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PANCREATITIS IN CHILDHOOD: EXPERIENCE WITH 15 CASES*

BY

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Pancreatitis is considered generally to be an unusual condition during infancy and childhood; much of the literature on this subject is confined to single case reports and post-mortem studies (Anderson, 1923; Blumenthal and Probstein, 1961; Collins, 1958; Gibson and Gibson, 1956; Gruenwald, 1950; Haigh, 1956; O'Brien, 1961; Pender, 1957; Plechas, 1960; Power, 1961; Steiner and Tracy, 1943; Stickler and Yonemoto, 1958; Warwick and Leavitt, 1960). In the first report on pancreatitis, Fitz (1889) had no children in his series from the Massachusetts General Hospital; in 1935 Dobbs called attention to the occurrence of pancreatitis in childhood.

During the past 9 years we have encountered 15 children with pancreatitis, and these cases are the subject of this report. They do not represent material drawn from hospital files, but living patients whom we have seen during this period. From this experience we believe that pancreatitis in children, if looked for, is probably more common than previously supposed.

TABLE 1

PRESENTING PICTURE IN 15 CASES OF PANCREATITIS IN CHILDREN

No. of Cases	Presenting Symptoms
5	Intermittent abdominal pain (1 with jaundice)
4	Acute 'surgical abdomen'
3	Acute onset of ascites with fever
1	Abdominal mass following trauma
1	Contusion with ruptured spleen
1	Pancreatitis with mumps

Clinical Presentation

As outlined in Table 1, the presenting clinical picture was variable: 5 patients had intermittent abdominal pain, 1 with jaundice (Cases 3, 8, 10, 12, and 14); 4 presented as acute abdominal emergencies (Cases 1, 2, 7, and 13); 3 had acute onset of ascites with fever (Cases 4, 6, and 11); in one a large abdominal mass developed a month after removal of a ruptured spleen (Case 9); in another explored two days after rupture of the spleen, the distal part of the tail of the pancreas was found to be acutely inflamed from trauma and was removed (Case 15); in one mild pancreatitis was found in association with mumps (Case 5).

TABLE 2

AETIOLOGY IN 15 CASES OF PANCREATITIS IN CHILDREN

No. of Cases	Aetiology
6	Unknown aetiology (2 with pseudocysts)
3	Obstruction at ampulla of Vater
2	Trauma (1 with pseudocyst)
1	Gastric duplication in accessory pancreatic lobe
1	Gall-stone in ampulla (with pseudocyst)
1	Sepsis
1	Mumps

Aetiology

The causes of pancreatitis in this series are summarized in Table 2. In 6 cases, 2 with pseudocysts, we are uncertain as to the cause of pancreatitis (Cases 1, 3, 4, 6, 12, and 14); in 3 we think there was evidence of obstruction at the ampulla of Vater (Cases 8, 10, and 11); 2 occurred after abdominal trauma, one with pseudocyst formation (Cases 9 and 15); in one a small gastric duplication communicating with an accessory lobe of pancreas was the cause (Case 13); one child had gall-stones, with acute fulminating pancreatitis caused presumably by passage of a common duct stone with temporary obstruction of the ampulla (Case 2); in another, a small infant, pancreatitis appeared secondary to overwhelming sepsis in association with malnutrition

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and dehydration brought on by a hiatus hernia (Case 7); another had mumps (Case 5).

It is intriguing to speculate about the 6 patients with pancreatitis of unknown aetiology. Only one of them, Case 14, had exploration and pancreatography; the sphincter of Oddi was normal, but the pancreatogram was inconclusive; this case may possibly represent a duct anomaly. Case 1 has had no further trouble in 8½ years since exploration and simple drainage; with no recurrence it appears unlikely that she had obstructive pancreatitis. Case 3 had sphincterotomy which excluded stenosis of the ampulla, but pancreatography was not performed, thus a duct anomaly has not been disproved. Case 4, treated by enteric drainage of a pseudocyst, had neither exploration of the ampulla nor pancreatography; this could be a case of obstruction relieved by proximal drainage via the pseudocyst. Case 6 is one of obscure aetiology; the background of this youngster raised the suspicion of maltreatment. Case 12 has not been operated on; with his history of recurring pain, and a repeatedly positive morphine-prostigmine provocative test, he may have obstructive pancreatitis.

We have not recognized a case of pancreatitis in children on steroid therapy as has been reported (Baar and Wolff, 1957; Marczynska-Robowska, 1957; Oppenheimer and Boitnott, 1960) or from hydrochlorothiazide (Shanklin, 1962). Similarly we have not had a patient with pancreatitis secondary to *Ascaris* obstruction of a pancreatic duct, undoubtedly due to the low prevalence of round worm infestation in New England. Successful operative relief of pancreatitis due to acute duct obstruction by this worm was recorded many years ago by Novis (1923). In a recent series of 17 children with pancreatitis J. H. Louw (personal communication) had 12 children with pancreatitis secondary to *Ascaris* in a region where there is a high prevalence of the parasite. He has also treated two children with congenital stenosis of the ampulla of Vater. Pancreatitis has been reported in association with choledochal cysts (Gibson and Haller, 1959) and other anomalies such as annular pancreas (Frey and Redo, 1963), but we have not seen this association. The hereditary occurrence of pancreatitis has been noted (Gross and Comfort, 1957), and Case 11 in this series may be such an example: there was obstruction at the ampulla. Gerber (1963) reported hereditary pancreatitis in childhood treated by direct operation on the duct system of the pancreas. Oeconomopoulos and Lee (1960) reported 3 cases of pancreatic pseudocyst in childhood and found an additional 8 case reports; they concluded that many such cases were unrecognized. Our own experience with 4 pseudocysts tends to support that view.

In reviewing the published reports relating to obstruction of the pancreatic duct outflow we have found 16 cases; 4 additional examples can be recorded from this series (Cases 2, 8, 10, and 11). We think it likely that more would be brought to light by exploration of the sphincter of Oddi and pancreatography in selected patients. The points of obstruction are shown in Fig. 1.

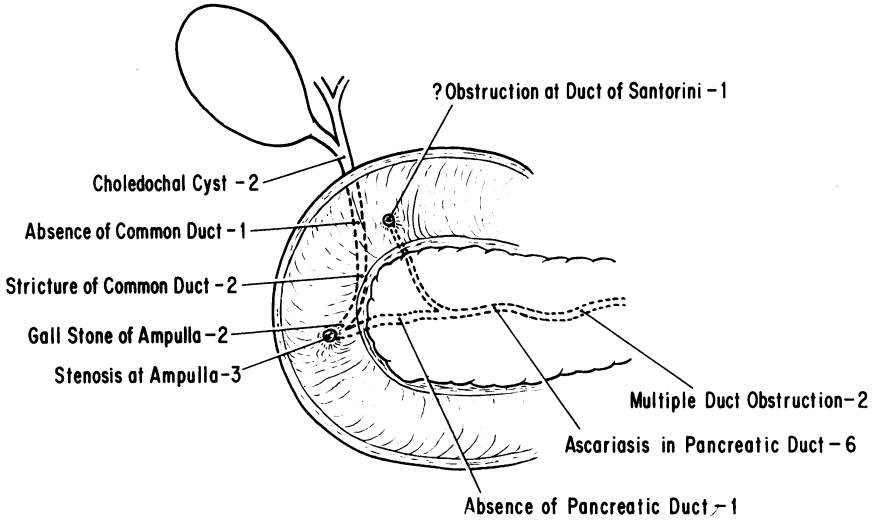

FIG. 1.—Obstructive causes of pancreatitis in children (20 cases: 16 from published reports, and 4 in this paper).

