ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY

An evaluation of ERCP in various pancreatic and biliary diseases.

PROEFSCHRIFT

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TABLE OF CONTENTS

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CHAPTER I

INTRODUCTION

During an 8 year period from 1973 to 1981 903 endoscopic retrograde cholangiopancreatographies (E.R.C.P.'s) were performed in the University Hospital Rotterdam-Dijkzigt. The introduction of this technique represented a major advance in the diagnostic approach to diseases of the pancreas and biliary tract.
This thesis describes an evaluation of E.R.C.P. in various pancreatic and biliary disorders, based on these groups of patients. The aims of the study were to characterise the changes associated with disease, and to determine objective criteria for radiological diagnosis.
The disorders selected for detailed study were those which are difficult to diagnose by means other than E.R.C.P..
In addition the diagnostic success rate and complication rate of E.R.C.P. in the whole group of patients has been studied.

HISTORY OF PANCREATOGRAPHY

In 1909 Pillan (17) made the first pancreatogram, of a pancreas removed at autopsy. Doubilet, Mulholland (10) and Leger (15) subsequently developed methods for peroperative pancreatography. The first non-surgical cannulation of the papilla of Vater was described in 1965 by Ravinov and Simon (24), who introduced a specially designed instrument through the mouth, using fluoroscopic monitoring. Waldron et al. (31) showed in 1967 that it was sometimes possible to fill the pancreatic and bile ducts by provoking reflux of contrast medium from the duodenum.
In 1968 Mc Cune et al. (16) reported successful cannulation of the papilla of Vater and visualisation of the pancreatic duct, using a fiberoptic Eder duodenoscope. In 1970 Oi (20) and Takagi (29) showed that cholangiography as well as pancreatography was possible using a duodenoscopic technique. With improvement in fiberoptic instruments the method was developed and refined by endoscopists troughout the world (2, 6, 8, 9, 13, 18, 30). The first E.R.C.P. in this hospital was performed in the beginning of 1973. The introduction of E.R.C.P. provided a fresh stimulus for improving and reevaluating older investigations such as barium meals and hypotonic duodenography.

E.R.C.P. METHOD USED IN THIS HOSPITAL

Preparation
The patient fasts for 18 hours, and is premedicated (table 1) 30 minutes before the start of the investigation.

Method
The investigation takes place in a radiology unit which is suitable for gastroenterological studies. Following local anaesthesia of the mouth and throat (table 1), the patient is placed on his left side, and 10 to 20 mg of diazepam given slowly through an intravenous cannula. The duodenoscope (Olympus, Fujinon) is introducted through the mouth, oesophagus, stomach and pylorus into the duodenum, and the position checked fluoroscopically.
Loops in the stomach, which reduce the manouverability of the duodenoscope, are corrected by pulling back gently on the duodenoscope so that is stretched along the lesser curvature. It is often difficult to find the afferent loop-opening in patients who have undergone a Billroth II gastrectomy or a Roux-en-Y anastomosis. In these patients the duodenoscope must be fixed by external pressure on the abdomen to prevent movement, as the afferent loop is mobile in comparison with the normal duodenum.

Table 1. — Pre- and postmedication in ERCP

Premedication (30 minutes before the start)
- 1 gr. Ampicillin i.m.
- 0,5 mg. Atropine i.m.
- 5 mg. Droperidol i.m.

Medication (immediately before endoscopy)
- Xylocaine 2% gargle
- 10-20 mg. diazepam (Valium®) i.v.
- 1-2 mg. Buscopan® i.v.
- 0.5-1 mg. glucagon i.v.
- 80 mg. gentamycin in 60 ml. contrastmedium

Postmedication (during the next 48 hours)
- 4 x 1 gr. ampicillin i.m. or
- 3 x 750 mg. amoxyllin orally
- 3 x 80 mg. gentamycin i.m.

Once the duodenoscope has passed the pylorus 0.5 mg of glucagon and 1 mg of Buscopan® are given to cause hypotonia. The duodenal mucosa is now inspected, and the papilla of Vater is sought. The papilla mass is often visible fluoroscopically, and this may be helpful in guiding the endoscopist. The papilla of Vater is situated on the inner curve of the duodenum between the transverse folds of Kerkring, and is best inspected with a lateral viewing system in the normal situation or with a 180° viewing system in patients with a Billroth II gastrectomy. The papilla of Vater varies in size and may be mistaken for the papilla minor or accessory papilla. A longitudinal mucosal fold, formed by the intramural portion of the choledochus lies proximally to the papilla maior and the frenulum distally. The accessory papilla, if present, is situated proximally and is not associated with frenulum or longitudinal fold.

A swelling of the head of the pancreas can make inspection of the papilla of Vater impossible. Stenosis of the papilla, choledochoduodenostomies and fistulae may be seen by the endoscopist. Haemobilia and blood loss from the pancreas are also readily recognisable by the endoscopist.

Once the papilla of Vater has been found, a teflon cannula (external diameter 1.7 mm) is introduced. Firm closure of the sphincter of Oddi sometimes prevent cannulation. Intravenous cholecystokinin (Kinevac®) will cause relaxation. Cannulation is also difficult in the presence of stenosis of the papilla of Vater. Contrast medium can often be injected if the teflon cannula is firmly pressed against the papilla opening. Cannulation of the choledochus is achieved by passing the duodenoscope beyond the papilla and directing the cannula proximally within the longitudinal fold. The pancreatic duct is cannulated by placing the duodenoscope opposite the papilla and introducing the cannula in a horizontal and ventral direction. A common opening for both systems allows visualisation of both ducts with a single injection. If cannulation cannot be achieved while the patient is lying on his left side attempts should be made with the patient prone or supine. Cannulation is difficult in the presence of a papillary stenosis or prepapillary stenosis of the common bile duct or pancreatic duct. It is often surprisingly easy in patients with carcinoma of the papilla of Vater. It may be impossible if the papilla is mobile or if it lies within a duodenal diverticulum.

Following cannulation contrast medium is slowly injected (table 2). It is of great importance to exclude air bubbles in filling the cannula and syringes prior to the investigaton. Overfilling of the ducts is dangerous and we have included a guide wire in the system which prevents too rapid injection. The ducts should only be filled under fluoroscopic control; perforation of a pancreatic duct is often not felt immediately by the patient and continued injection in the presence of a perforation might have disastrous effects. Filling a cavity usually does not create problems, but overfilling, especially if the cavity is distal to

a stenosis, is associated with an increased risk of sepsis. To reduce the chance of sepsis gentamycin is added to the contrast medium if stenoses are found. Most of the röntgenograms are made while the patient is lying face down, as the compression of the abdomen ensure stability of the duodenoscope and creates a more homogenous mass of the abdominal organs. During an ERCP other extrapancreatic changes (ascites, hepato-splenomegaly, sentinal loop, colon cut-off sign, displacements, calcifications, pleural fluid, pulmonary infiltration or changes in mobility or the position of the diaphragm) may be also visible. On completion of the investigation, the patient is observed for 48 hours because of the possible complications. The radiation dose to the patient during E.R.C.P. is less than that during a barium meal.

Therapeutic E.R.C.P.
Therapeutic E.R.C.P. in this hospital started in 1978 with papillotomies and was followed by stone extraction with a Dormia basket and balloon catheters. It is also possible to introduce endoprotheses into the bile ducts in patients with biliary stenoses.

Table 2. — Contrast media used in ERCP

Bile ducts:	
— general use	Conray 60®
— post cholecystectomy	Conray 30® + F + G
— dilated ductus hepatocholedochus	Conray 30® + F + G
— concrements suspected	Conray 30® + F + G
— jaundice	Conray 60® + G
— carcinoma suspected	Conray 60® + G
Gall bladder:	
— general use	Conray 30® + F
Pancreas:	
— general use	Conray 70®
— stenosis suspected	Conray 70® + G
— cavities or fistulae	Conray 70® + G

Conray 30®	*141 mg. iodine/ml.*
Conray 60®	*282 mg. iodine/ml.*
Conray 70®	*410 mg. iodine/ml.*
G	*gentamycin*
F	*physiological saline*

INDICATIONS FOR E.R.C.P.

- jaundice
- suspected or known biliary disease
- suspected or known pancreatic disease
- severe abdominal pain for which no other cause can be found
- evaluation of pathology indicated by ultrasonography or computerised tomography.

CONTRAINDICATIONS FOR E.R.C.P.

- acute pancreatitis
- severe cardiopulmonary disease, making it impossible for the patient to lie flat
- lack of cooperation on the part of the patient.

COMPLICATIONS

It is difficult to avoid complications during ERCP as during instillation of contrast medium

pathogenic microorganisms may be introduced into a ductal system and cause inflammation, especially in patients with impaired drainage.
Serious complications with this procedure tend to develop in patients with obvious pathology of the duct system (19). It has been reported that severe febrile reactions, cholangitis and bacteremia occur occasionally in patients with obstructive changes of the bile duct or the pancreatic duct (32) and especially in those with a pancreatic pseudocyst (1). Vennes et al. (30) reported that cholangitis developed in 13% of the cases within 36 hours after visualization of the obstructed common bile duct.
Zimmon et al. (32) also reported that sepsis occurred in 5% of the cases with extrahepatic biliary obstruction within 72 hours after ERCP. Koch et al. (14) mentioned that infection of the pancreatic cyst was induced in 15.7% of the cases with one death after visualization. Cotton et al. (8) reported bacteremia in a case with hepatic cirrhosis and Ohto et al. (19) had a similar experience. Other severe complications including bile leakage in the abdominal cavity or peritonitis have also been reported (5, 21).
Acute pancreatitis which is the most feared complication has rarely happened except in the patients with carcinoma or pseudocyst of the pancreas (1, 3, 14). Koch et al. (14) described that acute suppurative pancreatitis occurred in a case with a normal pancreatic duct system.
Although serum and urine amylase levels are often elevated to varying degrees after successful filling of the pancreatic duct, they usually return to normal within a few days (19, 21, 22, 29). This is usually not accompanied by clinical symptoms. Moderate acute pancreatitis occurred in the Ohto-series (19) in 0.2% with ERCP; one of the patients had no obvious abnormality of the pancreatic ducts.
The use of the procedure in the acute phase of pancreatitis can potentially cause an exacerbation which might be catastrophic.
The complications of endoscopy itself, such as perforation, significant bleeding from oesophageal varices, cardiovascular collaps, and chest infection due to aspiration of vomitus, occur very rarely with the use of modern fiberoptic instruments.
Only the serious complications were registered in the Dijkzigt series. Two patients died (an incidence of 0.2%), one from acute pancreatitis following the ERCP, one patient due to septic shock.
Non-fatal sepsis occurred in a further five patients and acute pancreatitis in two.
Perforation of the oesophagus followed by mediastinitis occurred in a single instance.

THE NORMAL BILIARY TREE

The length of the intraduodenal (intrapapillary) common bile duct averages 15 mm, with a range of 11 to 27 mm (12, 26). The internal diameter of the common bile duct narrows in this portion to a few millimeters because of the presence of muscular sphincter surrounding the common bile duct and the pancreatic duct of Wirsung. The common bile duct and duct of Wirsung join to form a common channel within the duodenal wall in up to 85% of the cases, but the length of the channel varies from 2 to 17 mm (12). Continuing in a cephalad direction, the common bile duct is seen to have an intimate relationship with the pancreas and the first portion of the duodenum. Since the site of entrance of the cystic duct determines the length of the hepatic duct and the beginning of the common bile duct, there is great variation in the length of these two segments.
The cystic duct and gallbladder should normally fill with contrast medium during ERCP if that system is patent. The bifurcation of the hepatic duct is usually extrahepatic. The normal bile duct forms a tree-shaped duct system, with smooth contoured ducts. The intrahepatic branches are smaller the further they are from the liver hilus. The extrahepatic ducts (ductus hepatocholedochus) are the trunk of the biliary tree. In contrast to a normal tree, this trunk narrows distally (papilla of Vater) and is always to a greater or lesser ex-

tent convex to the left, usually rounded but occasionally angulated. The measurements of the extrahepatic bile ducts are given in chapter III.

THE NORMAL PANCREATIC DUCT

An understanding of the normal pancreatic duct is essential before attempting to evaluate the pathological gland. The papilla of Vater is most commonly located in the middle third of the descending duodenum, at or near the 2nd lumbar vertebral body (27).
The normal pancreatic duct typically tapers smoothly from head to tail. Dividing the main pancreatic duct into thirds, Classen et al. (1973) found the mean rise of the duct in the head, body and tail of the gland to be 75 degrees, 19 degrees, and 21 degrees, respectively. Several different duct configurations are described, e.g. sigmoid (ascending-horizontal-ascending) configuration and pistol (ascending-horizontal-horizontal) configuration. Due to the highly variable course of the pancreatic duct we have not measured its length. Stewart (27) accepts 145 to 205 mm as the range for median duct length in several series. A review of multiple endoscopic and autopsy reports shows that the typical caliber of the pancreatic duct is 3 to 4 mm in the head, 2 to 3 mm in the body, and 1-2 mm in the tail. The duct of Santorini is frequently seen joining the branch of the uncinate process rather than the main pancreatic duct, and it communicates with the duodenum in greater than 50% of cases (11).
Important to recognize is non fusion of the ducts of Santorini and Wirsung. In such case the duct of Wirsung arises from the major papilla and terminates within 5 to 7 cm (23). The ventral pancreatic duct is recognized by its small caliber and its branching ductal patterns. In many cases the diameter approaches that of the cannula.
Normal side branches, when visualised, taper. In the body and tail, the side branches join the main pancreatic duct at right angles and insert on the main duct at alternate points from above and below (25). The side branches in the head are much more sinuous, joining at multiple angles (28).
In our opinion pancreatic acinarization is a sign of local inflammation of the pancreas, but may be due to too high a filling pressure during injection of contrast medium.

EVALUATION

All ERCP's were described immediately following the investigation. The criteria for reporting changes as pathological were largely based on the literature (19, 27).
The findings were correlated with the subsequent clinical diagnosis which was based on clinical, biochemical, radiological, and whenever possible, operative or postmortem investigation with histology.
The success rate and complication rate of the investigation were obtained by a retrospective analysis of the request forms for the ERCP and the patient files (4).
Objective criteria for the radiological diagnosis were sought for the various diseases (see chapter II to VI).

FINDINGS IN THE DIJKZIGT SERIES

Success-rate
During the period of 1973 to 1981 903 ERCP's were performed in 826 patients. In only 9 patients (1.1%) of the patients in whom ERCP was technically successful, were no abnormalities found in either biliary system or pancreatic duct, which suggests that the indications for ERCP were stringently adhered to.
Cannulation of the biliary system failed in 16.1% of patients for whom it was requested (table 3). It was often possible in these patients to provide a diagnosis following reexamination of radiological investigations performed elsewhere at an earlier date. In 117 pa-

tients the choledochus duct was visualised although this was not requested by the referring physician. In a surprisingly high proportion (65.8%) of these patients, biliary pathology was found.
Cannulation of the pancreatic duct failed in 18.3% of the patients (table 3). However a probable diagnosis could be made by retrograde cholangiography or by other means in 96.6% of these patients. The pancreatic duct was cannulated in 229 patients for whom it was not requested. In 68.1% of these patients abnormalities were found.

Table 3.

	Number of patients	*Percentage*
Total number of E.R.C.P.'s	903	109.3%
Total number of patients	826	100.0%
Number of patients without biliary or pancreatic pathology	9	1.1%

	Biliary system	*Pancreatic ducts*
Requested	491 (59.4% of total)	378 (46.9% of total)
Failed	79 (16.1% of requested)	71 (18.3% of requested)
Failed, diagnosis made	62 (12.6% of requested)	58 (15.0% of requested)
Total diagnosis	474 (96.5% of requested)	374 (96.6% of requested)
Not requested, but visualised	117 (14.2% of total)	229 (27.7% of total)
Not requested, abnormal	77 (65.8% of the non-requested)	156 (68.1% of the non-requested)

RADIOLOGICAL FINDINGS

Papilla of Vater
Changes in the region of the papilla of Vater are tabulated in table 4. Enlargement of the papillary "mass", especially when not sharply delineated, was diagnosed as oedema or inflammation. Chronic inflammation of the papilla of Vater gave papillitis deformans changes or an elongated or stenotic intrapapillary segment of the common bile duct and elongation of the intrapapillary segment of the pancreatic duct.

