in the remaining patients proving extremely difficult. In our patient a true histamine-fast achlorhydria without pepsin secretion initially suggested pernicious anaemia, and gastric biopsy findings were equivocal. While in some young subjects with pernicious anaemia acid secretion has returned after cyanocobalamin therapy (Magnus, 1958), such a state of affairs has not been reported in middle-aged or elderly subjects, and at this age normal gastroscopic appearances and the return of acid secretion after the anaemia had been corrected tend to refute the diagnosis.

Another point of differentiation from Addisonian anaemia is in the presence of steatorrhoea found in 13 of the previously reported cases. This was a prominent feature of our patient. Again the chance association of jejunal diverticulosis with idiopathic steatorrhoea must be borne in mind. Idiopathic steatorrhoea is an inborn gluten intolerance usually affecting young subjects and producing multiple malabsorptive defects. In the reported cases of diverticulosis steatorrhoea is usually of abrupt onset in elderly people, often accommpanied by obstructive symptoms, while steatorrhoea and other malabsorptive defects were usually mild. Oral glucose-tolerance tests, as in our patient, gave normal results, and the radiological findings were quite dissimilar from the sprue syndrome. Abolition of the steatorrhoea by sterilization of the bowel contents with antibiotics can usually be demonstrated, as in our patient.

Some similarity can be drawn between jejunal diverticulosis and tropical sprue in that both conditions are of abrupt onset, possibly related to changes in bacterial flora, and both improve with antibiotic treatment (French, Gaddie, and Smith, 1956). The beneficial effects of elective excision of all the diverticula on the steatorrhoea have not been previously quantitatively demonstrated, fat absorption increasing from 70% pre-operatively to 96% post-operatively. Scudamore, Hagedorn, Wollaeger, and Owen (1958), because of obstructive symptoms in one of their patients, found it necessary to excise 45 cm. of jejunum containing one large and many small jejunal diverticula, but made no observations of the effect of the operation on fat absorption.

As in other malabsorptive states, megaloblastic anaemia in jejunal diverticulosis might result from cyanocobalamin or folic acid deficiency, or from a combination of both. Absolute cyanocobalamin deficiency was demonstrated in our patient by the extremely low serum level, initially 20 $\mu\mu$g./ml., and the response to cyanocobalamin injections. There seemed to be neither tissue depletion nor defective absorption of folic acid as assessed by balance studies, though a minimal reticulocytosis followed its administration. Similar low serum cyanocobalamin levels in the syndrome were demonstrated by Badenoch and Bedford (1954) and by Spray and Witts (1958). Most of the cases reported in the literature responded to parenterally administered cyanocobalamin or liver extract, while the responses to folic acid were fewer and less well established.

The mechanism by which cyanocobalamin deficiency develops in jejunal diverticulosis has been ascribed to failure of secretion of the intrinsic factor (Castle *et al.*, 1931), to defective absorption which accompanies any steatorrhoea (Girdwood, 1953), or to competition for the vitamin by the abnormal bacterial flora and in the diverticula (Badenoch, 1958). Evidence that the third hypothesis is the likely explanation stems from the fact that sterilization of the gut with antibiotics often induces haematological improvement. However, it should be recalled that steatorrhoea is also abolished by oral antibiotics—improved intestinal absorption in part inducing haematological benefit, supporting Girdwood's hypothesis. Tests of the intestinal absorption of ^{60}Co-labelled cyanocobalamin have shown that, while the addition of excessive amounts of intrinsic factor to orally administered vitamin will improve absorption, it is normally absorbed when administered alone after previous sterilization of the gut contents by chlortetracycline (Badenoch, 1958; Scudamore *et al.*, 1958). The exact manner by which bacteria may interfere with the intestinal absorption of cyanocobalamin is unknown: stasis and prolonged retention of food within the diverticula may play a part, but why the condition should suddenly develop in diverticula known to have been present for many years, and in most instances asymptomatic, remains unsolved.

The beneficial effects of resection of the diverticula on the haematological picture have not been previously demonstrated. In the case reported by Scudamore *et al.* (1958) the absorption of ^{60}Co-labelled cyanocobalamin was not improved by resection of the diverticula, while haemoglobin levels tended to fall for the next two months, improving with cyanocobalamin therapy and antibiotics later. In our patient both blood count and serum cyanocobalamin levels improved without haematinics after operation, and improvement has been maintained.

Faced with the rare combination of megaloblastic anaemia with or without steatorrhoea, the possibility of coincident pernicious anaemia should first be excluded and may prove difficult. While test-meal findings and serum cyanocobalamin levels will be sufficient in many patients these tests may not be diagnostic and could not form a basis for differentiation in our patient. Haematological and absorptive improvements following sterilization of the gut by oral antibiotic therapy form one of the most useful diagnostic indications, and these can be beautifully demonstrated by absorption studies using ^{60}Co-labelled cyanocobalamin alone, with intrinsic factor and after oral antibiotic therapy (Halsted, Swendseid, Lewis, and Gasster, 1956). Provided the majority of diverticula are close together, surgical excision, in patients in whom medical treatment fails to effect haematological or nutritional improvement, seems a reasonable procedure and has yielded gratifying results in the case reported.

Summary

The case of a patient with the rare syndrome of massive jejunal diverticulosis with steatorrhoea and megaloblastic anaemia is described and the literature relating to the condition reviewed.

Difficulties in differentiation of this syndrome from coincident Addisonian anaemia are described. While test-meal findings, gastric biopsy, and low serum cyanocobalamin levels will usually enable distinction to be made, a firm diagnosis on these criteria was not possible in our patient initially, diagnosis being eventually made on haematological and absorptive improvements following sterilization of the gut by oral antibiotics.

Partial enterectomy, with excision of all the diverticula, induced both haematological improvement and abolished the steatorrhoea in our patient, and might be considered in other patients with this syndrome in whom medical treatment has failed.

Our thanks are due to Mr. F. J. Powell, who performed most of the biochemical tests; to Dr Winifred Mitchell for undertaking the folic-acid-balance tests; and to Dr. W. Goldie and Dr J. R. Fountain for their help at all stages of this investigation.

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