Treatment

Operation was carried out in 12 of these 15 cases as shown in Table 3. Transduodenal sphincterotomy was done in 4 (Cases 3, 8, 10, and 11). In 3 of these the sphincter was found to be abnormal; operation relieved the problem. In one (Case 3) the sphincter was not stenotic and further difficulty has ensued; later subtotal gastrectomy was done to decrease pancreatic stimulation. Simple drainage of the lesser peritoneal sac was done in 2 patients (Cases 1 and 7). Sphincterotomy and cyst gastrostomy was performed in one patient (Case 14); the sphincter was normal. Sphincterotomy (normal) and later partial pancreatectomy was performed in one (Case 13) in whom the underlying problem was found later to be an unusual cystic duplication of the stomach attached to an accessory lobe of pancreas. One patient (Case 2) was treated initially by cholecystostomy, removing gall-stones, and later marsupialization of a pseudocyst. One patient had a Roux-en-Y cyst jejunostomy (Case 4). One patient had simple transgastric cyst gastrostomy for a pseudocyst (Case 9) four weeks following removal of a ruptured spleen. One had partial caudal pancreatectomy with removal of a ruptured spleen (Case 15). No operation was undertaken in 3 (Cases 5, 6, and 12); these children were not severely ill, and conservative treatment seemed advisable. One of these children (Case 12) is having recurrent mild symptoms and may eventually require exploration.

TABLE 3
TREATMENT IN 15 CASES OF PANCREATITIS IN CHILDREN

No. of Cases	Treatment
4	Sphincterotomy and cholecystectomy (1 later had subtotal gastrectomy)
2	Drainage of lesser sac
1	Sphincterotomy and cyst gastrostomy
1	Sphincterotomy and cholecystectomy; later partial pancreatectomy
1	Cholecystostomy, removal of gall-stones; later cyst marsupialization
1	Roux-en-Y cyst jejunostomy
1	Cyst gastrostomy
1	Resection of tail with ruptured spleen
3	No operation

Case Reports

The following case reports are presented in order of occurrence from 1956 to 1964. Cases 1, 2, 4, 5, and 7 were treated at the Children's Hospital, Boston; Cases 6, 8, 9, 10, 11, 12, 13, 14, and 15 were treated on the Children's Service of the Massachusetts General Hospital; Case 3 was treated as a child at the Children's Hospital, and later as a young adult at the Massachusetts General Hospital.

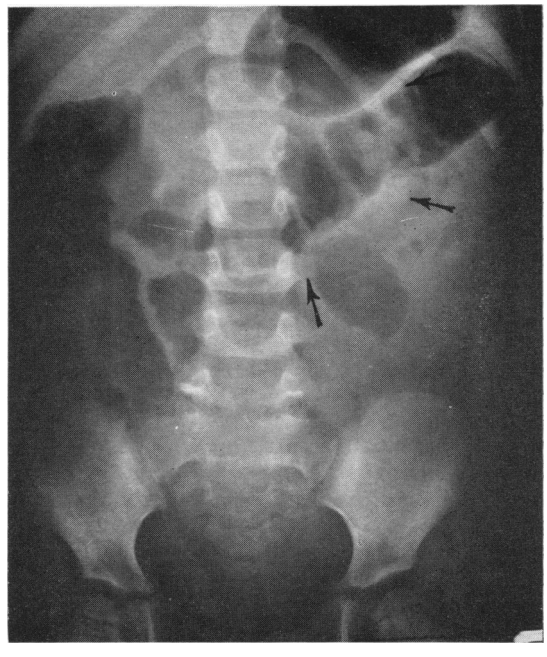

FIG. 2.—Abdominal film from Case 1, before operation, showing dilated loops of intestine and a suggestion of an epigastric mass that proved to be an enlarged, inflamed pancreas.

Case 1. S.W., a 6-year-old white girl, was admitted on January 3, 1956 with a three-day history of pain in the upper abdomen, nausea, and vomiting. Past history was negative except for a known congenital hip dislocation and coarctation of the aorta. There was diffuse upper abdominal tenderness and spasm; palpation suggested a mid-epigastric mass of considerable size. Temperature 102° F. (38·9° C.); pulse 140 min.; blood pressure 140/40 mm. Hg in left arm. Leucocyte count, 26,000. Abdominal film (Fig. 2) suggested a mass in the upper abdomen. After preliminary hydration, exploratory laparotomy (W.H.H.) revealed typical acute haemorrhagic pancreatitis with fat necrosis. There were 300 ml. of serous fluid in the abdominal cavity; amylase determination on this fluid 1,729 Somogyi units. There was discoloration, induration, and oedema of the entire pancreas. The gallbladder was small, easily compressible; no stones were felt. Two large drains were placed in the lesser omental bursa; they were removed 10 days later. The serum amylase was 166 Somogyi units (normal value under 150) the day after the operation and was 192 one week later. After the operation the patient made an uneventful recovery and was discharged two weeks later with no further drainage. She was readmitted to the hospital in December 1956 for resection of coarctation of the thoracic aorta (W.H.H.). She is at present alive and well; there have been no further episodes of abdominal pain.

Case 2. W.C., a 13-year-old white boy, was admitted on September 4, 1956 with severe upper abdominal pain,

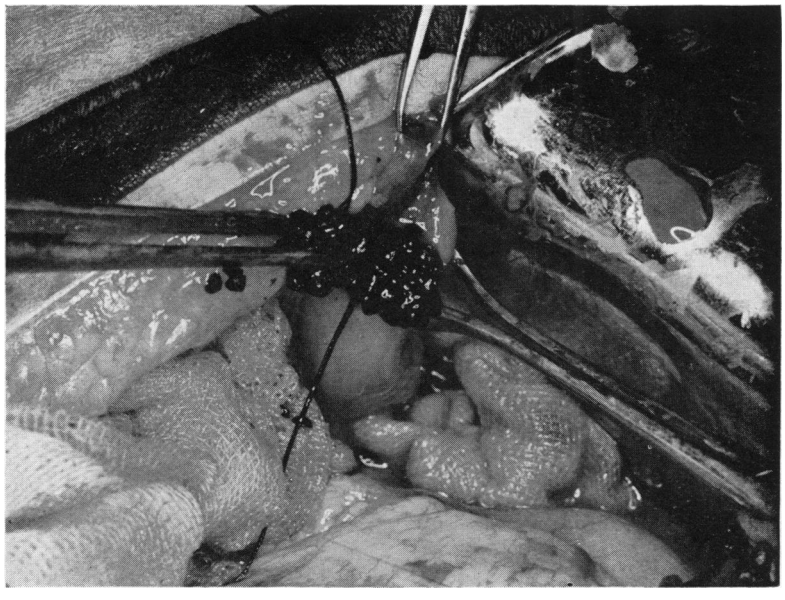

FIG. 3.—Multiple pigmented stones being removed from the gall-bladder in Case 2 at initial emergency operation. The patient had congenital hereditary spherocytosis. Pancreatitis was caused, presumably, by temporary impaction of a stone in the ampulla.

vomiting, and diarrhoea of three days' duration. His past history included congenital haemolytic anaemia, for which his father and sister had undergone splenectomy; operation had been refused for this child. He was in shock; there was diffuse tenderness of the upper abdomen; jaundice was evident; the spleen was palpable 6 cm. below the costal margin. Leucocyte count of 40,000; haematocrit 63%; serum amylase 605 Somogyi units; bilirubin 5 mg./100 ml. direct (0·4 normal) and 21·5 mg./100 ml. indirect (0·4 normal). After treatment of shock by hydration and transfusion, exploratory laparotomy (Dr. Lester Martin) revealed 1,500 ml. of serous fluid in the peritoneal cavity; the pancreas was diffusely inflamed and swollen. Two large drains were placed in the lesser sac. The gall-bladder was opened, removing numerous pigment stones (Fig. 3) and inserting a cholecystostomy tube. The patient's condition was thought too precarious to explore the common bile-duct for a stone in the ampulla. After the operation his course was very stormy with a large amount of necrotic debris in the drainage from the lesser sac. Two weeks later dye was instilled into the biliary tree through the cholecystostomy tube, and flowed freely into the duodenum with no evidence of a common duct stone; it was thought that a stone had probably been present but that it had passed into the duodenum. The cholecystostomy tube was clamped three weeks later and then removed. Gastro-intestinal series four weeks later showed widening of the duodenal loop and displacement of the stomach consistent with a pseudocyst (Fig. 4). On October 3, 1956 he was again operated on and the spleen was removed; the pseudocyst wall was thin, not suitable for anastomosis to the gastro-intestinal tract, and it was treated by