Table 4. — Abnormalities of the Papilla of Vater

	Number of patients
— Enlarged, oedematous Papilla of Vater	64
— Chronically inflamed Papilla of Vater (papillitis deformans, elongated intrapapillary segment)	43
— Neoplasma of the Papilla of Vater	23
— Benign stenosis of the Papilla of Vater	21
— Prolapse of the Papilla of Vater	18
— Papilla not found due to malignancy in the vicinity	12
— Insufficiency; open Papilla of Vater	8

Biliary tract

Abnormalities in the biliary tract were divided into intrabiliary and extrabiliary processes (table 5).
It was possible to demonstrate the primary site of tumours in most instances. Carcinoma of the head of the pancreas tends to infiltrate the common bile duct while carcinoma of the body of the pancreas obstructs the hepatic ducts.

Table 5. — Pathology of the bile ducts

I Intrinsic biliary abnormalities	*Number of patients*
— gall stones	248
— malignant biliary tumor	39
— bile fistula	22
— iatrogenic biliary stenosis	21
— chronic cholangitis	21
— sclerosing cholangitis	13
— choledochal cyst	8
— non neoplastic space occupying lesion	6
— benign, biliary stenosis, idiopathic	4
— septa	3
— bile leakage after percutaneous transhepatic cholangiography	3
— bile duct rupture after blunt trauma	2
— choledochal diverticula	2
— parasitic infection	2
II Extrinsic biliary abnormalities	
1. Hepatic pathology	
— macronodular livercirrhosis	18
— primary biliary cirrhosis	12
— micronodular cirrhosis, hepatic fibrosis	11
— solid tumors	9
— idiopathic stenosis	8
— cavities	7
— hepatitis	7
— primary hepatoma	3
— fatty liver	2
2. Pancreatic pathology	
— invasive carcinoma of the head of the pancreas	46
— inflammatory tumor of the pancreas	20
— biliary stenosis due to chronic pancreatitis	19
— invasive carcinoma of the body of the pancreas	15
— biliary stenosis due to a cavity in the head of the pancreas	7
3. Diverse	
— biliary stenosis due to inflammation and adhesions	8
III Pathology of the gall bladder	
— gall stones	113
— non-filling gall bladder with stones	8
— benign gall bladder tumor	4
— malignant gall bladder tumor	3

Pancreas

Disorders of the pancreas have been detailed in table 6. Chronic pancreatitis was classified by us in four stages.

Stage 1: Slight irregularity of the contours of the pancreatic ducts and occasionally the pancreatic ductules.

Stage 2: Stenoses and dilatations of both duct and ductules. The ductular changes are often more pronounced than the duct abnormalities.

Stage 3: Stenoses, dilatations and tortuosity of the pancreatic duct. The ductuli are more damaged than the main duct and the number of ductuli is reduced.

Stage 4: Obstruction, pseudocysts, fistulas, stones and calcifications in addition to the previous changes.

Table 6. — Pancreatic pathology

	Primary Localisation of the pathology				
	Head	*Body*	*Tail*	*Peripancreatic area*	*Total number of patients*
Chronic Pancreatitis stage I	23	29	24		
Chronic Pancreatitis stage II	22	26	27		201
Chronic Pancreatitis stage III	30	52	47		
Chronic Pancreatitis stage IV	71	90	93		
Acute Pancreatitis	88	109	98		
Necrosis	14	7	6		191
Overfilling of the ducts	13	17	31		
Neoplasm	60	30	11	7	145
Non neoplastic solid tumor	17	2	22		
Cavities	48	19	32	10	86
Calcification	26	22	24	8	58
Stones	23	24	20		
Pancreas fistulae	14	25	7		28
Congenital lesions	23	4	2		26
Iatrogenic trauma	24	1	0		25

Parenchymal opacification is seen in acute pancreatitis, and also in necrosis, overfilling and perforation of the pancreatic duct. Contrast medium in the parenchyma was usually sharply delinated in the case of perforation.
Although filling of a cavity is usually not advised in the literature (19); as complications (sepsis) may be caused it should be attempted. In one patient a pancreas carcinoma was missed due to insufficient filling of a cavity. Pancreatic stones are relatively non-opaque in our patients. Traumatic lesions of the pancreatic duct were almost entirely iatrogenic.

Duodenum
Changes in the duodenum, especially distal to the duodenal cap, are summarised in table 7. Extrinsic pathology was frequently detected. Criteria for detecting and reporting such changes are described in chapter VI. Post-bulbar ulcer was almost always malignant in our series. Diverticula of the duodenum near the papilla of Vater would appear to be associated with pancreatitis.

Table 7. — Duodenal pathology

	Number of patients
I. Intrinsic duodenal pathology	
— duodenum diverticula	89
— duodenitis	26
— erosions	17
— post bulbar duodenal ulcer	11
— polyp	4
— duodenal carcinoma	4
— haemorrhage, lesion not found	3
— benign tumor of the duodenum	2
II Extrinsic duodenal pathology	
— inflammation of the inner curve of the duodenum	223
— compression of the duodenum	147
— malignant invasion of the duodenum	72
— stenosis of the duodenum	61

ANALYSIS OF SPECIFIC DISORDERS

During the course of the past 8 years we collected series of patients with specific disorders for further evaluation of the diagnostic techniques.
From 1973 to 1978 we were able to examine 12 patients with an early carcinoma of the ampulla and papilla of Vater. Painless jaundice was the main presenting symptom, the non-jaundiced patients had abdominal pain. Occult blood was present in the faeces of all patients in whom the test was performed. The radiological changes are described in chapter II. An irregularly bordered obstruction in the ampulla or papilla of Vater is characteristic of carcinoma. The presence of an inflammed, rounded or prolapsed papilla or delayed efflux of contrast from the bile and pancreatic ducts and local inflammatory changes in the head of the pancreas are indirects signs of a tumor in this region. The smallest tumor found had a diameter of 3 to 4 millimeters.
Most diseases of the extrahepatic bile ducts are associated with changes in the shape of the common bile duct. Measurement of the bile duct diameter however is unreliable due to varying magnifications, different investigating techniques and different individuals.
In attempt to provide objective criteria of changes in the common bile duct we have devised a technique in which the diameter of the duct is related to its length. This is reported in chapter III. Changes in the shape of the common bile duct can be expressed mathematically by measuring the CBD diameter at five points and expressing these measurements as a percentage of the mean diameter. Variations in magnification are compensated for by relating the mean diameter to the length of the C.B.D.. By comparing the shape of the CBD in patients with various diseases with the shape of the normal common bile duct it was possible to define pathognomonic signs of various diseases of the extrahepatic biliary system.
Indirect signs of pathology of the extrahepatic bile ducts are discussed in this chapter.
As the radiological changes associated with pancreatic fistulas are poorly documented in the literature, we felt it would be of interest to present the result of a retrospective analysis of the clinical and radiological findings in 14 patients with radiologically documented pancreatic fistulas.
There is a relationship between proximal stenosis of the pancreatic duct, inflammatory cavities of the pancreas and the development of fistulas. Pancreatic fistulas can be blind, can open into various spaces in the body or can be attached to the abdominal wall. The associated pathology in patients with pancreatic fistulas is often severe and involves the whole pancreas (chapter IV).
Differentiation between diffuse chronic pancreatitis and pancreatitis distal to a malignant or benign stenosis is often difficult to determine from the shape of the pancreatic duct only. We considered the possibility that combinations of radiological findings might be more helpful in diagnosing these conditions than single criteria: Multivariate analysis was performed using several criteria, including measurements of the diameter of the pancreatic duct. In a group of patients it was possible to determine the correct diagnosis with a high degree of accuracy by 8 criteria mainly derived from changes in the pancreatic ductuli (chapter V).
Most patients referred for an ERCP arrived with a large package of X-ray films, the results of diverse "routine" investigations. On re-examination of these radiographs it was possible to make presumptive diagnosis in nearly 80% of patients before performing the ERCP. An example is given in chapter VI, in which we have analyzed the value of several investigating methods used in 36 patients with a space occupying lesion in the tail of the pancreas.
Changes of the stomach, duodenum (flexure of Treitz) and colon are suggestive of pathology in the pancreatic area.

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CHAPTER II

EARLY CARCINOMA OF THE AMPULLA AND PAPILLA OF VATER.

ABSTRACT

The clinical and radiological findings of 12 patients with early carcinoma of the ampulla or papilla of Vater are described. Endoscopic retrograde cholangio-pancreatography, percutaneous transhepatic cholangiography and hypotonic duodenography are the radiological techniques most suited to making the diagnosis. An irregularly bordered obstruction in the ampulla or papilla is characteristic of carcinoma. The presence of an inflamed, rounded or prolapsed papilla or delayed efflux of contrast from the bile and pancreatic ducts and local inflammatory changes in the head of the pancreas are indirect signs of a tumour in this region.

INTRODUCTION

The prognosis of patiënts with carcinoma of the pancreas, bile ducts or papilla of Vater is poor. This is partly due to the fact that the peak incidence is in the elderly, but also due to difficulties in diagnosing lesions in this area (Eaton and Ferrucci, 1973; Gouerou *et al.*, 1976; Ikejiri *et al*, 1977). The introduction of techniques such as endoscopic retrograde cholangio-pancreatography (ERCP), percutaneous transhepatic cholangiography (PTC) using a 'skinny' needle and echography have improved diagnostic accuracy and provide the potential of early diagnosis.
Since 1973 we have had the opportunity of examining 12 patients with carcinoma of the ampulla or papilla of Vater at an early stage. The symptoms, signs, endoscopical and roentgenological findings in these patients will be presented in this paper.

PATIENTS AND METHODS

All 12 patients were seen in the University Hospital Dijkzigt in the period 1973-78. During the first year ERCP was more an exception to the rule than a routine procedure. During the letter period ERCP or PTC followed echography. The main indication for the investigation was jaundice. Hypotonic duodenography was performed by the method of Jacquemet *et al.* (1965). ERCP was performed together with Dr. M. van Blankenstein of the Department of Internal Medicine using an Olympus duodenoscope. All patients received a broad-spectrum antibiotic on the day of the investigation and for the following

Table I. — Symptoms and signs of 12 patients with carcinoma of the ampulla or papilla of Vater.

Symptoms		Malaise	10
Painless jaundice		Pruritus	8
Deep jaundice	3	Anorexia	9
Moderate jaundice	1	Weight loss	8
Slight jaundice	4	Nausea and vomiting	4
Intermittent jaundice	2	Fever	6
No jaundice	2		
Pale stool		*Signs*	
Continuous	5	Enlarged liver	5
Intermittent	2	Enlarged gallbladder	5
Dark urine			
Continouos	7		
Intermittent	2		

two days. PTC was performed according to the Chiba technique. The diagnosis was confirmed at laparotomy in 11 patients; one patient refused the operation.

RESULTS

The mean age of the patients was 65 years with a range from 36 to 78 years; there were five males and seven females. The interval between the onset of complaints and diagnosis averaged 7.5 weeks. The symptoms and signs are summarised in Table 1. Painless jaundice was the main presenting symptom, the non-jaundiced patients had upper abdominal pain. In four patients pruritus preceded the other complaints. The rate of weight loss in

Table II. — Method of radiological diagnosis, the localisation of the neoplasm and the endoscopic diagnosis

Patient (number)	*Jaundice*	*Radiological investigation and results*				*Endoscopy*
		HD	*ERCP*	*PTC*	*Localisation of tumour*	*Visibility of tumour*
1	+++		+		Ampulla (congestion in the biliary tract)	—
2	−/+	+	+		Ampulla—papilla	—
3	+		+		Ampulla (congestion in the biliary tract)	—
4	+		+		Ampulla (more congestion in the pancreatic duct compared to the biliary tract)	—
5	−/+		+		Ampulla (congestion in the biliary tract and the pancreatic duct)	±
6	+++(subcom.)			+	Papilla	+
7	++		+		Ampulla (more congestion in the biliary tract compared to the pancreatic duct)	—
8	+++(high fever)			+	Ampulla—papilla	±
9	+		+	+	Ampulla (more congestion in the biliary tract compared to the pancreatic duct)	—
10	—	+			Ampulla—papilla	+
11	—	+			Papilla (submucosal)	—
12	+	+	+		Ampulla-papilla (more congestion in the biliary tract compared to the pancreatic duct)	—

Explanation of the signs

Jaundice
- \+ Light jaundice
- ++ Moderate jaundice
- +++ Severe jaundice
- −/+ Intermittent jaundice

Radiological investigation
The radiological investigation, which demonstrated the tumour explicitly is marked with +.

Endoscopy
- — No tumour mass visible, but practically always the papilla of Vater showed inflammation, slough and sometimes bleeding.
- ± Large, undulating papilla of Vater. No obvious tumour mass visible.
- \+ Evident neoplasm of the papilla of Vater.

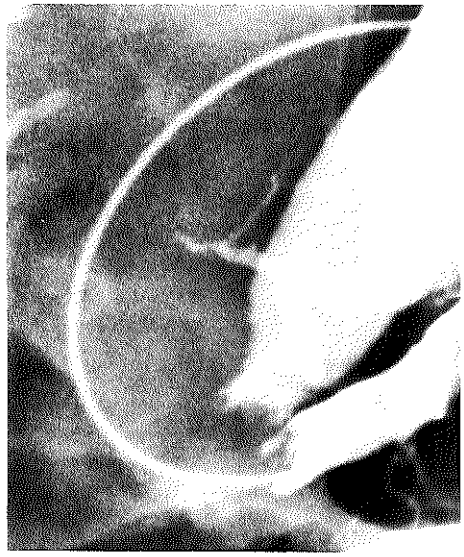

Fig. 1. — Carcinoma of the ampulla of Vater. Irregularly bordered space-occupying lesion in the ampulla obstructing the biliary tract and the pancreatis duct. Dilation of the common bile duct and the pancreatic duct. No obvious efflux of contrast medium in the duodenum.

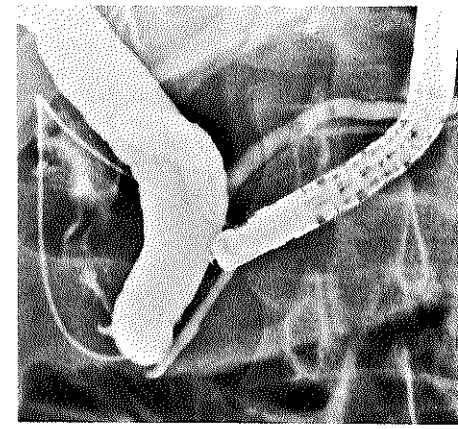

Fig. 2. — Ampullary carcinoma.
a. *The papilla of Vater is round and slightly enlarged. The contrast medium flows from bile duct into the pancreatic duct. There is a little passage into the duodenum.*
b. *Prolapsing of the papilla of Vater into the duodenum. Dilated common bile duct and cystic duct stump.*
c. *Irregularly bordered fixed space-occupying lesion in the ampulla of Vater obstructing the common bile duct more than the pancreatic duct.*

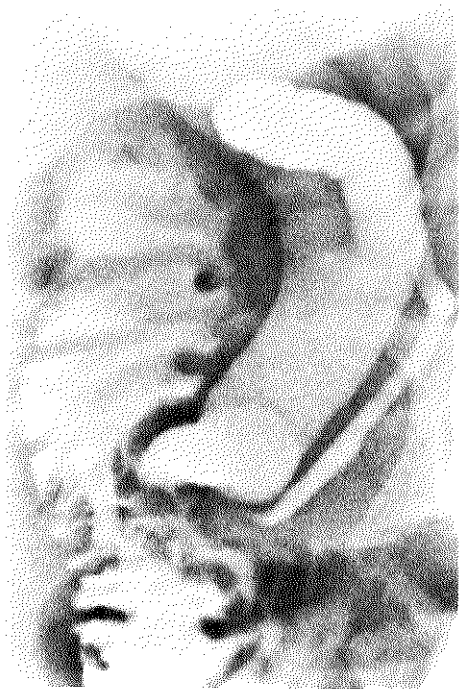

Fig. 2b

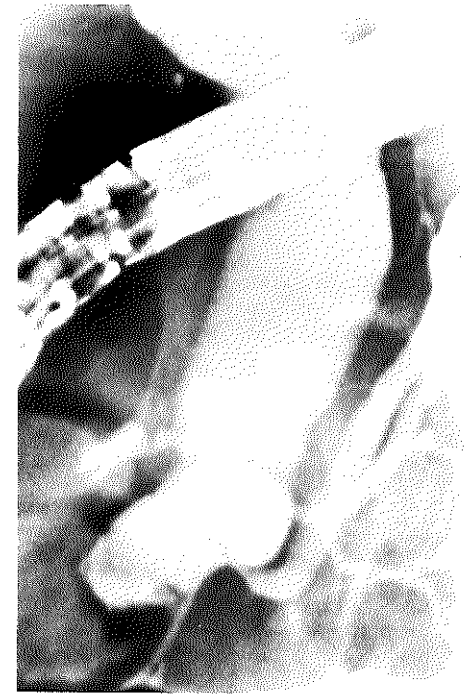

Fig. 2c

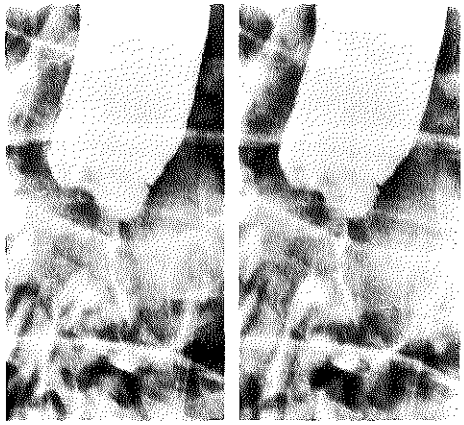

Fig. 3. — Carcinoma of the papilla of Vater. Eccentric applecore narrowing of the intrapapillary part of the common bile duct. Thin, asymmetric irregular passage to the duodenum like a broken stick. Markedly dilated common bile duct.

the patients varied between 1 and 5 kg per month. Liver function tests were compatible with obstructive jaundice in all patients. Occult blood was present in the faeces of all seven patients on whom the test was performed.

RADIOLOGICAL FINDINGS

ERCP

Carcinoma of the ampulla of Vater manifests as an irregularly bordered space-occupying lesion in the ampulla obstructing the biliary tract and/or the pancreatic duct (Fig. 1). If the neoplasm is localised to the papilla, the contrast medium flows from bile ducts into the pancreatic duct and vice versa, and very little escapes into the duodenum (Fig. 2*a*). An example of carcinoma of the papilla of Vater showing an asymmetric stenosis of the intrapapillary ductal system with frayed double borders is shown in Fig. 3.

PTC

Carcinoma of the ampulla of Vater appears as an irregularly bordered space-occupying lesion. There is marked delay of efflux of contrast medium. Sometimes there is spontaneous filling of the pancreatic duct as in papillitis. Carcinoma of the papilla of Vater produces an asymmetrical stenosis of the intrapapillary part of the common bile duct with a frayed border(Fig. 3).

Hypotonic Duodenography

Carcinoma of the ampulla of Vater is detected by indirect signs only: the papilla of Vater is round with hazy contours (Fig. 2*a, c*), but is not necessarily enlarged. In carcinoma of the papilla of Vater the papilla is enlarged with irregular borders. Sometimes there is spiculation and ulceration (Fig. 4). Table 2 shows the method and the localisation of the neoplasm, and also the endoscopic findings. Hypotonic duodenography revealed malignancy in the region of the pancreas especially in non-jaundiced patients. The ERCP is however the investigation of choice.

Associated pancreatitis is common with carcinoma of the ampulla or papilla of Vater (see Table 3). Hypotonic duodenography can demonstrate these inflammatory changes, but ERCP shows them to better advantage. Two patients underwent only PTC, so that there was no radiological information about the pancreas. In 10 patients the pancreas has been examined by hypotonic duodenography or ERCP or both. In six patients the pancreas was

abnormal. An abnormality in the head of the pancreas can be regarded as a possible indication of abnormalities in the ampulla or papilla of Vater.
Table 4 shows the surgical treatment, the final pathological diagnosis and pertinent side notes.

DISCUSSION

Most patients with carcinoma of the papilla or ampulla of Vater have painless jaundice. The two non-jaundiced patients had abdonimal pain. An intermittent jaundice can probably be caused by expulsion of necrotic clot from the tumour. When a transtumour cannulation is performed after PTC usually the tumour mass is not felt, indicating softness or necrosis of the tumour (Fig. 5). In four patients pruritus was the first symptom. Although echography has been more frequently utilised in the investigation of the jaundiced patient, it can only demonstrate dilated bile ducts, and in our hands has not proved of value in the diagnosis of early malignancy of the papilla of Vater. In the presence of jaundice, oral cholecystography and intravenous cholangiography are useless. For quick diagnosis of the probable anatomical cause of jaundice there are two alternatives.

1. *ERCP.* An ERCP can demonstrate not only the common bile duct, but also the pancreatic duct and the ampulla of Vater. The efflux of the contrast medium to the duodenum during an ERCP can also reveal (although not as well) the contours of the duodenum. During an ERCP the endoscopist can look at the intraduodenal portion of the papilla of Vater and can take biopsies.
2. *PTC.* A PTC can usually demonstrate the bile duct and (a part of) the ampulla of Vater, but generally not the pancreatic duct. During a PTC an external or transtumoural drainage of the bile ducts is possible. In a non-jaundiced patient with vague abdominal complaints, a barium study of the upper GI tract and hypotonic duodenography usually precede an ERCP.

Hypotonic duodenography can indicate the lateral border of a neoplasm in the papilla of Vater and can reveal an already invaded submucosa of the duodenum by tumour of the head of the pancreas.
The *endoscopic findings* in most cases were a large, red, inflamed papilla of Vater with or without sloughing, and with or without bleeding. In our material obvious tumour in the papilla of Vater was only seen twice, which is contrary to the experience of Gouerou *et al.*

Table III. — Abnormalities of the pancreas associated with carcinoma of the ampulla or papilla of Vater.

Patient number	*Abnormalities of the pancreas*				*Source of diagnosis*		
	Normal	*Dilated pancreatic duct*	*Ac. Pancr.*	*Chron. Pancr.*	*HD*	*ERCP*	*Pathology*
1		+				+	
2			+ (head)			+	+
3	+					+	
4				+		+	+
5			+ (head)			+	+
6							
7	+					+	
8							
9	+					+	
10				+	+		+
11	+				+		
12		+				+	

(1976). Indirect signs are very important in the detection of small tumours of the ampulla or papilla of Vater. These indirect signs are:

(i) Inflamed, rounded or prolapsed papilla of Vater.
(ii) Delayed efflux from the bile ducts and/or pancreatic duct to the duodenum.
(iii) Local abnormality of the pancreas, especially in the head.

In spite of early and accurate diagnosis, the curative operability remained less than 50% because of other factors. The survival rate after operation is uncertain, because of the short postoperative observation period. One patient, who was operated upon three years ago is in good health with no signs of recurrence.

Table IV. — Surgical procedure, final pathology and pertinent side-notes

Patient number	*Surgical procedure*		*Side-notes*	*Final pathology*							*Side-notes*
	Whipple	*Bypass*		*AC*	*ND*	*PD*	*MD*	*WD*	*MP*	*MMP*	
1	+					+					
2		+	Severe emphysema	+							
3	+					+					
4		+	Local excision in view of incurability		+						
5	+					+					Microscopic metastasis in the lymph nodes after removal of pancreas
6		+	Incurability			+	+		+		
7		+	Reimplant of CBD and pancreatic duct in view of old age and poor general condition				+			+	
8	+						+	+			Microscopic metastasis in the lymph nodes after removal of pancreas
9		+	Metastasis elsewhere								Obviously malignant during operation; no biopsy
10	+			+							
11			Patient died before operation	+							Generalised carcinomatosis
12			Patient refused operation								Per-endoscopic biopsy diagnostic

Explanation of the signs

AC Adenocarcinoma
ND Non-differentiated adenocarcinoma
PD Poorly differentiated adenocarcinoma
MD Moderately differentiated adenocarcinoma
WD Well-differentiated adenocarcinoma
MD Mucous producing adenocarcinoma
MMP Marked mucous-producing adenocarcinoma

Fig. 4. — Carcinoma of the papilla of Vater (hypotonic duodenogram). The papilla of Vater is markedly enlarged and shows irregular borders. There are many, little, sharp spikes and a necrotic ulcer (in the centre of the papilla).

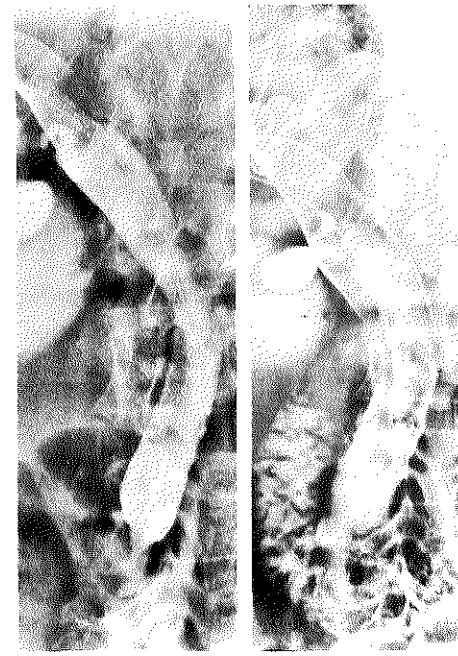

Fig. 5. — Carcinoma of the papilla of Vater.
a. *After PTC but before cannulation of the neoplasm there is no flow of contrast medium into the duodenum.*
b. *After cannulation with a thin catheter there is a profuse efflux of contrast medium into the duodenum.*

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CHAPTER III

A MATHEMATICAL APPROACH TO THE COMMON BILE DUCT

ABSTRACT

Changes in the shape of the common bile duct (CBD) can be expressed mathematically by measuring the C.B.D.-diameter at five points and expressing these measurements as a percentage of the mean diameter. Variations in magnification are compensated for by relating the mean diameter to the length of the C.B.D.. By comparing the shape of the C.B.D. in patients with various diseases with the shape of the normal common bile duct it was possible to define pathognomonic signs of various diseases of the extrahepatic biliary system. Indirect signs of pathology of the extrahepatic bile ducts are discussed.

EINE MATHEMATISCHE ANNÄHERUNG AN DEN DUCTUS CHOLEDOCHUS

Veränderungen der Gestalt des Ductus choledochus können mathematisch durch Messung des Gallengangsdurchmessers an 5 Punkten dargestellt werden, wobei diese Messungen als Prozentsatz des mittleren Durchmessers ausgedrückt werden. Schwankungen der Vergrößerung können dadurch kompensiert werden, daß der mittlere Durchmesser auf die Länge des Gallengangs bezogen wird. Durch Vergleich der Form des Gallengangs in Patienten mit verschiedenen Krankheiten mit der Form des Gallengangs bei gesunden Patienten ließen sich die Symptome verschiedener Krankheiten des extrahepatischen Gallengangssytems definieren. Indirekte pathologische Anzeichen der extrahepatischen Gallengänge werden diskutiert.

INTRODUCTION

Most diseases of the extrahepatic bile ducts are associated with changes in the shape of the common bile duct. Measurement of bile duct diameter is however unreliable due to varying magnifications with different techniques and in different individuals. In an attempt to provide objective criteria of changes in the common bile duct we have devised a technique in wich the diameter of the duct is related to its length. The shape of the bile duct can then be expressed mathematically. This method was applied to cholangiograms of a large group of patients with surgically or endoscopically confirmed diseases and compared with results obtained from the normal bile duct. The diagnostic value of changes in shape and filling of the bile duct and pancreatic duct could thus be evaluated.

PATIENTS AND METHODS

Cholangiograms of a 110 patients were examined. 19 patients had normal extrahepatic bile ducts and 91 had pathology in this area (Table 1).

The reason for cholangiography in the 19 patients with a normal extrahepatic bile duct was abdominal complaints, which were subsequently found to be caused by non-biliary diseases and which disappeared on treatment of the primary illness. The diagnosis of gallstones, stenosis of the papilla of Vater or stenosis of the bile ducts resulting from a common bile duct drain, were confirmed at operation in all patients. Malignancy of the papilla of Vater, intrinsic or extrinsic malignancy of the extrahepatic bile ducts, chronic pancreatis and sclerosing cholangitis was confirmed by histological examination in all cases. Oedema of the Papilla of Vater and distal bile fistula in the duodenum was seen on endoscopy.

One hundred and ten patients were investigated by means of endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTC), intra-

venous cholangiography (IVC) or T-drain cholangiography. Only those patients in whom the total length of the extrahepatic bile ducts was visible on the X-ray photo were included in this study. The patients, in whom this was not the case, for example due to malignant obstruction, were excluded. The length of the common bile duct was determined on an anteroposterior film by measuring the distance from the papilla of Vater to the point of transsection of the midlines of the right and left hepatic ducts and common bile duct at the bifurcation (Fig. 1).

The midline of the common bile duct (CBD) was subdivided into four equal parts resulting in five diameters (Fig. 1). The measured diameters (∅ I to ∅ V) were expressed in percentages of the length of the midline, thus compensating for the varying magnification factors at ERCP, PTC, IVC or T-drain cholangiography. The mean of these five diameters was determined per patient and is called the mean diameter of the CBD. The shape of the common bile duct can then be described by expressing each of the five measured diameters as a percentage of the mean diameter for that patient (Table 2).

To describe the relative length of the intrapapillary and extrahepatic, extrapapillary portion of the common bile duct, the measured intrapapillary and extrahepatic extrapapillary length in the midline are compared. The shape of the intrapapillary portion of the CBD is highly variable, but can be expressed according to the scheme given in Table 4 to 8.

The diameter of the normal pancreatic duct was measured in 30 patients at two positions in each segment (head, body and tail) and was corrected for the magnification factor. This is also given in Table 3. Finally the presence or absence of reflux from the bile duct or the ampulla of Vater to the pancreatic duct was reported and whether the pancreatic duct was dilated or not.

Table I. — Number, age, sex, history of cholecystectomy and presence of gallstones in the patient groups.

patient groups	*number of patients*	*mean age (years)*	*range (years)*	*men*	*women*	*cholecyst-ectomy*	*stones in gall-bladder*	*stones in bile duct*
normal extrahepic bile ducts	19	49	35-60	9	10	9	0	0
proximally wandering stones	18	68	28-81	9	9	10	7	18
distally wandering stones	23	63	33-80	12	11	13	6	23
impacted stones	9	61	43-78	6	3	1	8	9
distal fistula of the common bile duct	3	61	53-71	0	3	3	0	0
oedema of the papilla of Vater	4	52	34-68	2	2	2	0	0
stenosis of the papilla of Vater	3	68	61-75	1	2	3	0	0
malignancy of the papilla of Vater	10	58	36-78	3	7	3	?	1
malignancy in the hepatic hilus	4	62	50-77	1	3	1	?	0
sclerosing cholangitis	4	56	48-67	2	2	4	0	4
bile duct stenosis caused by T-drain	3	67	65-71	0	3	3	0	0
chronic pancreatic	7	48	40-59	7	0	2	1	0
bile duct invading malignancy	3	76	71-82	1	2	0	1	1

Table II. — The shape of the extrahepatic bile ducts in the various patient groups. The five diameters are expressed as a percentage of the mean diameter of the extrahepatic bile duct.

	Ø I		Ø II		Ø III		Ø IV		Ø V	
	mean	*p-value*	*mean*	*p-value*	*mean*	*p-value*	*mean*	*p-value*	*mean*	*p-value*
normal extrahepatic bile ducts	122 ± 14	—	112 ± 12	—	111 ± 12	—	110 ± 12	—	45 ± 22	—
proximally wandering stones	94 ± 30	0,002 < p p < 0.02	122 ± 20	> 0.10	128 ± 20	0.02 < p p < 0.05	122 ± 18	> 0.10	43 ± 25	> 0.10
distally wandering stones	103 ± 18	< 0.01	125 ± 15	≈ 0.05	121 ± 21	≈ 0.09	106 ± 20	≈ 0.9	44 ± 21	≈ 0.8
impacted stones	101 ± 31	0.05 < p p < 0.10	131 ± 26	> 0.10	114 ± 20	> 0.10	99 ± 16	> 0.10	56 ± 19	> 0.10
distal fistula of the common bile duct	92 ± 24	≈ 0.10	130 ± 11	> 0.10	122 ± 14	> 0.10	117 ± 12	> 0.10	38 ± 13	> 0.10
oedema of the papilla of Vater	122 ± 12	> 0.10	121 ± 16	> 0.10	115 ± 6	> 0.10	100 ± 12	> 0.10	41 ± 9	> 0.10
stenosis of the papilla of Vater	99 ± 18	> 0.10	148 ± 25	0.002 < p p < 0.02	125 ± 7	≈ 0.10	401 ± 510	> 0.10	27 ± 13	> 0.10
malignancy of the papilla of Vater	171 ± 291	0.002 < p p < 0.02	118 ± 14	> 0.10	118 ± 12	> 0.10	111 ± 12	> 0.10	72 ± 19	0.02 < p p < 0.05
malignancy in the hepatic hilus	2 ± 3	0.002 < p p < 0.02	161 ± 36	0.002 < p p < 0.02	138 ± 31	> 0.10	157 ± 14	0.002 < p p < 0.02	42 ± 8	> 0.10
sclerosing cholangitis	123 ± 23	> 0.10	121 ± 24	> 0.10	129 ± 43	> 0.10	84 ± 34	≈ 0.10	43 ± 22	> 0.10
bile duct stenosis caused by T-drain	106 ± 10	> 0.10	119 ± 3	> 0.10	108 ± 15	> 0.10	106 ± 16	> 0.10	60 ± 29	> 0.10
chronic pancreatitis	149 ± 44	> 0.10	170 ± 46	0.002 < p p < 0.02	107 ± 56	> 0.10	40 ± 38	0.002 < p p < 0.02	35 ± 33	> 0.10
bile duct invading malignancy	123 ± 8	> 0.10	103 ± 49	> 0.10	64 ± 18	≈ 0.10	151 ± 34	> 0.10	59 ± 42	> 0.10

Statistical methods (4)

The differences in the measurements between various groups of patients were tested by the Mann - Whitney U test for a two-tailed test.