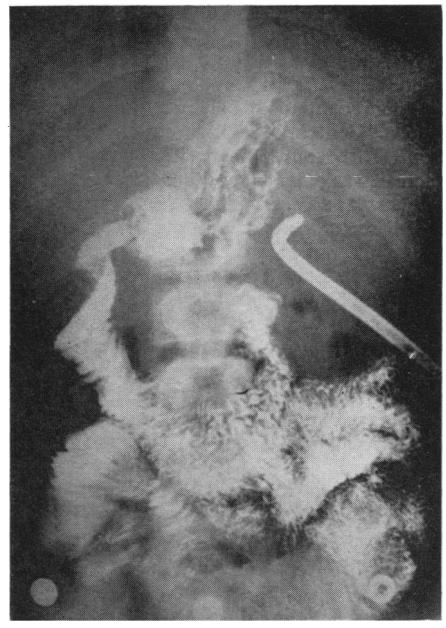

FIG. 4.—Gastro-intestinal series in Case 2 four weeks after initial laparotomy. The duodenal loop is wide and there is a pseudocyst in the lesser sac displacing the stomach anteriorly and to the right. A rubber tube lies in the lesser sac, replacing one of the simple drains placed at first operation. Cyst was subsequently marsupialized to surface.

marsupialization with large drains to the surface. Drainage continued for 9 months and then ceased spontaneously. He is at present a college student and free of abdominal complaints.

This boy was precariously ill with severe pancreatitis. It was felt that lesser sac drainage and biliary decompression were probably life saving, and that conservative, non-operative treatment would probably have ended fatally. It is difficult to know in retrospect whether expeditious duodenotomy and gentle exploration of the ampulla for a stone might have been wise at initial exploration. It seemed to be unwise under the circumstances to perform classical common duct exploration with blind probing of the ampulla from above with dilators and stone forceps in the face of severe pancreatitis.

Case 3. R.P., a 12-year-old white boy, was admitted on October 2, 1956 with a history of several months' duration of anorexia, fever, weight loss, and recurrent upper abdominal pain radiating to the back and between the scapulae. There was slight tenderness in the upper abdomen; bowel sounds were diminished; the abdomen was distended. During two weeks of observation symptoms improved. Gastro-intestinal series was negative. Serum amylase determination was 194 Somogyi units. Bilirubin, alkaline phosphatase, and leucocyte count were normal. Laparotomy on October 17, 1956 (Dr. Nicholas M. Stahl) disclosed that the gall-bladder was large but emptied on compression; that the pancreas was enlarged and nodular; and that there were inflammatory adhesions at the foramen of Winslow. Three days later serum amylase was 358. The patient was treated with a bland diet, antispasmodics, and sedation, but abdominal pain continued. He was admitted to the Massachusetts General Hospital on July 15, 1961. Exploration (Dr. Marshall K. Bartlett) showed that the entire pancreas was enlarged and oedematous, especially the head; there was adjacent fat necrosis; large varices up to 1 cm. in diameter were found near the common bile-duct; pressure in a varix was measured at 15 cm. of saline. The bile-duct, ampulla, and main pancreatic duct orifice were explored and found to be normal. Cholecystectomy and sphincterotomy were performed; pancreatography was thought to be unwise in the presence of active chronic pancreatitis. The patient's symptoms did not change and he was re-explored January 31, 1962. The pancreas was large and nodular. Pressure in the right gastro-epiploic vein was 30 cm. of saline; the spleen was four times enlarged. Subtotal gastrectomy with vagotomy was performed, restoring continuity with an anticolic Hofmeister gastrojejunostomy. Though improved, the patient continues to have brief attacks of abdominal pain which improve with temporary fasting.

It is contemplated that he will need further pancreatic surgery and probably a decompressive shunt operation for portal hypertension in the future. Pancreatography might prove useful in this case to exclude ductile obstruction amenable to caudal pancreatico-jejunostomy.

Case 4. K.G., a 6-month-old white girl with fever and ascites of three days' duration was admitted by Dr. Robert Haggerty on June 5, 1959. Although previously well, she developed a temperature of 102° F. (38·9° C.) and irritability 8 days before. Paracentesis revealed serous fluid with a specific gravity of 1·015, containing many erythrocytes and leucocytes; a cell block for microscopy was negative for tumour cells. On rigid dietary sodium restriction she lost ground steadily; exploration June 26 (W.H.H.) revealed 800 ml. of serous fluid in the peritoneal cavity; amylase determination was 182 Somogyi units on this fluid (normal under 150). There was diffuse inflammation throughout the upper abdomen, especially at the base of the transverse mesocolon and in the porta hepatis, all consistent with pancreatitis. Pressure in the portal vein was normal (8 cm. of saline). After exploration the patient was treated with antibiotics and a diet low in sodium and fat, but she deteriorated, and was readmitted two months later with massive abdominal distension and wasting (Fig. 5 and 6). There was pitting oedema of the anterior abdominal wall. Neck veins were distended and there was pulsus paradoxicus. It was felt that the child would soon expire and that the over-all diagnosis was still unclear. Constrictive pericarditis in association with a systemic disorder was considered. On August 12, 1956 she was operated on again (W.H.H.). A small left anterior thoracotomy was made to exclude pericarditis; the pericardium was normal. There was no free fluid in the abdomen but there was a tremendous pseudocyst containing 1,000 ml. of murky brown fluid. Roux-en-Y cyst jejunostomy was carried out, followed by rapid convalescence. The patient is now a normal youngster with no apparent gastro-intestinal problems (Fig. 7).

Pancreatitis was not even considered originally in this child, and even after the findings at first operation we did

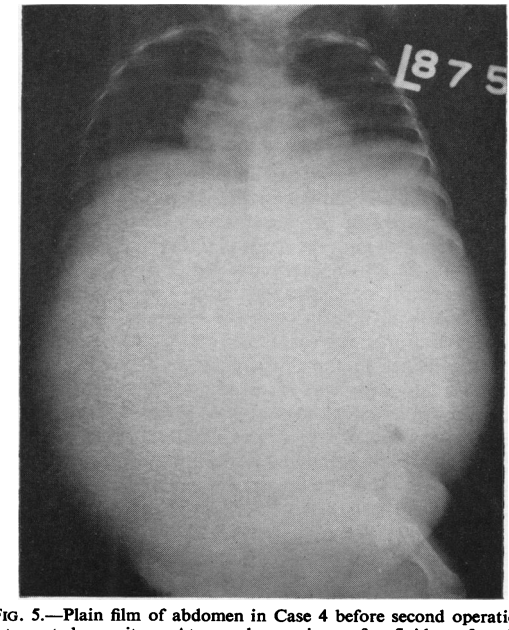

FIG. 5.—Plain film of abdomen in Case 4 before second operation, interpreted as ascites. At second operation no free fluid was found in abdomen; this was fluid in a huge pseudocyst.

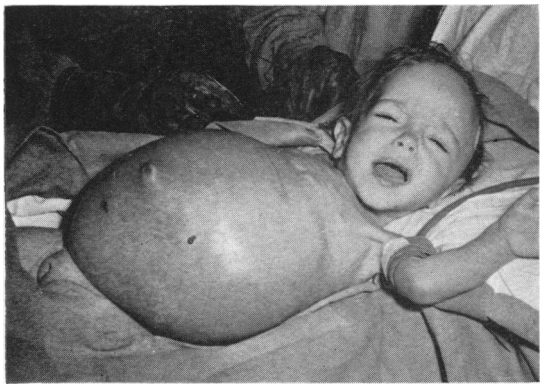

FIG. 6.—Case 4 just before second operation. The child was very wasted and had enormous abdominal distension caused by a pseudocyst; it was drained by Roux-en-Y cyst jejunostomy.

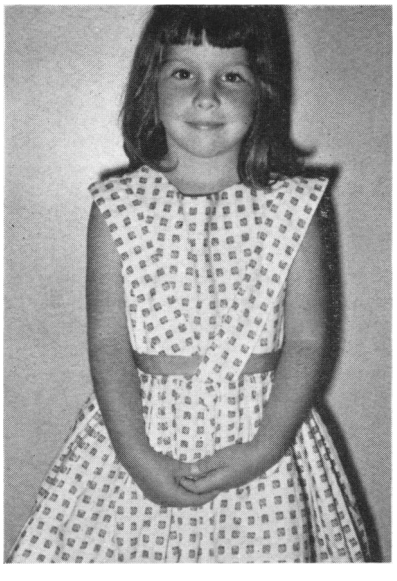

FIG. 7.—Case 4 five years after cyst jejunostomy. She is a healthy child with no pancreatic problems. The aetiology of her pancreatitis is not known.

not suspect development of a pseudocyst. In retrospect common duct exploration, transduodenal sphincterotomy, and pancreatography might have proved quite helpful at initial exploration. This may be a case with obstructive pancreatitis relieved by retrograde drainage via the pseudocyst into the gastro-intestinal tract.

Case 5. C.K., a 4-year-old white girl, was admitted on March 20, 1960, with vomiting and severe upper abdominal pain for one day; mumps appeared three days previously. There was pronounced upper abdominal tenderness with spasm; bowel sounds were diminished. The serum amylase was 344 Somogyi units. Two serum lipase determinations were normal. Leucocyte count 12,000. The patient's tenderness subsided gradually; she was discharged four days later perfectly well, and has had no further difficulty.

Though mild pancreatitis is not rare in association with mumps (Bole and Thompson, 1958), this is the only case we have seen in the past 9 years.

Case 6. L.A., a 3-year-old negro boy, entered the hospital on August 6, 1961 with swelling of the abdomen, hands, and feet for one day. These abnormalities were noted when he was received by his third set of foster parents. There was a history of serious family problems and possible maltreatment. His abdomen was protuberant, but he was not in acute distress (Fig. 8). There was a palpable fluid wave and minimal tenderness to deep palpation of the epigastrium. Normal values were obtained for alkaline phosphatase, transaminase, blood sugar, blood urea nitrogen, prothrombin time, serum electrolytes, cephalin flocculation, serum electrophoresis, bromsulphalein retention test, intravenous pyelogram, barium enema, and upper gastro-intestinal series. Leucocyte count 12,150. Paracentesis revealed serous fluid on which amylase determination was 2,480 Russell units (normal 4-25), and lipase determination 41·2 units per ml. (normal less than 2 units per ml.). The serum amylase and lipase values were normal. Morphine-prostigmine provocative test was normal. During 4 weeks of observation the abdominal protuberance subsided, tenderness disappeared, and there has been no recurrence.

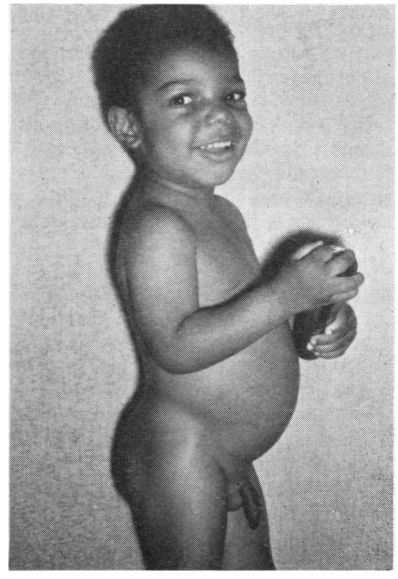

FIG. 8.—Case 6 two weeks after admission showing abdomen filled with fluid, but the child was not ill. The fluid disappeared spontaneously and he has done well during continued observation.

It is not certain that this child had pancreatitis, though this diagnosis seems reasonable with upper abdominal tenderness and ascites containing high levels of pancreatic enzymes. The aetiology is unknown; maltreatment is possible, but this is speculative.

Case 7. D.M., a 3-month-old white infant boy, was admitted June 26, 1961 for vomiting since 1 month of age. He was premature and while being fed by gavage there was no problem. When he reached 5 lb. (2,267 g.) weight he began having oral feeds, and vomiting occurred and continued. Two gastro-intestinal x-ray series were negative but the third demonstrated a sliding hiatus hernia. Conservative treatment was poorly tolerated; prolonged vomiting resulted in lethargy and hypoglycaemia (blood sugar 13 mg./100 ml.). After rehydration transabdominal hiatus herniorrhaphy was performed 5 days after admission (W.H.H.). The fundus of the stomach was incarcerated in the hiatus; it was reduced and repair was accomplished. The liver was abnormal, with greenish discoloration suggesting neonatal hepatitis; a biopsy was taken, which suggested cholangiolitis, possibly of bacterial origin. Two days after operation the infant became deeply jaundiced, distended, and finally moribund. Abdominal exploration was performed under local anaesthesia (W.H.H.), revealing murky abdominal fluid which contained Gram-positive cocci. There was fat necrosis at the root of the transverse mesocolon. The pancreas was oedematous and indurated; the gall-bladder was tense, and was decompressed with a tube. The lesser omental bursa was drained widely; a decompressive gastrostomy tube was placed in the stomach. Serum amylase 106 Somogyi units; peritoneal fluid amylase was 26·4. After an initially precarious post-operative course the child recovered and has thrived subsequently with no further illness and no vomiting.

In retrospect we believe that this child may have been at the onset of septicaemia when he was first operated on, complicating dehydration and starvation, and that pancreatitis may have been just a part of a generalized infection. Trauma to the tail of the pancreas during hiatus hernia repair may have been a factor, but with the liver biopsy report and the over-all clinical picture together with bacteria in the peritoneal fluid we favoured sepsis.

Case 8. R.H., a 2½-year-old white girl, was admitted on November 5, 1961 with recurrent upper abdominal pain and jaundice for 3 months. Leucocyte count 13,700; alkaline phosphatase 36·3 Bodansky units (5-14 normal); transaminase 143 (10-40 normal); bilirubin 5·4 mg./100 ml. (0·7 normal); serum amylase 72 Russell units (4-25 normal). Oral and intravenous cholangiography showed non-filling of the gall-bladder. An upper gastro-intestinal series showed indentation of the duodenal bulb, presumably by a distended gall-bladder (Fig. 9). Exploration was performed (W.H.H.). The gall-bladder was distended and the common duct was very dilated. On opening the duodenum a prominent ampulla of Vater (Fig. 10) was found in which there appeared to be no opening. The common bile-duct was opened, and a probe was passed down into the ampulla demonstrating a pin-point orifice through which the smallest probe would not pass. Sphincterotomy was performed. The orifice of the duct of Wirsung was normal; pancreatography was not carried out because there was induration and oedema of the pancreas suggesting active pancreatitis. The patient has had no further abdominal pain or jaundice and is completely well now 2½ years after operation.

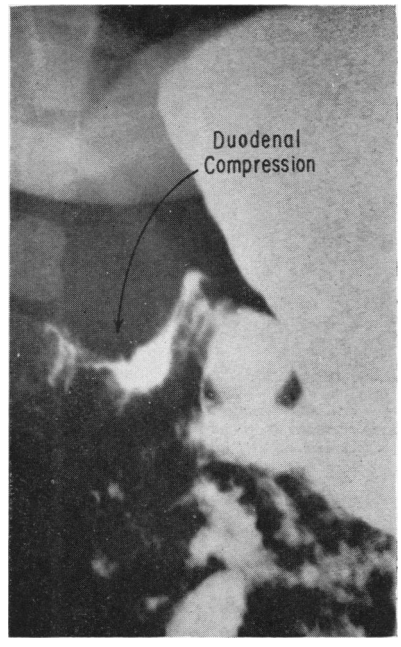

FIG. 9.—Gastro-intestinal x-ray in Case 8 showing compression of the duodenum by the gall-bladder. At operation the gall-bladder was large and the common bile-duct was quite dilated. Obstruction was found in the ampulla of Vater.