P-values given refer to comparison between the patient group and the controls with the normal bile duct.

RESULTS

The following aspects of normal and pathological ducts were evaluated

- mean diameter
- shape (deviation)
- form of the intrapapillary part of the duct
- IP/EH coefficient
- reflux of contrast medium into the pancreatic duct
- dilatation of the pancreatic duct

Table III. — Diameters of the normal pancreatic duct after correction for magnification.

	Kasugai et al. (1972)	*Ogoshi et al. (1973)*	*Sivak and Sullivan (1976)*	*range this study (1980)*
caput pancreatis	3.4 mm	3.4 mm	3.2 mm	3.4 mm
corpus pancreatis	2.9 mm	2.9 mm	2.3 mm	2.8 mm
cauda pancreatis	2.0 mm	2.0 mm	1.2 mm	1.8 mm

Side note: The values given for the above reference articles are mean normal diameters.

The normal extrahepatic bile ducts (Table 4, Fig. 2)

The normal common bile duct is funnel-shaped, the diameters tapering off from one to five.

The intrapapillary part of the common bile duct is either concave or convex towards the lumen.

Reflux of contrast medium into the pancreatic duct or dilatation of the pancreatic duct was not seen in this group of patients.

The pathological extrahepatic bile ducts

The patients are divided according to the shape of their bile ducts into the following groups.

Gallstones and distal fistula of the CBD (Table 5, Fig. 3)

Gallstones

The largest group of patients with abnormal extrahepatic bile ducts has stones. This group was subdivided into the following three groups:

— *Proximally wandering stones* (Table 5, Fig. 3). The patients were classified into this group if the largest number of stones were be found between ∅ I and ∅ III. The majority of patients with proximally wandering stones who had not yet undergone cholecystectomy also had stones in the gallbladder (Table 1). Proximally wandering stones were in general larger than distally wandering stones.

The mean diameter of the CBD is significantly larger than normal in this group, although ∅ I is narrower and ∅ III larger than normal.

The intrapapillary part of the choledochus duct had a prolapsed or sawtoothed appearance. Reflux from the ampulla of Vater to the pancreatic duct occurred, and surprisingly the pancreatic duct was dilated in more than half of the patients.

— *Distally wandering stones* (Table 5, Fig. 3). The patients were classified in having distally wandering stones when the majority of the stones were to be found between ∅ III and ∅ V. In general distally wandering stones are smaller than proximally wandering stones.

Gall-bladder stones were not seen in all patients who hat not yet undergone cholecystectomy (Table 1). The mean diameter of the common bile duct is larger than normal, but ∅ I is smaller and ∅ II is larger than normal.

The intrapapillary portion of the duct is triangular, sharply angulated or prolapsed.

Dilatation of the pancreatic duct was also found in this group of patients.

— *Impacted stones* (Table 5, Fig. 3). The patients were included in this group when the stone was not movable preoperatively and when the surgeon found a fixed position at operation. Impacted stones occurred more often in men, and gall-bladder stones were almost always present (Table 1). The mean diameter of the extrahepatic ducts in the case of impacted stones was larger than normal and again the ∅ I was in general narrower than normal. The intrapapillary part of the common bile duct is usually difficult to see, but may be sawtoothed. In all patients the pancreatic duct showed an obvious dilatation.

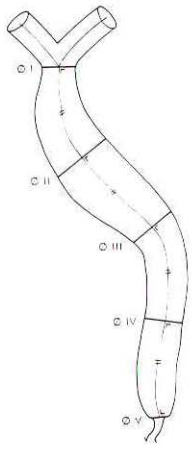

Fig. 1

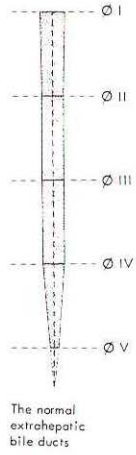

Fig. 2

Fig. 1. — Measurements of the extrahepatic bile ducts. The length of the common bile duct is the distance in the midline from the papilla of Vater to the point of transsection of the midlines of the right and left hepatic ducts and common bile duct at the bifurcation. The midline of the C.B.D. was subdivided into four equal parts resulting in five diameters (Ø I to Ø V).

Fig. 2. — The normal extrahepatic bile ducts. The normal, funnel-shaped extrahepatic bile ducts reconstructed from statistical data in the group of 19 patients with normal extrahepatic bile ducts.

Table IV. — The normal extrahepatic bile duct (n = 19). Mean Ø: 6.0 ± 1.4% (of the length of the E.H.B.D.).

shape: Ø I	7.32 (122 ± 14% of mean Ø)
Ø II	6.72 (112 ± 12% of mean Ø)
Ø III	6.66 (111 ± 12% of mean Ø)
Ø IV	6.60 (110 ± 12% of mean Ø)
Ø V	2.70 (45 ± 22% of mean Ø)
intrapapillary portion:	$^{9}/_{19}$ $^{10}/_{19}$
IP/EH coefficient:	0.12 ± 0.039
reflux into the pancreatic duct:	$^{0}/_{19}$
dilated pancreatic duct:	$^{0}/_{19}$

Table V. — Bile duct stones and distal fistula of the C.B.D.

	proximally wandering stones (n = 18)	*distally wandering stones (n = 23)*	*impacted stones (n = 7)*	*distul fistula of the common bile duct (n = 3)*
mean diameter	12.2 ± 3.1 (↑) (p < 0.002)	10.0 ± 2.4 (↑) (p < 0.0002)	12.5 ± 3.8 (↑) (p < 0.002)	13.7 ± 2.1 (↑) (p < 0.02)
shape deviation	Ø I < normal (0.002 < p < 0.02) Ø III > normal (0.02 < p < 0.5)	Ø I < normal (p < 0.01) Ø II > normal (p ≈ 0.05)	Ø I < normal (0.05 < p < 0.10)	no statistical significance
intrapapillary portion	6 5	7 8 3	4 3 miscellaneous	3
IP/EH coefficient	0.153 ± 0.057 (p > 0.10)	0.142 ± 0.063 (p ≈ 0.50)	0.124 ± 0.054 (p > 0.10)	0.177 ± 0.024 (↑) (0.02 < p > 0.05)
reflux into the pancreatic duct	$^{2}/_{18}$	$^{1}/_{23}$	$^{1}/_{9}$	$^{0}/_{3}$
dilated pancreatic duct	$^{5}/_{8}$	$^{7}/_{10}$	$^{4}/_{4}$	$^{0}/_{1}$

der than normal. The intrapapillary portion of the common bile duct usually has a saw-toothed appearance.
In all cases reflux occurred from the ampulla of Vater to the pancreatic duct, which was usually dilated.
— *Malignancy of the papilla of Vater* (Table 6, Fig. 4) (3). Malignancy of the papilla of Vater mainly was found in women (Table 1).
The common bile duct usually has a consistent diameter in these patients.
The mean diameter of the common bile duct is enlarged in these patients. Especially ∅ I and ∅ V.
The intrapapillary portion of the common bile duct is often bordered by irregular double contoured figures proximally, and the intrapapillary canal is excentric and very irregular given a broken stick appearance. A prolapsed appearance is also possible, and the tumor should be looked for in the prolapsed area. The IP/EH-coefficient is larger than normal. In half of the patients reflux occurred into the pancreatic duct and pancreatic duct was dilated in all patients.

Intrinsic pathology of the bile ducts.
— *Malignancy in the hepatic hilus* (Table 7, Fig. 5). A tumor in the hepatic hilus mainly occurred in women (Table 1). In most instances the gallbladder could not be visualised.
The bile ducts show a star-shaped stenosis in the area of the hepatic ducts, and the arms of the star do not reach the centre. The intrahepatic bile ducts are usually dilated.
The common bile duct is narrower in position I and often wider in position II and position IV. The intrapapillary portion of the duct is sawtoothed in shape. In all instances obvious reflux occurred from the ampulla of Vater to the pancreatic duct and in half of the patients the pancreatic duct was dilated.
— *Sclerosing cholangitis* (Table 7, Fig. 5). All patients with sclerosing cholangitis had undergone cholecystectomy and in addition all had bile sludge in the common bile ducts (Table 1). Stenosis and dilatation alternate at different levels. Often there are skip lesions.
The mean diameter of the common bile duct was larger than normal.
The shape of the common bile duct is so irregular and variable that a clear pattern is not obvious from the mean values. The intrapapillary portion of the bile duct is either tapered or shaped like an inverted funnel.
All patients had a dilated pancreatic duct.

Table VII. — Intrinsic pathology of the bile ducts.

	malignancy in the hepatic hilus (n = 4)	*sclerosing cholangitis (n = 4)*
mean diameter	7.6 ± 3.1 ($p > 0.10$)	10.9 ± 3.4 (1) ($p < 0.002$)
shape deformation	∅ I < normal ($0.002 < p < 0.02$) ∅ II > normal ($0.002 < p < 0.02$) ∅ IV > normal ($0.002 < p < 0.02$)	very irregular shape
intrapapillary portion	 4	 2  2
IP/EH coefficient	0.138 ± 0.040 ($p > 0.10$)	0.143 ± 0.025 ($p > 0.10$)
reflux into the pancreatic duct	$^{4}/_{4}$	$^{0}/_{4}$
dilated pancreatic duct	$^{2}/_{4}$	$^{2}/_{2}$

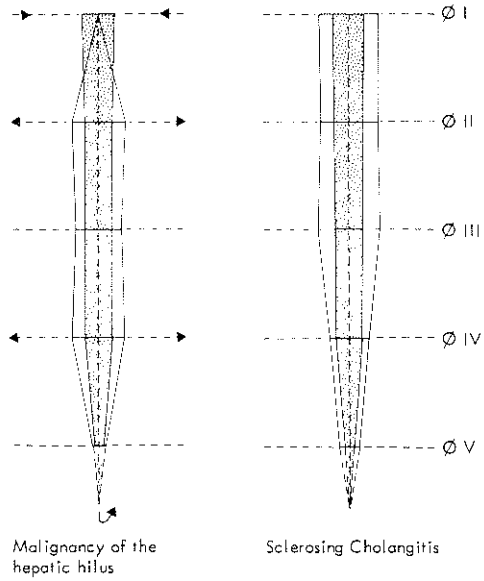

Fig. 5. — Intrinsic pathology of the bile ducts.
— Malignancy in the hepatic hilus: Star-shaped stenosis in the hepatic hilus (Ø I) and poststenotic dilatation of the C.B.D. (Ø II and Ø IV). Sawtoothed intrapapillary part. Reflux into the pancreatic duct in all patients.
— Sclerosing cholangitis: Enlargement of the mean diameter of the C.B.D.. Alternating stenosis and dilatation of the bile ducts. All patients had a dilated pancreatic duct.

Extrinsic pathology of the bile duct.
— Bile duct stenosis caused by T-drain (Table 8, Fig. 6). All our patients with T-drain stenosis were women who had undergone cholecystectomy. Gallstones were not demonstrated (Table 1).
The stenosis of the bile duct resulting from a common bile duct drain is a localised, smoothly bordered stenosis which can cause dilatation of the intrahepatic bile ducts.
The intrapapillary portion of the common bile duct is usually triangular.
In most patients reflux occurred from the ampulla of Vater to the pancreatic duct, the pancreatic duct however was not dilated.
— Bile duct stenosis caused by chronic pancreatitis (Table 8, Fig. 6). This type of stenosis was mainly observed in men (Table 1). Stenosis of the bile duct by chronic pancreatitis only occurs in patients with severe chronic pancreatitis (stage III and IV) in the head of the pancreas. This stenosis begins gradually, is relatively smoothly bordered and extends from a considerable length. The mean diameter of the common bile duct in these patients was within the normal limits.
This is due to the shape of the common bile duct; Ø II is markedly wider and Ø IV markedly narrower than normal (Table 2).
The intrapapillary portion of the CBD is shaped like a pipe or increases in diameter distally.
All patients had dilatations of the pancreatic duct, which in addition showed the typical characteristics of chronic pancreatitis (stenoses, dilatations and tortuosity).
— Bile duct invading malignancy (Table 8, Fig. 6). None of the patients had undergone cholecystectomy, and in most, stones were to be found in gall-bladder and bile ducts (Table 1). The stenosing tumors were all pancreas carcinomas. Usually there was an abrupt irregularly bordered stenosis which often extended over a longer portion of the duct than the intrinsic biliary tumors.

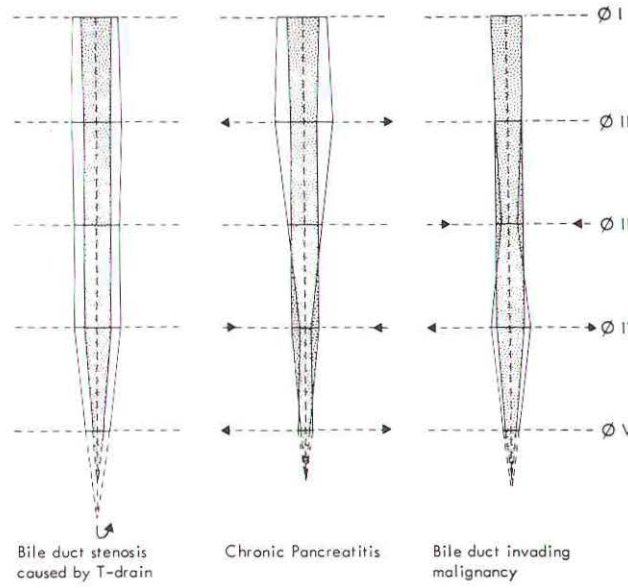

Fig. 6. — Extrinsic pathology of the bile ducts.
— Bile duct stenosis caused by T-drain: Smooth, localised narrowing of the bile duct. Reflux in pancreatic duct often present.
— Bile duct stenosis caused by chronic pancreatitis: Smoothly bordered stenosis extending for a considerable length (Ø IV) and a prestenotic dilatation (Ø II) of the C.B.D.. The dilated pancreatic duct shows typical characteristics of chronic pancreatitis (dilatations, stenosis and tortuosity).
— Bile duct invading malignancy: Irregularly bordered stenosis extending for a considerable length. Insufficient data for statistical analysis.

As the stenosing pancreas tumor could originate in the head, but also in the body of the pancreas, the group of patients is inhomogenous and the small number not suitable for statistical evaluation.

Table VIII. — Extrinsic pathology of the bile ducts.

	bile duct stenosis caused by T-drain (n = 3)	*bile duct stenosis caused by chronic pancreatitis (n = 7)*	*bile duct invading malignancy (n = 3)*
mean diameter	10.2 ± 4.7 (p > 0.10)	8.1 ± 4.6 (p > 0.10)	6.2 ± 1.3 (p > 0.10)
shape deviation	no abnormality	Ø II > normal (0.002 < p < 0.02) Ø IV < normal (0.002 < p < 0.02)	statistical insufficient (Ø III < normal)
intrapapillary portion	2 1	3 3	various
IP/EH coefficient	0.205 ± 0.094 (p > 0.10)	0.105 ± 0.040 (p > 0.10)	0.136 ± 0.102 (p > 0.10)
reflux into the pancreatic duct	2/3	0/7	0/3
dilated pancreatic duct	0/3	7/7	1/2

DISCUSSION

By comparing the width of the common bile duct with it's length it is possible to eliminate magnification factors which are used in the different investigations (ERCP, PTC, IVC and T-drain cholangiography). The effect of increasing pressure during introduction of contrast into the bile ducts (1) is also largely corrected by this technique.
However a common bile duct which is not visible over it's entire length can not be examined.
Small localised stenosis or dilatation are not recorded by the standard method, unless extra measurements are made at the site of the abnormality.
The standard deviation of the measurements of the common bile duct in the normal control population is smaller than that which is presented by the other authors (1, 2)
This description of the shape of the common bile duct can be used to demonstrate pathology which is not obvious at first glance - such as a migrating stone. The use of a computerised image analyser would improve this technique and allow automatic analysis in a much shorter time. This would be of value, especially in the case of small gallstones where the abnormal shape of the bile duct would lead to a more diligent search for the stone.
The intrapapillary portion of the common bile duct has a variable shape, but it is usually possible to differentiate between normal and pathological ducts. An increase in the IP/EH-coefficient and reflux into the pancreatic duct are not chance findings but signs of bile duct pathology.
Although it is generally accepted that the diameter of the pancreatic duct increases with age, the findings in this group of patients suggest that this dilatation is often associated with biliary disease.

ACKNOWLEDGEMENTS

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CHAPTER IV

PANCREATIC FISTULAS

ABSTRACT

During a retrospective analysis of about 1000 ERCP investigations pancreatic fistulas were found in 14 patients. There is a relationship between proximal stenosis of the pancreatic duct, inflammatory cavities of the pancreas and the development of fistulas. Pancreatic fistulas can be blind, can open into various spaces in the body or can be attached to the abdominal wall. The associated pathology in patients with pancreatic fistulas is often severe and involves the whole pancreas.

BAUCHSPEICHELDRÜSENFISTELN

Im Verlauf einer retrospektiven Analyse von 1000 endoskopischen retrograden Cholangiopankreatographien stellten wir bei 14 Patienten das Vorhandensein von Bauchspeicheldrüsenfisteln fest. Es besteht eine Beziehung zwischen der proximalen Stenose des Bauchspeicheldrüsengangs, der entzündeten Bauchspeicheldrüsenhöhle und der Entwicklung von Fisteln. Pankreasfisteln können entweder "blind" sein oder Öffnungen aufweisen, die auf verschiedene Körperhöhlen gerichtet sind; sie können auch an der Bauchwand auftreten. Die in Patienten mit Pankreasfisteln dabei auftretenden pathologischen Erscheinungen sind oft sehr ernster Natur und betreffen die gesamte Bauchspeicheldrüse.

INTRODUCTION

Pancreatic fistulas have mainly been reported as a complication of surgery of the pancreas or surrounding organs (4). With the introduction of endoscopic retrograde cholangiopancreatography (ERCP) we have observed pancreatic fistulas in the non-operated patient, usually in patients with severe chronic pancreatitis. As the radiological changes associated with pancreatic fistulas are poorly documented in the literature, we felt it would be of interest to present the results of a retrospective analysis of the clinical and radiological findings in 14 patients with radiologically documented pancreatic fistulas.

MATERIALS AND METHODS

About 1000 consecutive ERCP's performed during the period of 1973 to 1979 were examined for the presence of pancreatic fistulas. Fourteen patients were found; the incidence of pancreatic fistulas in severe pancreatitis was approximately 5%. The mean age of the patients with a pancreatic fistula was 46 years, with the range of 33-59 years. There were 11 men and 3 women.

RESULTS

Symptoms and signs

The most important clinical findings are presented in table 1. In three patients who had a pancreatic fistula leading to the skin the attacks developed when the fistula dried up, and the attacks ended when the fistula again began to leak a fluid with high amylase content.

Radiological findings

All fistulas were demonstrated by means of ERCP. Those pancreatic fistulas which connected with the skin were also filled via the external opening. From the 14 patients with pancreatic fistulas 8 patients had a single and 6 patients multiple fistulas (Table 2). The

three woman all had a single fistula. The fistulas started in the head of the pancreas in 5 patients, in 6 patients in the body of the pancreas and in 4 patients in the tail of the pancreas (Table 2). There was no obvious relationship between the site of origin of the fistula in the pancreas and its nature, either simple or complex.

Local pancreas pathology and fistula formation
According to Davis (1969) and our own findings there is a relationship between proximal stenosis of the pancreatic duct and localisation of the fistula (Fig. 2). In addition there appears to be a relationship between the presence of inflammatory cavities of the pancreas and the development of fistulas (6).

Table 3 shows the site of origin of the pancreatic fistulas and associated pancreatic changes. As in some patients more than one fistula was present and more than one associated change was present, the total in this and in other tables may exceed 14. The cavities were abscesses in 6 of 7 patients and in 1 of the 7 an inflammed pseudo-cyst (Fig. 1).

Endpoint of the pancreatic fistulas
Pancreatic fistulas can be blind, can open into various spaces in the body (Fig. 2, 3, 4 and 5) or can be attached to the abdominal wall. The position of the pancreatic fistulas which were visualised is shown in table 4. Abscesses are often associated with the development of multiple blind fistulas which are not easy to quantitate. In such situations the lesions are reported as being one fistula.
Fistulas which end in a cavity in the pancreas often derive from the head of the pancreas. Fistulas which have a blind ending or end in a subphrenic space (Fig. 4), pleural cavity or mediastinum (Fig. 5) derive from the body of the pancreas. Fistulas which end in a space in the abdomen often derive from the tail of the pancreas (Fig. 1). The associated pathology in patients with pancreatic fistulas is often severe and involves the whole pancreas (Table 5). These patients often have in addition, extensive extra-pancreatic changes.

Table I. — Clinical aspects of patients with pancreatic fistulas.

attacks of colickly and irradiating pain in abdomen	12 of 12
fever	10 of 12
leucocytosis	9 of 14

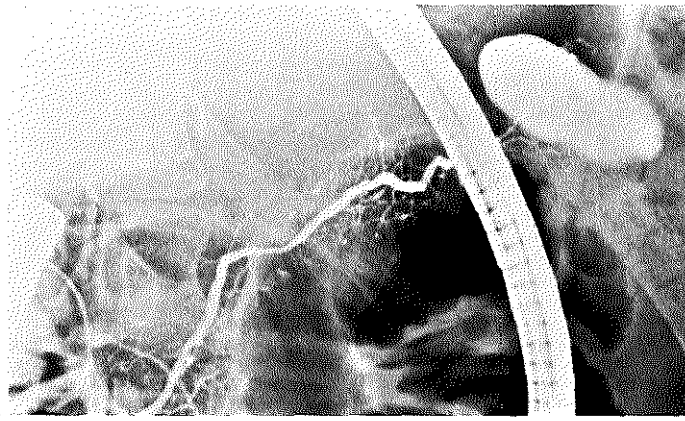
Table II. — Simple and complex fistula of the pancreas.

	head	*body*	*tail*
simple fistula	3	3	2
complex fistula	2	3	2

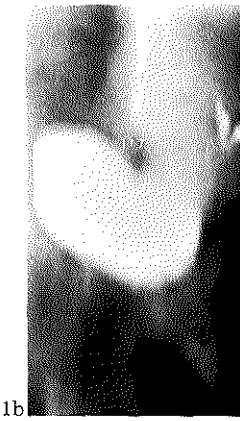
Table III. — Associated lesions and site of origin of the pancreatic fistula.

lesion in the pancreas	*number of patients*
cavity in the pancreas distal to a pancreatic duct stenosis resulting from chronic pancreatitis	7
distal to a pancreatic duct stenosis resulting from inflammatory tumor	3
distal to a pancreatic duct obstruction by stone	1
distal to a pancreatic duct stenosis due to carcinoma	1
unknown	3

In addition to these patients we have had one patient with a pancreatico-bronchial fistula (2, 3), but this patient was however too ill to undergo an ERCP. Another patient with a fistula between the pancreas and perineum also did not undergo ERCP.



1a



1b

Fig. 1. — Patient with chronic alcoholic pancreatitis of moderate severity and acute exacerbation in the distal part of the pancreas.

Fig. 1a. — In the tail of the pancreas there is an ill defined cavity with an extension fixed to the stomach.

Fig. 1b. — The planigram of the filled cavity shows two small blind fistulas at the left side.

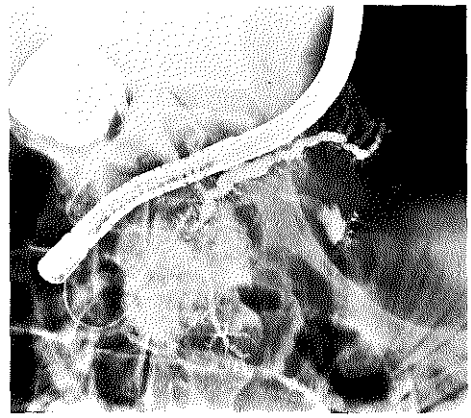


Fig. 2. — Patient with necrotic malignancy in the head of the pancreas and chronic pancreatitis in the distal part (body and tail) of the pancreas. The pancreatic duct is stenosed in the head of the pancreas. There is a fistula from the pancreatic duct (body) to the jejunum.

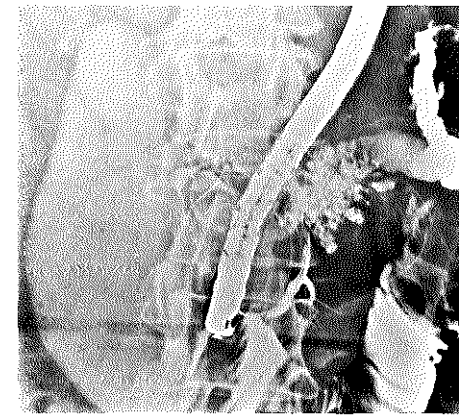


Fig. 3. — The pancreatic duct is normal in the head of the pancreas Stenosis of the pancreatic duct caused by malignancy in the body of the pancreas. Severe chronic pancreatitis in the distal part of the pancreas. Tumor-invasion in the ligament of Treitz. Fistula from pancreatic neoplasm (distal to the beginning of the stenosis) to the gallbladder.

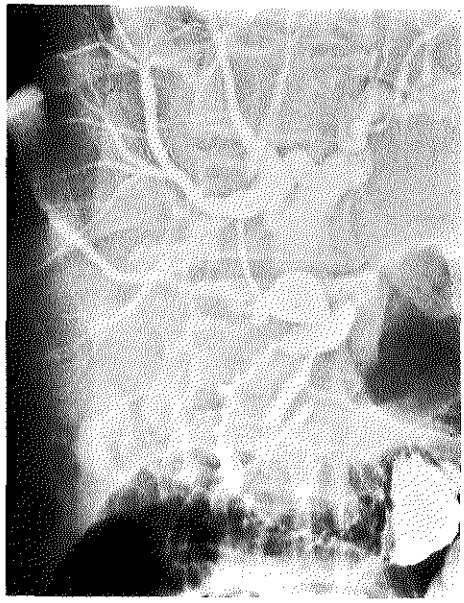


Fig. 4a. — Patient with malignancy on the junction of the head and the body of the pancreas. Distal to the site of the stenosis there is an abscess. Fistula from abscess laterally to the right and the subphrenic.

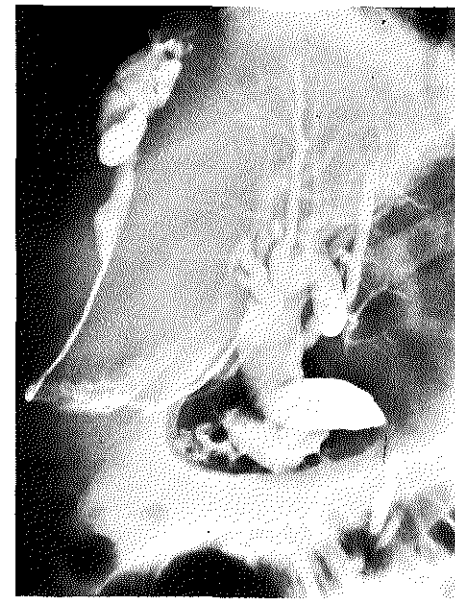
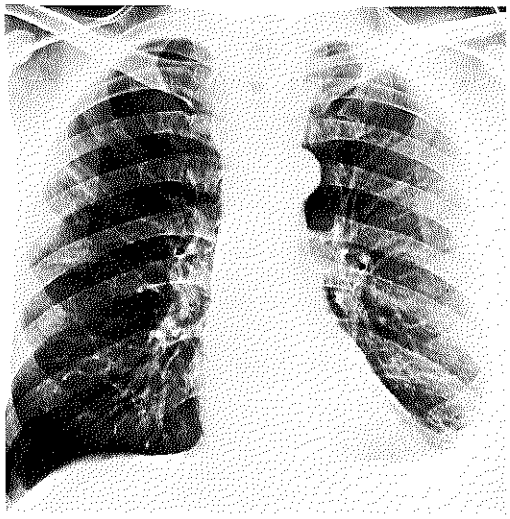
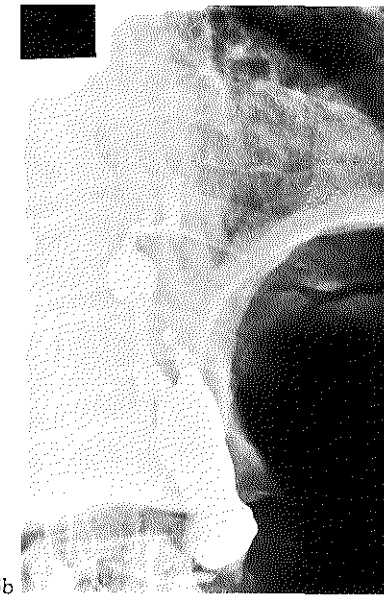


Fig. 4b. — On the lateral view there is a multiformed cavity under the right hemidiaphragm.



5a

Fig. 5a. — Patient with recurrent pleural fluid at the left side.



5b

Fig. 5b. — Moderate chronic pancreatitis. Stenosis of the pancreatic duct (in the head of the pancreas) not visible on this picture. Fistula orginates from the junction of the body and tail of the pancreas. This fistula is complicated by several other fistulas. There is an intrathoracic cyst.

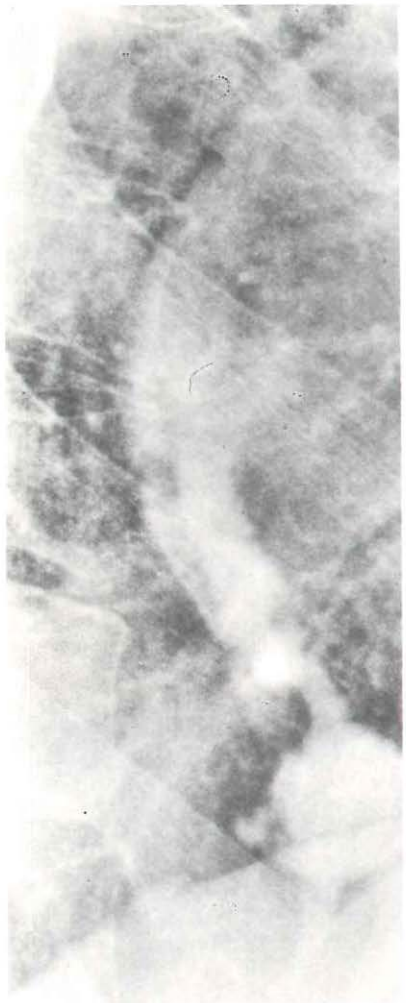


Fig. 5c. — The wall of the cyst is visible by contrast medium coming from the pancreatic duct.