Congenital malformation of the sphincter of Oddi appears responsible in this case for both obstructive jaundice and pancreatitis.

Case 9. S.D., a 15-year-old white boy, was admitted on December 9, 1961 one hour after a blow to the left upper abdomen playing football. At operation (Dr. Chester J. Dexter) a ruptured spleen was removed. There was no other intra-abdominal injury . The post-operative course was complicated with vomiting and fever; serum amylase rose to 240 Russell units. No abdominal mass appeared and the patient was discharged three weeks later to be observed for the possibility of a post-traumatic pseudocyst. Shortly after discharge severe upper abdominal pain developed and he was readmitted; serum amylase determination was 610 Russell units. Gastro-intestinal x-ray one week later showed a large mass displacing the stomach anteriorly (Fig. 11). At re-exploration on January 13, 1962 (C.J.D.) a pseudocyst containing 4,000 ml. of clear yellow fluid was anastomosed to the posterior wall of the stomach. The patient made an uneventful recovery and has done well since.

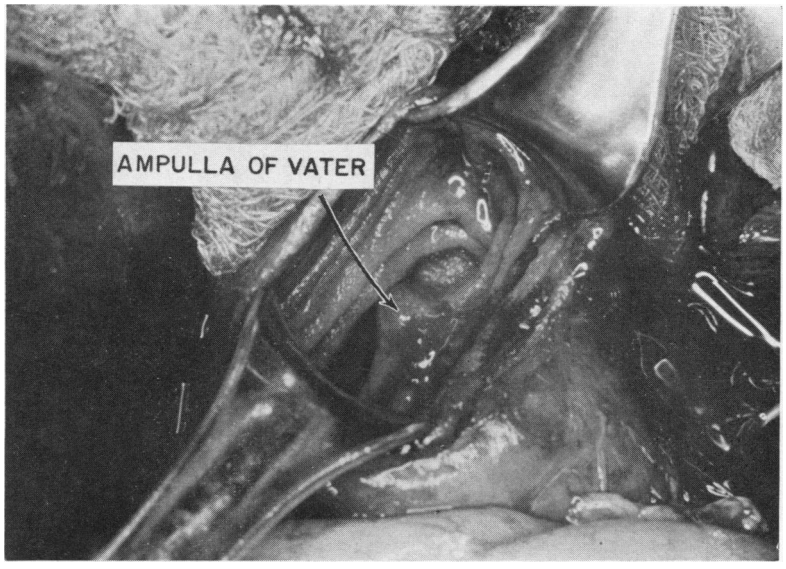

FIG. 10.—Operative view in Case 8 showing the enlarged, polypoid ampulla of Vater; the drainage orifice was found to be a pin-point opening. There was also pancreatitis, probably secondary to obstruction of the ampulla into which the duct of Wirsung drained. Sphincterotomy was performed; the child has had no further jaundice or abdominal pain.

This case is a clear-cut example of pancreatic trauma resulting in pseudocyst formation and serves to emphasize that delayed pancreatic complications should be considered following upper abdominal trauma in any age-group. A baseline amylase determination is desirable in children with upper abdominal trauma; the pancreas should be inspected routinely if exploration is performed (see also Case 15).

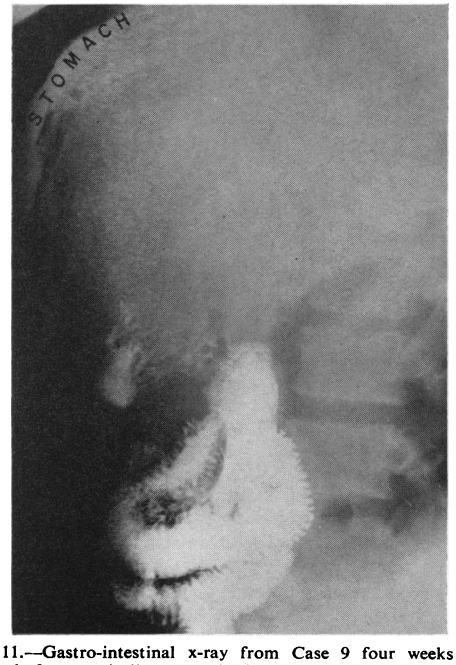

FIG. 11.—Gastro-intestinal x-ray from Case 9 four weeks after removal of traumatically ruptured spleen. This large pseudocyst was anastomosed to the back wall of the stomach.

Case 10. N.S., a 7-year-old white girl, was admitted on February 23, 1962 with upper abdominal pain and vomiting for one day. There had been several similar attacks in the previous two years. Past history included resection of a coarctation of the thoracic aorta at the age of 4. There was tenderness in the epigastrium and right upper quadrant. Normal values were obtained for the leucocyte count, serum amylase, bilirubin, and alkaline phosphatase. Gastro-intestinal x-rays showed slight displacement of the duodenum by the gall-bladder. Intravenous cholangiogram showed satisfactory function of the gall-bladder, though it appeared slightly enlarged. The child's pain and tenderness disappeared and she was discharged a week after admission. One week later she re-entered with the same complaints, and on this occasion a morphine-prostigmine provocative test was performed (5 mg. morphine and 0·3 mg. prostigmine) with abnormal findings: fasting amylase 17 Russell units; 1 hour, 96; 3 hours, 275; 5 hours, 208. Lipase values were also raised. The test produced the pain noted by the patient on admission. Repeat cholangiography showed an enlarged gall-bladder with dye remaining at 48 hours. It was felt that the clinical picture was consistent with mild recurrent pancreatitis with ampullary obstruction and exploration was performed on March 12, 1962 (W.H.H.). There was oedema adjacent to the head of the pancreas which was indurated. There were adhesions surrounding the gall-bladder. The common bile-duct was thought slightly

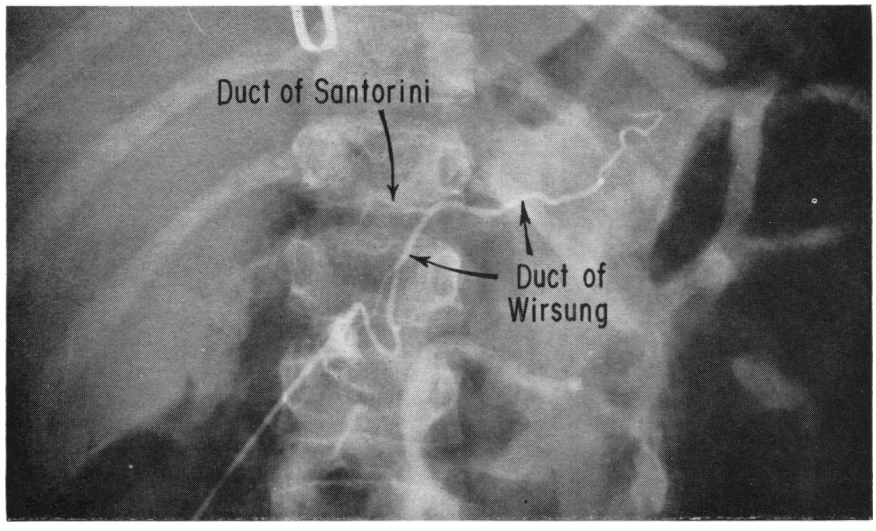

FIG. 12.—Pancreatogram obtained after transduodenal sphincterotomy in Case 10. The ducts are normal. The ampulla was stenotic.

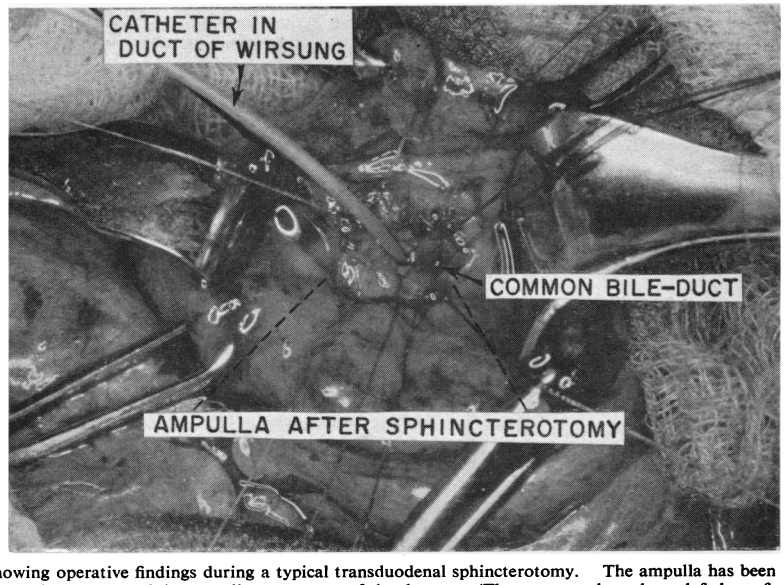

FIG. 13.—Case 10 showing operative findings during a typical transduodenal sphincterotomy. The ampulla has been incised upwards from the drainage orifice, suturing mucosa of the ampulla to mucosa of duodenum. (These sutures have been left long for traction to facilitate exposure.) A small catheter is seen in the duct of Wirsung for pancreatography. The lower common bile-duct is visible just craniad to the pancreatic duct orifice.

dilated for this age, measuring 8 mm. in diameter. The duodenum was opened and a 1 mm. probe was found to be very tight in the orifice of the sphincter of Oddi. Sphincterotomy was performed and bile gushed from the ampulla. The orifice of the duct of Wirsung was situated 3 mm. from the lower rim of the ampulla. The orifice was enlarged by operation, a ureteral catheter was inserted; a pancreatogram (Figs. 12 and 13) was normal. The gall-bladder was removed. Microscopical examination of the ampulla showed chronic inflammation with fibrosis. A post-operative morphine-prostigmine test revealed a flat curve with no rise in amylase levels in contrast to two pre-operative tests (Fig. 14). A week after discharge the patient developed acute intestinal obstruction which proved to be due to a small bowel intussusception which was reduced at laparotomy. There were two brief admissions 2 months and 8 months later for alleged abdominal pain, but there were no

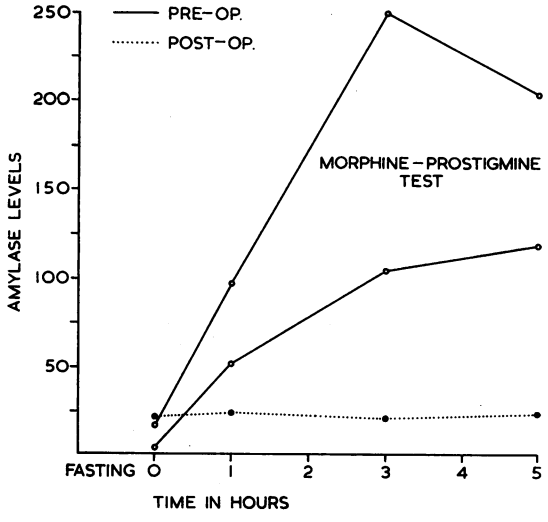

FIG. 14.—Morphine-prostigmine provocative test in Case 10. The two high curves were obtained before operation, showing a marked rise in serum amylase values. The flat curve was obtained following transduodenal sphincterotomy of the stenotic ampulla of Vater.

abnormal physical findings or laboratory determinations, and it was felt by all observers that this was a psychological attention-seeking reaction to the birth of a new sib. During the past year and a half there has been no further trouble.

We believe that this child had mild recurring pancreatitis caused by obstruction at the ampulla of Vater. The pre-operative and post-operative morphine-prostigmine provocative tests, together with the operative findings, and the pathology report, as well as the subsequent clinical course, tend to support this contention.

Case 11. E.P., an 11-month-old white infant boy, was admitted by Dr. John Robey on April 25, 1962 with fever and ascites. Two weeks before, the child had developed diarrhoea, abdominal pain, and then abdominal swelling three days before admission. He was irritable and febrile. There was impressive abdominal distension with a palpable fluid wave. The liver and spleen were not felt. Leucocyte count was 6,800; haematocrit 23%. Blood urea nitrogen, serum electrolytes, transaminase, alkaline phosphatase, and total protein showed normal values. The serum amylase was 280 Russell units. Paracentesis yielded bloody fluid (haematocrit 13%) with an amylase value of 1,560 Russell units. Two days later exploration (W.H.H.) revealed about 1,000 ml. of bloody fluid which was removed from the peritoneal cavity. There was abundant fat necrosis in the greater omentum and at the root of the transverse mesocolon. There was oedema of the structures at the porta hepatis. No gall-stones were felt. The pancreas was only slightly enlarged and slightly oedematous, much less impressive than anticipated. Fat necrosis was maximal near the tail of the pancreas. Two large drains were placed in the lesser sac. The serum amylase determination was 62 two days later. The patient convalesced uneventfully and was discharged 11 days after exploration, only to be readmitted 10 days later with acute intestinal obstruction which did not improve with gastro-intestinal intubation. At laparotomy (W.H.H.) a single stout band was found obstructing the terminal ileum; there was considerable fat necrosis at the site of this peritoneal band. The patient was readmitted on June 18, 1962 at the age of 13 months for elective reinvestigation. Morphine-prostigmine provocative test (2·4 mg. morphine and 0·24 mg. prostigmine) was abnormal: fasting amylase 21 Russell units; 2 hours, 172; 4 hours, 130. An intravenous cholangiogram was normal. It was decided to re-explore the patient to exclude obstruction as the cause for pancreatitis (W.H.H.). The pancreas was firm and enlarged to at least twice its normal size; the gall-bladder was surrounded by adhesions. On opening the duodenum the orifice of the ampulla appeared normal, but a probe met a point of obstruction 6 mm. from the tip of the ampulla; sphincterotomy revealed marked fibrotic narrowing of the midportion of the ampulla. The main pancreatic duct opening was located exactly at this point of fibrotic narrowing. The pancreatic duct orifice was enlarged by operation, releasing clear pancreatic juice. Pancreatogram was attempted, but the film appeared to show extravasation of dye, and so a second injection was not performed at that site. The accessory duct of Santorini orifice was located 3 cm. proximal in the duodenum, and a pancreatogram of this duct revealed a normal duct system out into the tail of the pancreas. The gall-bladder was removed. Morphine-prostigmine provocative test was performed one week after operation: fasting, 37 Russell units; 2 hours, 232; 3 hours, 248. This test was repeated one month later: fasting, 15; 1 hour, 130; 2 hours, 136. This patient has done well since discharge.

This appears to be a case in which an anomaly of the ampulla caused the pancreatitis. In retrospect the first exploration might have been avoided, since the diagnosis seemed fairly certain and the patient was not deteriorating. The two post-operative morphine-prostigmine tests were abnormal but they were obtained in the early post-operative period. Further study of this child is contemplated. It is of considerable interest that this boy's paternal grandfather has recently undergone exploration for obstructive jaundice, found to be due to pancreatitis. Additional delving into the family history has revealed an uncle with pancreatic calcification discovered incidentally during radiological examination, and that the father has post-prandial epigastric pain. This boy may be an example of hereditary pancreatitis.

Case 12. J.M., an 11-year-old white boy, was admitted on September 5, 1962 with vomiting and abdominal pain radiating to the back for two days. There was upper abdominal tenderness. He had had splenectomy three years before for hereditary spherocytosis. Leucocyte count 12,200. Normal values were obtained for serum amylase, bilirubin, transaminase, alkaline phosphatase, cephalin flocculation, and thymol turbidity. Gastro-intestinal series and oral cholecystogram were normal.