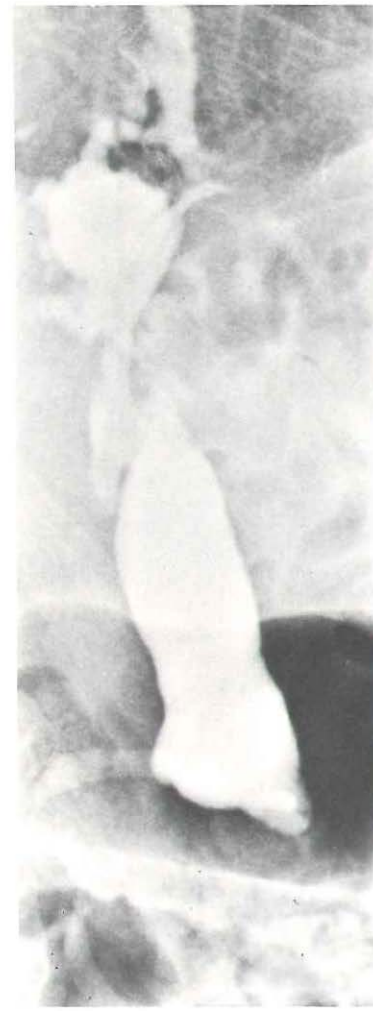


Fig. 5d. — Just above the left diaphragm there is a cavity with several fistulas. At least one fistula has a connection with the interpleural space.

Table IV. — Distal end of the pancreatic fistulas in relation to their site of origin in the pancreas.

distal end	*number of fistulas*	*site or origin*		
		head	*body*	*tail*
blind ending	4	1	3	0
cavity in the pancreas	4	3	1	0
abdominal cavity	4	0	0	4
subphrenic space	2	0	2	0
gallbladder	2	1	1	0
jejunum	1	0	1	0
pleural cavity	2	0	2	0
mediastinum	2	0	2	0
abdominal wall and skin	3	2	1	0

Table V. — Abnormalities of the pancreas associated with pancreatic fistulas.

pat. no.	*head of the pancreas*	*body of the pancreas*	*tail of the pancreas*
1	C.P. II-III	backpressure	backpressure
2	C.P. IV	C.P. IV	not diagnostic
3	inflammatory tumor abscess	C.P. IV	C.P. IV
4	C.P. II abscess	C.P. II	C.P. IV
5	A.P. abscess	postoperative appearances after distal pancreatectomy	
6	malignant tumor	abscess	C.P. IV
7	C.P. IV abscess, stones	technically not diagnostic	
8	malignant tumor	C.P. IV	C.P. IV
9	A.P. abscess	A.P.	A.P.
10	C.P. I	C.P. II	abscess
11	C.P. IV	C.P. IV inflammatory tumor	C.P. IV
12	C.P. III	C.P. III	C.P. III abscess
13	2 cavities	C.P. II	C.P. II
14	N.A.D	malignant tumor	C.P. IV

Explanation of the signs: C.P. I, II, III or IV = chronic pancreatitis stade I, II, III or IV; A.P. = acute pancreatitis; N.A.D. = no abnormality denoted.

DISCUSSION

Pancreatic fistulas were seen in our group more often in men than in women. The associated pathology in these patients is often so complex that is is almost impossible to determine which symptoms and signs are due to pancreas pathology and which are due to fistulas.

The fistulas demonstrated by ERCP were in most instances also found during laparotomy. In three of the operated patients the fistula was not found at the time of the laparotomy. This might be due to spontaneous closure of the fistula (4), but is more likely due to difficulties in defining the anatomy in a severely inflamed area.

The number and the extent of the fistulas which can be demonstrated is largely dependent upon the amount of contrast fluid used and the pressure with which this contrast fluid is injected into the pancreatic duct. Although there is a danger of overinjecting the pancreatic duct and fistulas, if one applies continuous low pressure the risk is also low. The tendency to form fistulas is great whenever the duct system is stenosed (2). In addition fistulas can start in abscesses. It is of interest that fistulas starting in the body of the pancreas often show marked cranial extension whereas the fistulas developing from the tail of the pancreas extent caudally into the abdominal cavity.

Pancreatic fluid leaking via a fistula to a cavity causes inflammation and sepsis is possible (1); surgery is therefore indicated. The ERCP diagnosis of fistula and its extension aids the surgeon in planning his operative approach (1).

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CHAPTER V

DIAGNOSTIC FEATURES OF CHRONIC PANCREATITIS DISTAL TO BENIGN AND TO MALIGNANT PANCREATIC DUCT OBSTRUCTION

KEY WORDS

Endoscopic retrograde pancreatography · Pancreatic duct obstruction · Pancreas carcinoma · Chronic pancreatitis.

ABSTRACT

Differentiation between diffuse chronic pancreatitis and pancreatitis distal to a malignant or benign stenosis has important prognostic and therapeutic implications. We examined the retrograde pancreatograms of 64 patients with histologically confirmed diagnosis of diffuse chronic pancreatitis, chronic pancreatitis distal to a benign tumor and chronic pancreatitis distal to a malignant tumor. The nature of the stenosis was often difficult to determine from the shape of the pancreatic duct only. By using discriminant analysis it was possible to determine an allocation rule based on 8 criteria mainly derived from changes in the pancreatic ductuli. This allocation rule allowed the correct diagnosis to be made in 24 out of 26 patients with diffuse chronic pancreatitis (92%), 19 out of 20 patients with pancreatitis distal to a benign tumor (95%) and all 18 patients (100%) with pancreatitis distal to a malignancy.

INTRODUCTION

The radiological findings in chronic pancreatitis have been well described in recent years [1, 5, 6]. In addition to chronic pancreatitis occurring without duct obstruction (CPO), chronic pancreatitis may develop distal to a malignant (CPM) or benign (CPB) tumor or stenosis. These three types of chronic pancreatitis can usually be distinguished by their radiological appearance, but the nature of the pancreas tumor causing the obstruction is often difficult to define on the basis of the shape of the stenosis [3, 7]. In some instances the tumor is so small that it is easily missed. Differentiation between these three subtypes of chronic pancreatitis has important therapeutic and prognostic implications. We therefore decided to analyze the pancreatograms of a group of patients with chronic pancreatitis in an attempt to define objective criteria for the three groups. As differentiation was not possible using any single criterium, we used linear discriminant analysis to determine whether combinations of criteria might allow accurate diagnosis [4].

PATIENTS AND METHODS

Patients

During the period from 1973 to 1979 26 patients with CPO, 18 patients with CPM and 20 patients with CPB underwent endoscopic retrograde pancreatography and subsequently

Table I. — Number of patients, sex and age distribution in the three groups.

	Number of patients	*Sex*		*Mean age (years)*	*Range of age (years)*
		male	*female*		
CPO	26	21	5	42	23-76
CPM	18	10	8	58	46-70
CPB	20	16	4	41	27-69

had the diagnosis of the pancreas disease determined by histological examination of resected tissue. The age and sex distribution of the patients is given in table I.

Methods

Endoscopic retrograde pancreatography was performed in collaboration with Dr. *M. van Blankenstein* and Dr. *J. Dees,* using Conray 70 as contrast medium. The resulting pancreatograms were evaluated and scored for the presence or abscence of criteria, which were mainly related to changes in shape, contour and diameter of the ductuli (table II). A steno-

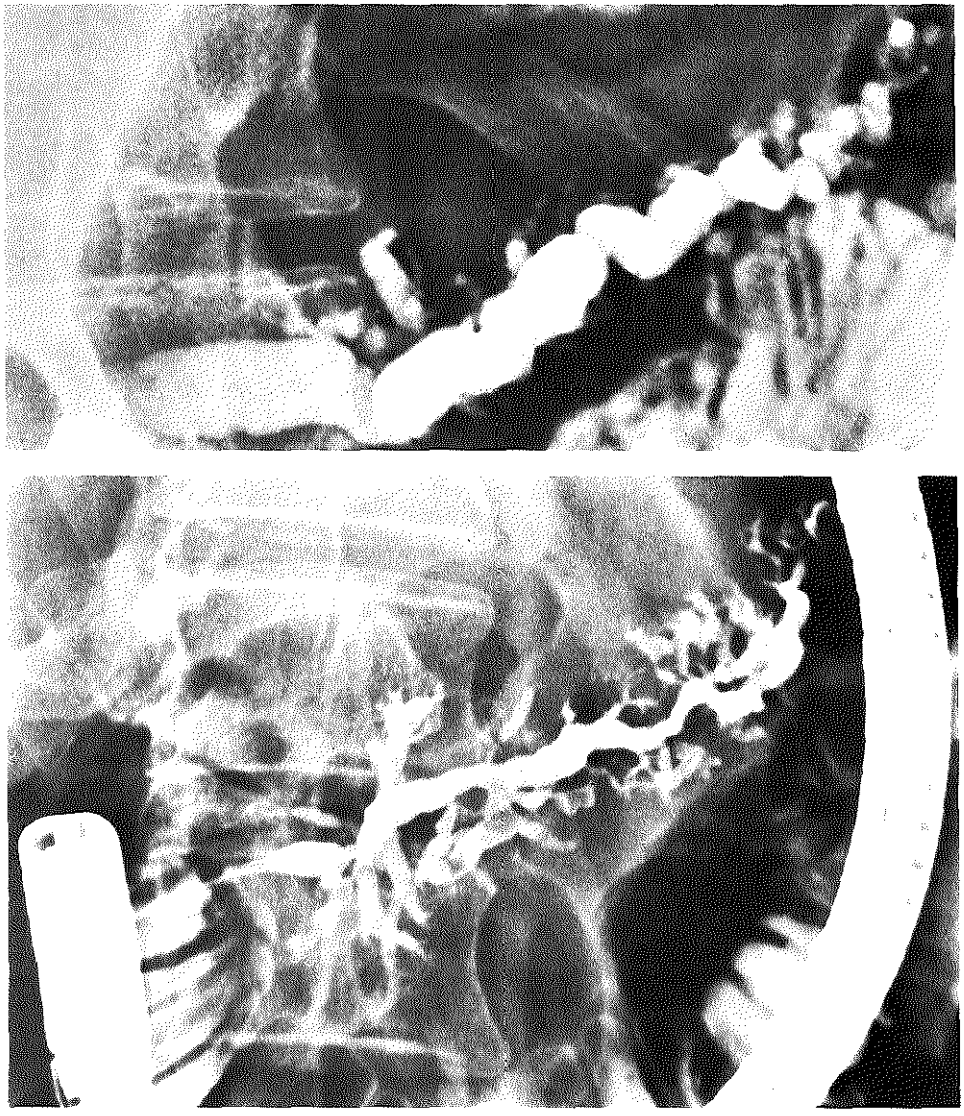
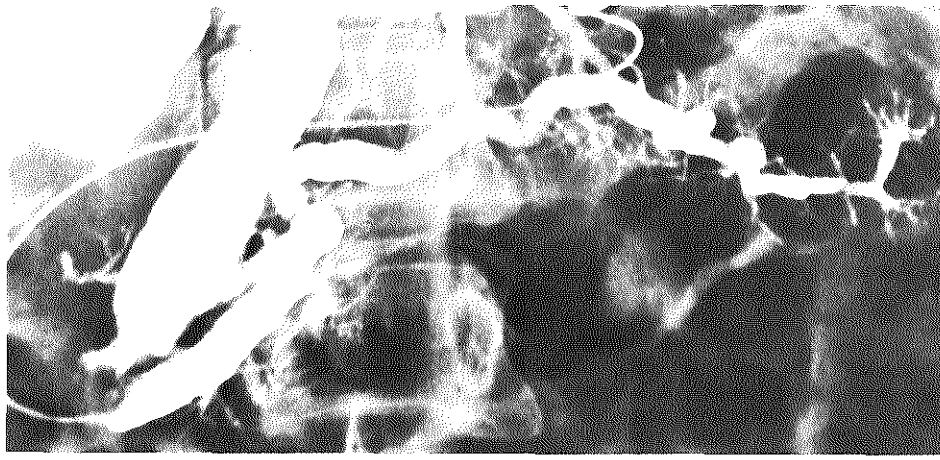


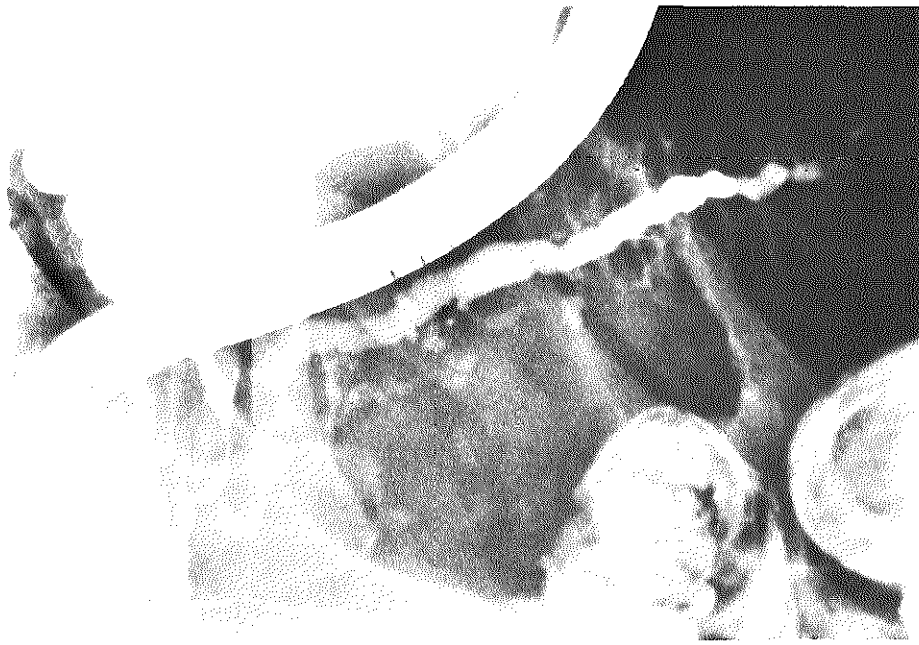
Fig. 1. — Chronic pancreatitis without obstruction.
a. *Dilated pancreatic duct with stenoses, dilatations and tortuosities. Reduced number of funnel-shaped ductuli with junctional stenosis, ductular stenoses, dilatations and some branching. Clearly dilated ductuli with a high dD ratio. Some nonopaque stones are present proximally in the pancreatic duct.*
b. *Severe chronic pancreatitis with stones in the pancreatic duct and side branches. Note junctional stenosis and funnel-shaped ductuli.*

sis localised to the junction of a ductulus with the pancreatic duct was called a junction stenosis (fig. 1).

Diameters of the pancreatic ductuli were measured by means of a nonius on pancreatograms enlarged ten times by projection by overhead projector onto a screen. The diameters of the ductuli (d) were expressed as a percentage of the diameter of the main pancreatic duct (D) in the same segment of the pancreas (head, body or tail). The use of the dD ratio diminishes the effects of a variable magnification factor.

a





b

Fig. 2. — Chronic pancreatitis distal to malignancy.
a. *Chronic pancreatitis distal to malignancy in the papilla of Vater. Pancreatic duct with slight stenoses, dilatations, tortuosities and an irregular diameter. Relatively lance-shaped and smooth bordered ductuli with minimal stenoses and dilatations. The dD ratio is lower than in CPO and CPB.*
b. *Chronic pancreatitis distal to malignancy in the head of the pancreas. Branching ductuli without obvious tortuosity. Local ductular stenosis and dilatation.*

Table V. — Allocation results based on classification functions Z_1, Z_2, Z_3

True diagnosis	*Allocated diagnosis*			
	CPO	*CPM*	*CPB*	*total*
CPO	24	0	2	26
CPM	0	18	0	18
CPB	1	0	19	20

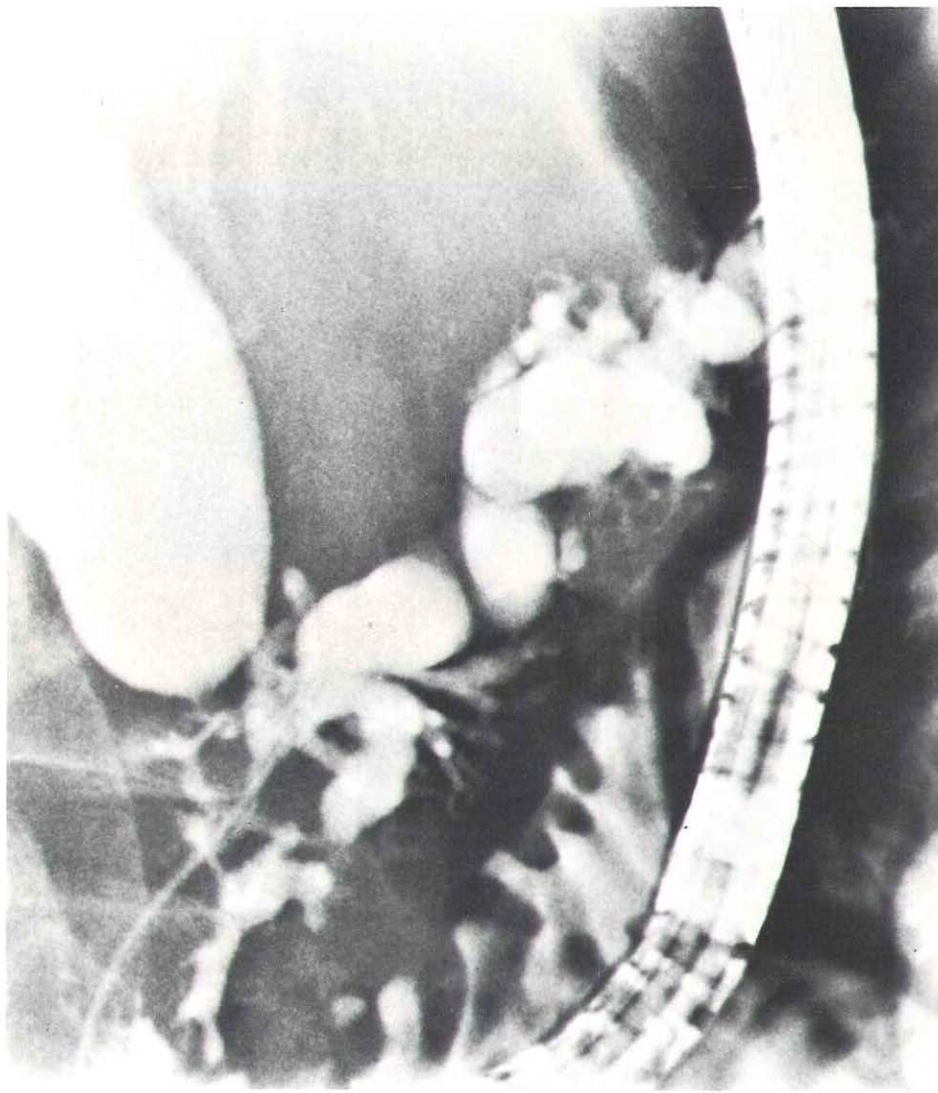


Fig. 3. — Chronic pancreatitis distal to a benign stenosis. Junctionally stenosed, funnel-shaped and branching ductuli. The dD ratio is greater than in CPM and smaller than in CPO.