A morphine-prostigmine provocative test was abnormal: fasting amylase, 16 Russell units; 45 minutes, 100; 1½ hours, 360; 2½ hours, 580; a repeat test was confirmatory; the tests provoked his abdominal pain. This child was not clinically ill and it was decided to follow his course. He has continued to have mild episodes of mid-epigastric pain radiating to the back and further study is contemplated. We suspect that he may have obstructive pancreatitis of mild degree.

Case 13. W.C., a 5-year-old white boy, was admitted on March 19, 1963 with abdominal pain and a mid-epigastric mass. He had been well until three months before when he developed recurrent dull upper abdominal pain. Exploratory laparotomy three weeks before had revealed subsiding acute haemorrhagic pancreatitis. Three days before admission pain had recurred, a mass was discovered, and he was referred for further evaluation. There was a large, slightly tender upper abdominal mass. Normal values were obtained for Van den Bergh, alkaline phosphatase, cephalin flocculation, bromsulphalein retention, transaminase, and leucocyte count. The fasting serum amylase determination was normal (24 Russell units), but morphine-prostigmine provocation resulted in an abnormal rise: 1 hour, 61; 2 hours, 138; 3 hours, 142; no pain was evoked by the test. Exploration was planned but the patient developed an upper respiratory infection and was discharged to be readmitted six weeks later. The mass had diminished, remaining as a small sausage-shaped mass. A repeat morphine-prostigmine provocative test was again abnormal: fasting serum amylase, 18 Russell units; 1 hour, 204; 2 hours, 700; 3 hours, 690; 5 hours, 520. Exploration on May 18 (Dr. Stephen E. Hedberg) revealed a cystic structure 5 cm. in diameter adjacent to the body of the pancreas. Probing of the ampulla of Vater revealed no stenosis. Sphincterotomy was performed to obtain a pancreatogram which showed a cystic structure communicating with the duct system. The gall-bladder was removed. The patient continued to have abdominal pain and was readmitted four months later; again a small upper abdominal mass was palpable. At operation on October 14, 1963 (S.E.H.) the cystic mass adjacent to the body of the pancreas was mobilized and found to be located at the tip of an accessory lobe of pancreas arising from the mid-portion of the tail of the pancreas (Fig. 15). Resection was easily accomplished; microscopic examination revealed a muscular wall lined with gastric epithelium with peptic ulceration. The patient has had no further difficulty since operation. This case has been reported previously in greater detail (Case Records of the Massachusetts General Hospital, 1964).

In retrospect it might have been better to attempt excision of this cystic gastric duplication at the second laparotomy, in view of the finding of a normal ampulla and lack of obstruction in the pancreatic duct system to account for recurring pancreatitis. There was no way to suspect that this was not a cyst of the pancreas proper, and it had been hoped to avoid excessive manipulation of the pancreas lest further inflammation be caused by operative trauma.

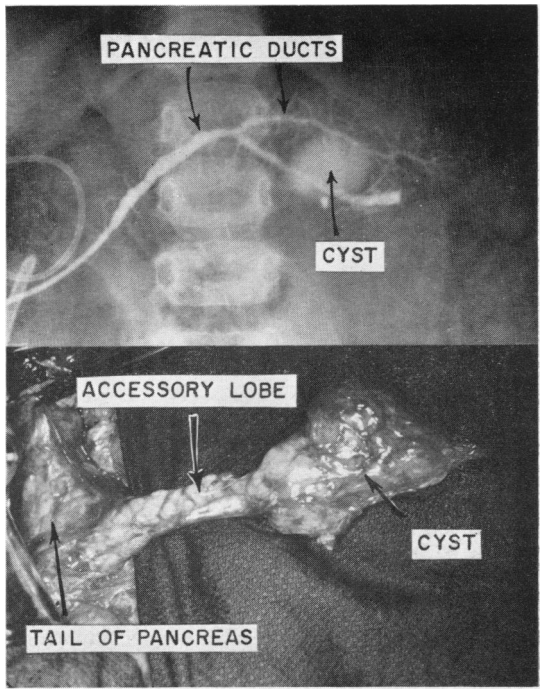

FIG. 15.—Operative findings in Case 13. A pancreatogram, showing a cyst-like structure communicating with the ducts in the tail of the pancreas. Though this 'cyst' communicated freely with the ducts, and sphincterotomy was performed, symptoms and the mass persisted. Lower half of figure shows findings at second operation. There was an accessory lobe arising from the tail of the pancreas. At the end of the accessory lobe lay a cyst-like structure which was lined with gastric mucosa; excision cured the patient.

Case 14. R.S., a 12-year-old white girl, was admitted on August 27, 1963 for severe weight loss and vomiting. Four months previously she had developed abdominal pain with vomiting and was explored elsewhere, with the finding of acute haemorrhagic pancreatitis. The serum amylase was reported at that time to be 625. After doing well for a short time, she developed recurrent abdominal pain, anorexia, vomiting, and severe weight loss. Leucocyte count, total protein, cholesterol, and bilirubin were all normal. The stool was strongly guiac positive. Fasting serum amylase determination was increased (204 Russell units). No pseudocyst was palpable; gastro-intestinal series suggested slight anterior displacement of the stomach. The patient was discharged after a week of observation, but was readmitted 2 months later because of further deterioration. She was very cachectic, weighing only 39 lb. (17·7 kg.) (Fig. 16); there was a palpable upper abdominal mass consistent with a pseudocyst. A morphine-prostigmine provocative test was performed: fasting amylase, 84 Russell units; ½ hour, 94; 1 hour, 92; 1½ hours, 94; 2 hours, 110; 3 hours, 90. Gastro-intestinal series showed a large mass behind the stomach. On March 22, 1963 exploration (W.H.H.) revealed a large pseudocyst in the lesser sac which was decompressed by

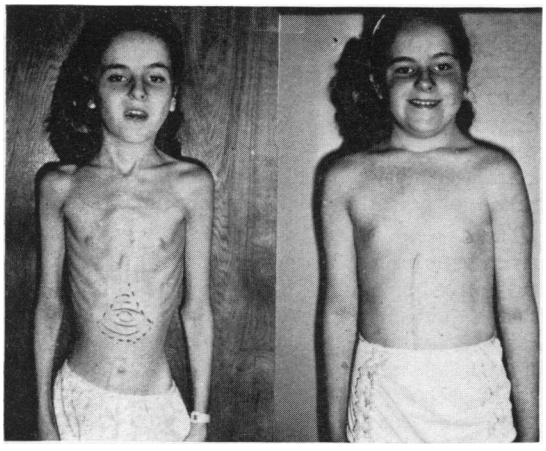

FIG. 16.—Pre- and post-operative photographs of Case 14, a 12-year-old girl. She weighed only 39 lb. (17·7 kg.), was emaciated, and the large epigastric mass outlined was palpable. Six months after transgastric anastomosis of her pseudocyst to the back of the stomach, her weight had doubled and she was well.

transgastric anastomosis to the posterior wall of the stomach, making a very large longitudinal opening between the cyst and the stomach. Sphincterotomy revealed a normal ampulla of Vater; the orifice of the duct of Wirsung was normal. Attempted pancreatogram showed apparent extravasation into the head of the pancreas, though it was thought that the dye could be in a dilated, distorted duct. The accessory pancreatic duct orifice was injected, demonstrating a normal duct of Santorini. The gall-bladder was removed. A Meckel's diverticulum was removed (thought to be the cause for the strongly guiac positive stool), and Ladd's procedure was performed for malrotation of the intestine. The child has done extremely well since operation, with impressive weight gain, and she is now perfectly well.

The aetiology of pancreatitis in this case is not known. The ampulla of Vater and both pancreatic duct orifices were normal. Pancreatography suggested that there might be an abnormality of the pancreatic duct system but we could not be certain that the dye shadow did not represent extravasation.