DISCUSSION

In the literature [2, 3, 7, 8] changes in the pancreatic duct have been extensively described in relation to benign or malignant stenoses. However, this study suggests that ductular changes have an even greater diagnostic value. Another interesting finding is that although calcifications may be seen in the region of the tumor itself, they were never observed distal to the tumor on the plain abdomen radiogram or during pancreatography.
By using discriminant analysis we were able to calculate an allocation rule which correctly assigned 100% of the patients with a malignant stenosis. It should, however, be pointed out that this allocation rule should be tested in a new patient population. Evaluation of such a rule in the same patient group from which the initial data were obtained tends to give a more favorable result. In chronic pancreatitis, ductular changes are more pronounced than changes in the pancreatic duct. If the ductular abnormalities are limited in comparison with the duct changes, if ductular junction stenosis is absent and the dD ratio is low, then one must be highly suspicious of a malignancy proximal to the chronic pancreatitis changes.

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CHAPTER VI

SPACE-OCCUPYING LESIONS IN THE TAIL OF THE PANCREAS

KEY WORDS

Space-occupying lesion in the tail of the pancreas · Plain abdomen film · Barium enema · Barium study of the upper gastrointestinal tract · Hypotonic duodenography · Endoscopic retrograde pancreatography.

ABSTRACT

Most patients referred for an ERCP arrived with a large package of X-rays, the result of diverse routine investigations. On re-examination of these radiographs it was usually possible to make a diagnosis before performing the ERCP. In this article we analyze the value of several investigating methods used in 36 patients with a space-occupying lesion in the tail of the pancreas. Attention is paid to radiological changes suggestive of pathology in this area.

INTRODUCTION

In recent years, due to the introduction of new techniques, the pancreas has become an organ accessible to detailed radiological examination. This has led to increased awareness of early symptoms and radiological signs of pancreatic disease. Disease processes in the tail of the pancreas do not often cause complaints obviously connected with the pancreas, and such complaints may only occur when the disease has spread to the rest of the organ. In this article we describe the radiological signs which suggest the presence of a space-occupying lesion (SOL) of the tail of the pancreas, based on a series of 36 patients with a SOL in the tail of the pancreas.

Patients and Methods

36 patients with a SOL of the pancreatic tail were seen in the period from 1973-1978. The main indication for the investigation was symptoms suggestive of pathology of the pancreas. Most patients had already undergone the following examinations: chest radiograph [*Eaton and Ferrucci,* 1973]; plain abdomen film [*Meyers,* 1976]; intravenous pyelogram [*Gorder and Stargardter,* 1969]; barium meal [*Mani et al.,* 1966]; hypotonic duodenography [*Eaton and Ferrucci,* 1973]; barium enema [*Shockman and Marasco,* 1967]. The diagnostic workup was extended to echography and endoscopic retrograde cholangiopancreatography, and when necessary, superselective angiography. As ERCP was the most reliable, the results of the basic diagnostic programme have been compared with the ERCP, in addition to surgical and pathological diagnosis when available. The patients were classified according to ERCP criteria.

The SOL's in the tail of the pancreas are divided into solid lesions and cavities. The cavities have been subdivided into regularly bordered (pseudocysts and cysts) and irregularly bordered (abscesses). The solid processes have been subdivided into inflammatory tumors (swelling with visualization of the parenchyma) and malignant tumors (solid masses). In addition there is a small miscellaneous group comprising patients with hematoma and nonruptured aneursysm of the splenic artery.

RESULTS

The ages and sex of the patients in various groups are shown in table I, the symptons and signs in table II.

Table I. — Ages and sex of the patients with a SOL in the tail of the pancreas.

Disease	*Mean age (years)*	*Range (years)*	*Sex*	
			males	*females*
(Pseudo)cyst	37.0	2-67	7	5
Abscess	52.1	31-66	8	0
Inflammatory tumor	59.5	46-70	5	1
Malignant tumor	58.5	40-73	5	1
Hematoma	20.5	12-28	2	0
Nonruptured aneurysm of the lienalis art.	55.8	47-64	0	2

Table II. — Symptoms, signs and laboratory of the patients with a (pseudo)cyst, abscess, inflammatory tumor and malignant tumor in the tail of the pancreas.

Disease	*(Pseudo)cyst (n = 12)*	*Abscess (n = 8)*	*Inflammatory tumor (n = 6)*	*Malignant tumor (n = 6)*
Symptoms				
Nausea - vomiting	7/11	3/6	2/6	1/6
Food intolerance	1/9	2/7	1/6	3/6
Pain	7/11	7/8	4/6	5/6
Diarrhea	3/7	3/6	0/5	1/5
Constipation	1/7	0/6	0/5	3/5
Signs				
Palpable tumor	5/9	2/7	0/6	1/5
Bruit	5/9	3/6	0/6	0/5
Weight loss	6/9	4/6	3/5	5/6
Fever	5/12	6/7	4/6	1/6
Diabetes mellitus	3/10	2/5	1/6	3/6
Splenomegaly	1/10	2/7	2/6	0/5
Pleural fluid	2/7	4/6	1/6	0/6
Thrombophlebitis migrans, lung embolism	3/9	0/3	3/6	0/6
Laboratory				
Increased BSE	9/11	6/8	6/6	2/5
Anemia	6/12	6/8	2/6	0/6
Increased amylase level in urine	6/7	4/7	4/6	0/3
Increased amylase level in blood	5/7	4/8	3/5	1/4
Occult blood in the feces	2/7	2/4	2/4	1/5

Number of patients in parentheses

Clinical Data

As can be seen from table II the main clinical characteristics of patients with a pseudocyst in the tail of the pancreas are nausea and vomiting, attacks of sharp or cramping pain in the upper abdomen radiating to the back, and relieved by changing position. In general the frequency of attacks increased progressively. A small number had diarrhea. A palpable tumor was found in more than half of the patients, and this was often associated with a bruit. The amylase levels in urine and blood were increased considerably during the pain attacks. The main clinical characteristics of patients with an abscess in the tail of the pancreas are attacks of sharp nagging pain in the upper abdomen, which is also relieved by change of position. A limited number had diarrhea and fever was present in nearly all patients. Most patients had pleural fluid and anemia. The main clinical features in pa-

tients with inflammatory infiltration in the tail of the pancreas are periods of nagging pain in epigastrium which was seldom relieved by changing position. Thrombophlebitis migrans and lung emboli occurred in 3 out of 6 patients with pancreatitis of the pancreatic tail and 3 out of 9 patients with pseudocysts and in none of the patients with tumors. The main clinical characteristics of patients with malignancy in the tail of the pancreas are food intolerance in about half and continuous pain often described in dramatic terms as boring, gnawing or a raw sensation. Changing position had no effect on the pain. 3 out of 6 patients complained of constipation starting 6 months to 1 year before the diagnosis was made. 3 out of 6 patients had diabetes mellitus.

General Radiographic Changes

General radiographic changes found in the various investigations used in the basic programme are summarized in table III. A SOL in the tail of the pancreas is suggested by change in the position of the left diaphragmatic dome and by reduced mobility of the left diaphragma, visible on in- and expiratory films or during fluoroscopy.

The presence of a SOL is then also suggested by finding left and right kidney at the same level, due to displacement of the left kidney [*Gorder and Stargardter,* 1967]. Local calcifications (fig. 4a, c, d) and densities (fig. 2a, 4c) in the pancreatic area may also be found. Changes of the intra-abdominal part of the esophagus may also occur [*Eaton and Ferrucci,* 1973]. It may be seen as a straight line, or as a curved line convex ventrally and to the left. The stomach is often displaced: either laterally (fig. 2a) or medially. In lateral deviation the curvature is displaced starting at the cardia (fig. 2a). When deviated medially the curvature is projected over the lumbar spine. Ventral displacement of the stomach was seen in 22 out of 25 patients causing a local enlargement of the retrogastric space (fig. 1b, 4c) or a cascade [*Poole,* 1970; *Seaman et al.,* 1974]. It is important to take a lateral photo to demonstrate this. A local enlargement of the retrogastric space may also be visible on the PA view after the barium meal, as spreading of the mucosa folds (fig. 1a). Sometimes the stomach fundus appears to have two borders (fig. 2a). Changes in the border of the great curvature was seen in malignancy and in hematoma of the pancreas [*Shockman and Marasco,* 1967]. The distance between the stomach and the colon was locally increased in absesses, trauma and malignancy [*Mani et al.,* 1966]. The ascending part of the duodenum may also be deviated (fig. 2a, 5a, 6, 7) or show an impression (fig. 4d, 6).

The flexure of Treitz is nearly always displaced caudally (fig. 4d, 5a) and medially (fig. 5a), sometimes ventrally. Impression of the flexure of Treitz (fig. 2a, 6) may also be seen. Changes in the contours of the duodenum are specially seen in malignancy (fig. 4d, 6). A sentinel loop and colon cut-off sign were seen only in abscesses in this material. Barium enema shows in a majority of patients a deviation and impression of the transverse colon in the area where the transverse colon rises to the splenic flexure which changes with the position of the patient (fig. 5b). The splenic flexure itself may also be displaced laterally or folded over on itself medially. 14 of the 22 patients showed an impression of the splenic flexure. Changes in the borders of the colon was seen only in malignancy (fig. 5b). Changes in the colon in the splenic area are variable in the SOL in the tail of the pancreas and in some patients these changes are dependent on the position of the patient of may only be seen on maximal filling of the colon.

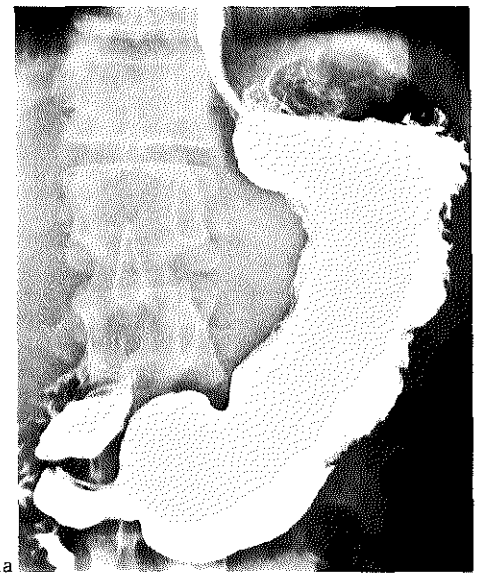
ERCP Findings in SOL in the Tail of the Pancreas

Pseudocysts (table IV). The diagnosis was confirmed at operation in all 8 operated patients. In 7 out of 10 who had undergone ERCP, a rounded or oval solitary cavity with a smooth border was seen, 1 patient had a lobulated, solitary cavity with a smooth border and 2 patients had multiple cavities with smooth borders. The cavity was found to have a connection with the ductal system in 7 out of 10 patients (fig. 1d), in 3 out of 10 the cavity was not

Table III. — Radiological changes of extrapancreatic structures caused by a SOL in the tail of the pancreas.

Disease	*(Pseudo)cyst*	*Abscess*	*Inflammatory tumor*	*Malignant tumor*
Left and right diaphragmatic dome at the same level	3/11	2/7	4/6	0/5
Left diaphragmatic dome higher than the right	5/11	3/7	1/6	2/5
Soft tissue density	7/12	4/8	2/5	2/3
Calcifications in pancreas	3/12	2/7	0/6	2/3
Left and right kidney at the same level	2/5	0/2	2/3	1/3
Left kidney at the lower level than the right	2/5	1/2	0/3	1/3
Displacement of the left kidney	4/5	1/2	1/3	1/3
Displacement of esophagus	3/11	1/5	0/5	2/5
Stomach displaced laterally	6/11	4/5	3/5	3/5
Stomach displaced medially	5/11	1/5	2/5	1/5
Stomach displaced ventrally	8/11	4/4	5/5	5/5
Stomach displaced cranially	4/11	2/5	0/5	3/4
Local enlargement of the retrogastric space	8/11	4/4	5/5	5/5
Impression of the stomach	7/10	5/5	4/5	5/5
Changes in the border of the stomach	0/11	0/5	0/5	3/4
Deviation or impression of the ascending part of the duodenum	2/9	4/4	1/2	3/5
Flexure of Treitz displaced caudally	9/9	6/6	3/3	4/5
Flexure of Treitz displaced medially	6/9	5/5	2/3	2/5
Flexure of Treitz displaced ventrally	2/3	1/5	0/3	2/5
Local impression of the flexure of Treitz	2/9	2/6	1/3	3/5
Changes in the contours of the duodenum	0/9	0/6	1/2	5/5
Deviation of the proximal part of the jejunum	3/9	3/4	0/3	0/5
Sentinel loop	0/9	4/5	0/5	0/5
Colon cut-off sign	0/8	1/2	0/3	0/4
Distance between the stomach and the colon locally increased	0/11	5/6	0/5	1/5
Deviation of the colon transversum	4/6	7/8	3/3	3/4
Impression of the colon transversum	4/6	7/8	3/3	3/4
Deviation of the splenic flexure	5/7	7/8	3/3	3/4
Impressure of the splenic flexure	4/7	4/8	3/3	2/4
Changes in the borders of the colon	0/7	0/8	0/2	2/4

connected with the ductal sytem (fig. 7b) and caused only a deviation of the pancreatic duct (fig. 2a). In 4 patients there was a soft tissue density increase caused by the cavity (fig. 2a, 7b), and in three calcifications or stones in the tail of the pancreas (fig. 2a). A majority of patients showed a stenosis (fig. 1a) of the pancreatic duct proximal to the cavity and deviation of the pancreatic duct. The other findings are summarized in table IV.