Case 15. L.J., a 9-year-old white boy, was admitted by Dr. Murrary Rosenthal on June 16, 1964 for observation after abdominal trauma from an automobile accident. There was slight upper abdominal tenderness; blood pressure was 110/70 mm. Hg, pulse 88/min. Haematocrit 35%; leucocyte count 10,100. Serum amylase, 7 Russell units. A plain abdominal film suggested slight displacement of the stomach. Though rupture of the spleen was considered possible, it was decided to observe the patient because his condition was completely stable and his tenderness was minimal. During the next 24 hours the haematocrit decreased to 29%, the leucocyte count rose to 12,000, and left upper abdominal tenderness became more marked. Exploration (W.H.H.) revealed 500 ml. of free intra-abdominal blood; there was a small laceration through the hilum of the spleen, filled with blood clot and not actively bleeding. There was considerable swelling and induration of the distal 2 in. of the tail of the pancreas adjacent to the spleen, with marked surrounding inflammatory reaction. The spleen was removed together with the contused part of the tail of the pancreas; the rest of the pancreas was completely normal. Amylase determination four days later was normal. The patient made an uneventful recovery.

Partial distal pancreatectomy appeared to be a reasonable manoeuvre in this patient, for it could be done with little additional risk and it may have prevented formation of a post-traumatic pseudocyst such as that encountered in Case 9.

Discussion

Pancreatitis is a disease of variable aetiology and should be considered in children with either acute or chronic upper abdominal pain, in ascites of obscure aetiology, and following upper abdominal trauma. The serum amylase determination is helpful if raised, but the amylase value may fall rapidly to normal levels even in severe pancreatitis. Upper gastro-intestinal x-rays can be helpful in certain instances by showing deformity of the duodenum or compression of the stomach by a pseudocyst.

We believe that the morphine-prostigmine provocative test merits further trial in children. The physiological basis of this test rests on morphine-induced contraction of the sphincter of Oddi with concomitant stimulation of pancreatic secretion by prostigmine, causing a rise in the serum amylase value if the sphincter is abnormal. As shown in Case 13, the test can be positive under other circumstances. An increase of over three times the fasting amylase value is considered significant in adults; the test has not been used to our knowledge in childhood and we do not know what normal values should be in children. We have performed the test in a small number of children not suspected of having pancreatitis with no significant rise in amylase values. This test was performed in six patients in this series (Cases 6, 10, 11, 12, 13, and 14). In Case 6 the test was normal, and this child has had no further trouble. In Case 10 (Fig. 14) there was a marked rise in amylase levels before sphincterotomy, with a completely flat curve after sphincterotomy. The test was abnormal in Case 11 before operation, and also after it to a lesser extent, but the determination was made only shortly after the operation. A subsequent study is planned and it will be of interest to see whether it is different. The test was abnormal on three occasions in Case 12; this lad is continuing to have mild clinical difficulty; the test reproduces his pain which is suggestive of obstructive pancreatitis. The test was abnormal in Case 13 in which the pathology lay not at the ampulla

but in a cystic duplication arising from an accessory lobe of the pancreas. The duplication had a muscular wall which may have contracted with morphine stimulation, producing a temporary rise in pancreatic duct pressures causing an increase in serum amylase values. It is of interest that the fasting amylase determination in Case 14, where no ampullary stenosis was found, was raised both before and after operation, but provocation did not result in a significant rise in the amylase value.

The role of surgical intervention in pancreatitis is variable. In mild cases where the diagnosis is certain and the patient is not dangerously ill emergency laparotomy is not necessary; initial treatment should be supportive, including stopping oral alimentation, nasogastric suction, antibiotics, an anticholinergic drug to suppress pancreatic secretion, a drug to relieve pain (not morphine), intravenous fluids and electrolytes, and occasionally calcium. Contrary to popular opinion, we believe that surgical exploration is indicated in certain cases of severely ill children; in some, laparotomy is necessary to confirm the diagnosis, because other conditions such as intestinal perforation can cause a marked rise in serum amylase values. If there is strong reason to suspect acute duct obstruction from a gall-stone, such as in Case 2, or by a worm, exploration of the common bile-duct, ampulla of Vater, and even pancreatic duct should be considered even in a very ill child to relieve total duct obstruction rather than treating such a patient supportively and risking a fatal outcome. In any patient who is severely ill we favour drainage of the lesser sac to remove the highly irritative enzymes which come forth from the inflamed pancreas; drainage may avert pseudocyst formation by evacuating such a collection (this did not prove to be true however in Case 2). Possible pseudocyst formation should be anticipated in any child after pancreatitis or after upper abdominal trauma. A thin-walled pseudocyst is probably treated best by marsupialization to the surface, though this has the disadvantage of pancreatic cutaneous fistula formation in some instances. Rarely, a cyst of the pancreas may be amenable to excision. Most pseudocysts are best drained into the adjacent stomach or by means of a Roux-en-Y loop of jejunum; it is important to make the anastomotic opening as large as possible to prevent spontaneous closure with reformation of the cyst. We believe that more attention should be focused on the ampulla of Vater and on the ductile system of the pancreas as visualized by pancreatography. Three children in this series have undergone elective exploration of the ampulla with relief following sphincterotomy. Finally, in surgical exploration for upper abdominal trauma, we think that the pancreas should be inspected routinely for lacerations or contusions. In an occasional case partial pancreatectomy may be indicated, such as Case 15. In rare instances suturing is necessary to stop bleeding or to reapproximate severed duct structures. All cases of pancreatic injury should be drained in anticipation of leakage of necrotizing digestive enzymes.

The clinical course following a severe attack of pancreatitis in childhood is variable. Case 1 has had no further trouble during 8½ years of follow-up. Blumenstock, Mithoefer, and Santulli (1957) reported a similar case with normal follow-up into adult life. In contrast we have in this series several children in whom there were serious sequelae requiring operation. We feel that a child should be watched carefully after an episode of acute pancreatitis; studies should include upper gastro-intestinal series, cholecystography and choledochography, and the morphine-prostigmine provocative test. In some cases transduodenal exploration of the ampulla and common bile-duct together with pancreatography will be rewarding. Sphincterotomy is not difficult. The duodenum is mobilized and opened through a vertical incision, exposing the ampulla; if a small probe cannot be passed into the ampulla from below, it is passed down into the ampulla from an opening in the common bile-duct. With a probe in the ampulla incision is made upward from the orifice, a little bit at a time, sewing the mucosa of the ampulla to the mucosa of the duodenum. Interrupted fine chromic cat gut sutures are used, placing gentle traction on the sutures to afford better exposure. No sutures are placed in the medial aspect of the ampulla or near the orifice of the ampulla until the opening of the duct of Wirsung is identified for certain, lest a suture be placed inadvertently through it. Administration of 'secretin' can stimulate pancreatic secretion as an aid in locating the duct orifices. If the incision in the ampulla is extended too far upward, there is danger of cutting through the back wall of the duodenum. Probing and manipulation of pancreatic ducts should be done very gently; pancreatography should be performed with great care; forceful injection is dangerous and can produce pancreatitis. Duodenal closure is done transversely to avert narrowing at the site. The gall-bladder is removed with sphincterotomy in the belief that opening the sphincter disturbs the physiological mechanism of gall-bladder emptying, which can result in stasis and stone formation.

Summary

15 children with pancreatitis have been observed during the past 9 years, and the diverse aetiology,

variable course, and possible surgical sequelae of this condition have been outlined. All patients survived. It is concluded that pancreatitis may be more common in childhood than previously suspected, and that this condition should be considered in children with upper abdominal pain, ascites of acute onset, and after trauma.

We would like to express appreciation to the following for permission to report certain of these cases: Dr. Robert E. Gross, Cases 1 and 2 from the ward service of the Children's Hospital; Drs. Nicholas M. Stahl, J. Roswell Gallagher, Warren W. Point, and Marshall K. Bartlett, Case 3; Dr. Chester J. Dexter, Case 9; Drs. Anne P. Forbes and George L. Nardi, Case 14.

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