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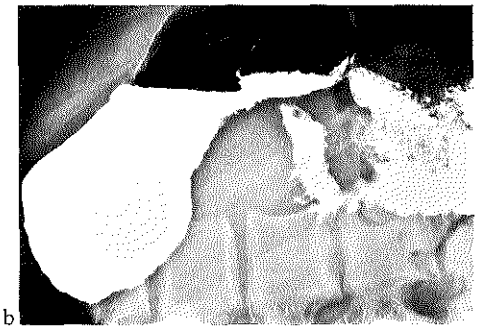

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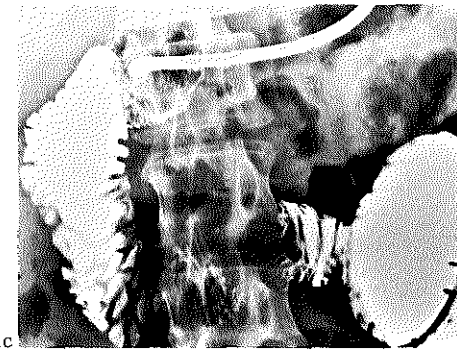
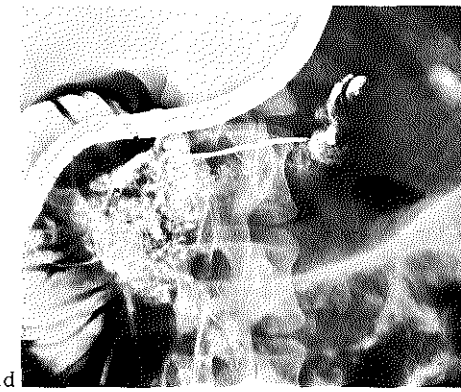


1c



1d

Fig. 1. — Patient with a pseudocyst in the tail of the pancreas.

a. *AP view of the stomach in standing position: the lesser curvature of the stomach is displaced to the left by a soft tissue density. Mucosa folds in the upper part of the body of the stomach are barely visible. The duodenal cap is also displaced and there is an impression of the air containing flexure of Treitz.*

b. *Lateral view of the stomach: local enlargement of the retrogastric space with a soft tissue density.*

c. *Hypotonic duodenography: the flexure of Treitz has been displaced caudally and laterally. Dubious soft tissue density between the stomach and flexure of Treitz.*

d. *ERCP: acute inflammation in the head and the body of the pancreas. Distal stenosis of the pancreatic duct. Distal to the stenosis the pancreatic duct is ectatic and has been displaced convexally, cranially and medially by a SOL (pseudocyst).*

Abscesses. The diagnosis was confirmed at operation in all 6 patients who underwent laparotomy. In all patients the abscess was irregularly bordered. 4 had a fistula and in 6 the cavity was connected with the ductal system. Again most of the patients showed stenosis of the pancreatic duct proximal to the cavity. Deviation of the pancreatic duct caused by the cavity was only seen in 1 patient. The other changes are summarized in table IV.

Inflammatory Tumors. In 6 patients the ductal system shows minimal irregularity of the borders. Side branches of the pancreatic duct are visible in all patients and parenchyma is also visible (fig. 3) in all patients. The appearance is that of a wire sponge. The diagnosis was confirmed at operation in all 3 operated patients.

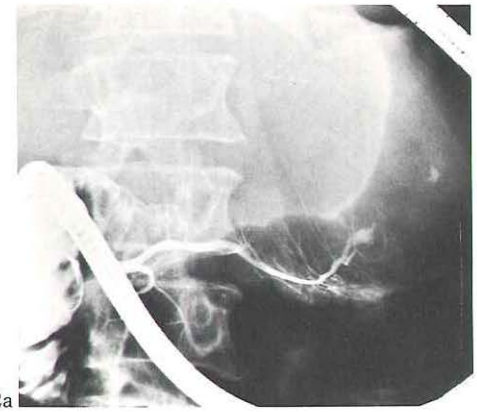
Malignancy. In 3 patients in whom an ERCP was performed, a tapered pancreatic duct was seen in all (fig. 4e) and the stenosis was total in all patients. The pancreatic duct was

not deviated, and the side branches were not visible in the tumor area. In 1 patient an irregular dense area with multiple local calcifications was seen distal to the malignancy stenosis, another patient showed multiple calcifications only distal to the malignant stenosis (fig. 4) and the third patient showed a vague opacity distally to the malignant stenosis.

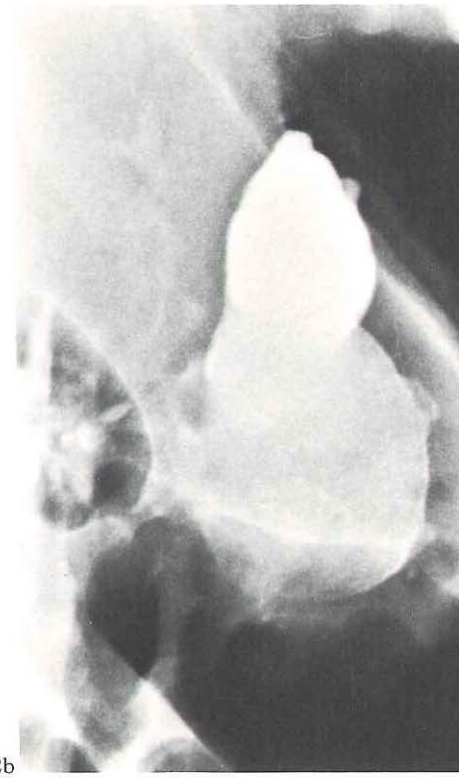
Table IV. — ERCP criteria of a (pseudo)cyst, abscess and malignant tumor: an inflammatory tumor has its own characteristics.

Disease	*(Pseudo)cyst (n = 10)*	*Abscess (n = 8)*	*Malignant tumor (n = 3)*
Proximal stenosis of the pancreatic duct	7	7	3
Tapering of the pancreatic duct	4	4	3
Deviation of the pancreatic duct	6	1	0
Ectatic ductal system distal to the SOL	3	1	0
Deviation of the side branches	4	0	not visible
One or more cavities	10	8	0
Cavity in connection with ductal system	7	6	0
Cavity not in connection with ductal system	3	2	0
Soft tissue density	4	0	2
Visibility of parenchyma proximal to the stenosis or cavity	3	3	0
Calcifications or stone(s)	3	1	2
Fistulae	0	4	0

Number of patients in parentheses.



2a



2b

Fig. 2. — Patient with a cyst (a) and another patient with an abscess (b) in the tail of the pancreas.
a. *ERCP: pancreatic duct and side branches displaced caudally and medially. The lesser curvature of the stomach has also been displaced laterally. There is a smooth double border in the stomach. Caudal deviation of the flexure of Treitz. Caudo-convex impression of the flexure of Treitz. Pancreatic duct obstructed by stone. Calcifications in cyst.*
b. *ERCP: irregularly bordered cavity in the tail of the pancreas. Chronic inflammated pseudocyst with pus (operative finding). Note the deviation of the lesser curvature in the distal part of the body and in the antrum of the stomach.*

Aneurysm of the Splenic Artery. The ERCP signs of an aneurysm of the splenic artery are variable. In 2 patients the pancreatic duct was displaced caudally and laterally, one of them also showed calcifications in the aneurysm. In a third patient we have found a pseudocyst in addition to the aneurysm (fig. 7b). A fourth patient had an abscess in addition to the aneurysm. During the operation the surgeon found an irregular cavity containing pus and blood clots. The value of the various investigations used is expressed as the percentage of patients showing the above changes and is presented in table V.

Table V. — Value (in %) of several investigative methods in SOL in the tail of the pancreas.

Investigative method	*CR*	*PAF*	*IVP*	*BE*	*UGIT*	*HD*	*ERCP*
Localization of the SOL							
Left side of abdomen	41						
Left upper part of the abdomen		28					
Retrogastric space		48					
Extrarenal			33				
Extracolic				92			
Pancreatic region					91	100	
Pancreas							100
No signs of a SOL	28	24	33	8	9	0	0
Nature of lesion							
Unknown	100	100	100	92	77	54	3.5
Dubious				0	5	15	3.5
Obvious				8	18	31	93

CR = Chest radiograph; PAF = plain abdomen radiograph; IVP = intravenous pyelogram; BE = barium enema; UGIT = barium study of the upper gastrointestinal tract; HD = hypotonic duodenography; ERCP = endoscopic retrograde cholangiopancreatography.

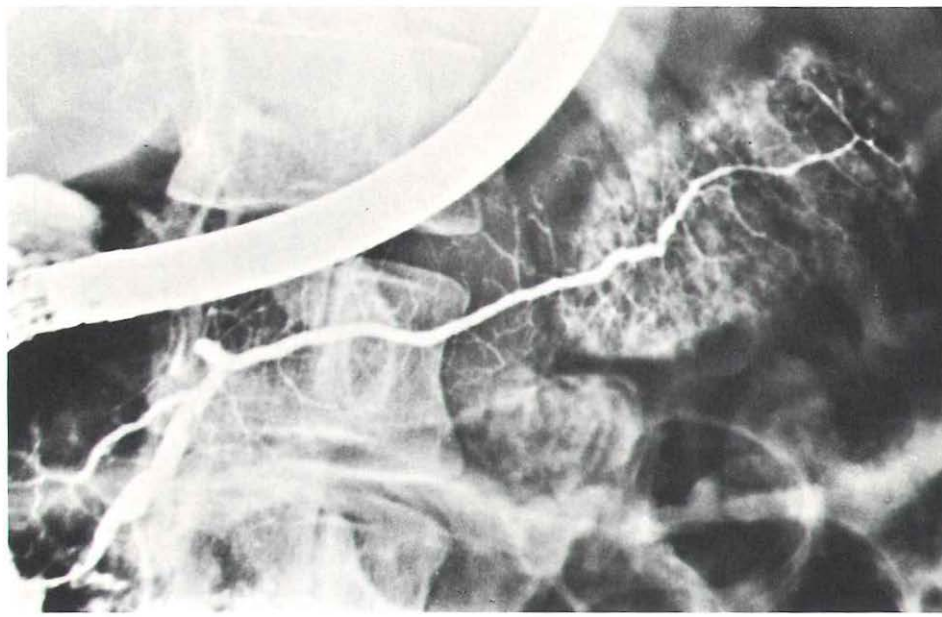
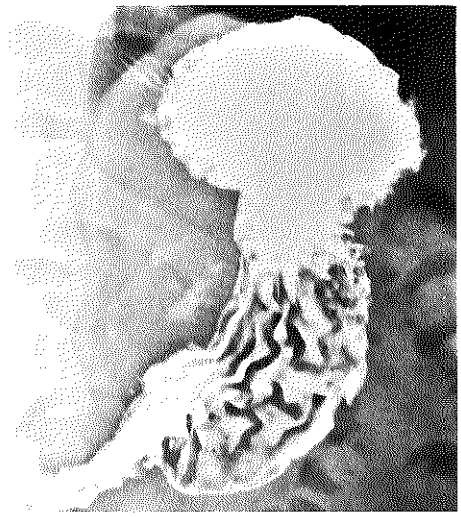


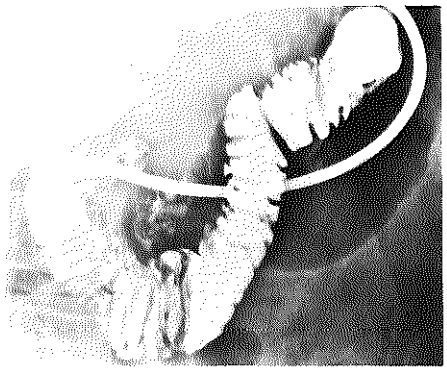
Fig. 3 — Patient with an inflammatory infiltration in the tail of the pancreas. ERCP: slight lateral deviation of the flexure of Treitz. Local acute inflammatory reaction and swelling of the tail of the pancreas.



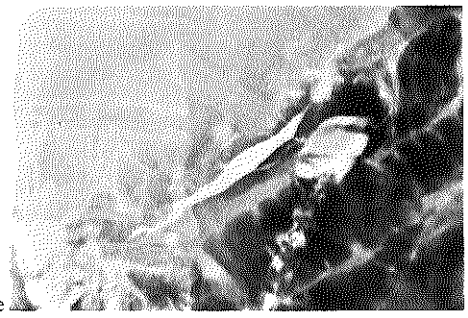
4a

4b

4c



4d



4e

Fig. 4. — Patient with a carcinoma in the tail of the pancreas.

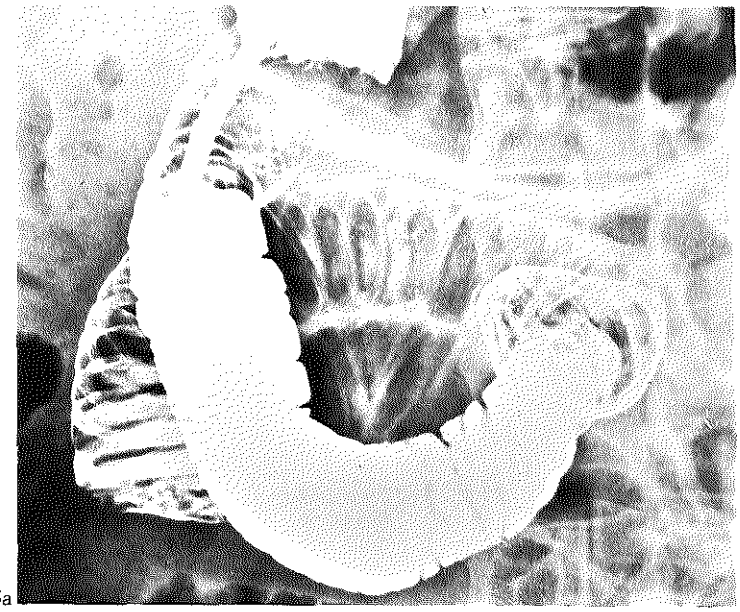
a. *AP view of the stomach in decubitus position: local calcifications medial to the lesser curvature of the stomach. Obvious, local impression in the lesser curvature of the stomach.*

b. *AP view of the stomach in standing position: hardly visible, slight local displacement of the lesser curvature of the stomach. Local calcifications medial to the lesser curvature of the stomach. Medial and caudal deviation of the flexure of Treitz.*

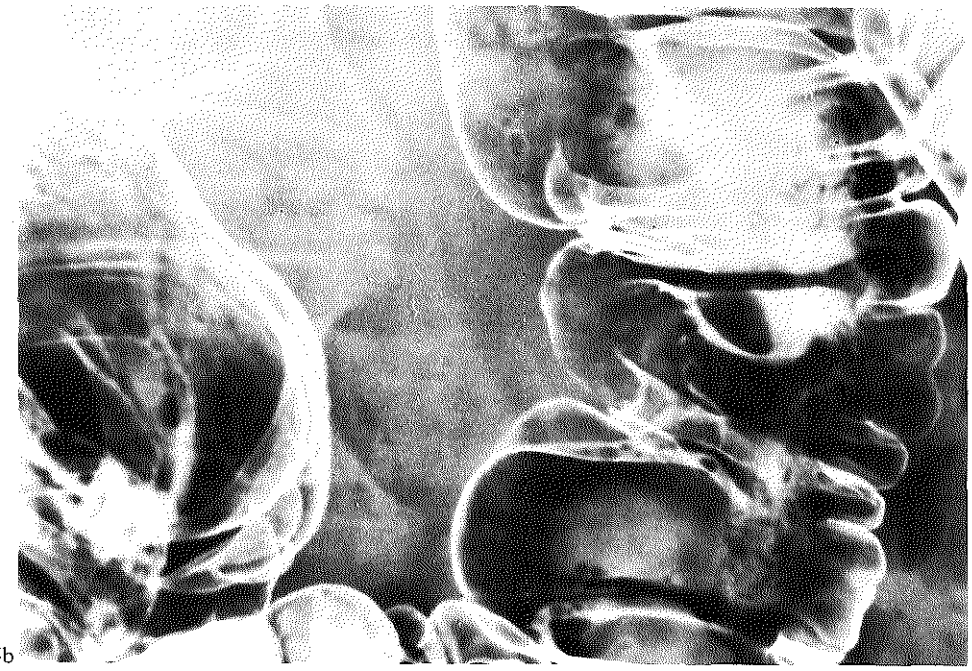
c. *Lateral view of the stomach in standing position: minimal, local enlargement of the retrogastric space starting at the upper level of the barium. Impression of the posterior wall of the stomach over a distance of one vertebral body. Local calcifications in the retrogastric space.*

d. *Hypotonic duodenography: malignant infiltration of the most distal part of the duodenum ascendens and minimal convex deviation caudally and laterally. At the cranial side of the flexure of Treitz multiple, local calcifications.*

e. *ERCP: obstructing stenosis of the pancreatic duct caused by malignancy. Ectatic and destroyed ductal system distal to the tumor. Also calcifications in that area.*



5a



5b

Fig. 5. — Patient with a carcinoma in the body and the tail of the pancreas.

a. *Hypotonic duodenography: duodenal cap deviated caudally. Stretched duodenal loop. Flexure of Treitz deviated caudally and medially. The jejunum turns to the right. No obvious invasion of the duodenal wall.*

b. *Colon: obvious invasion of the upper margin of the transverse colon by neoplasm.*

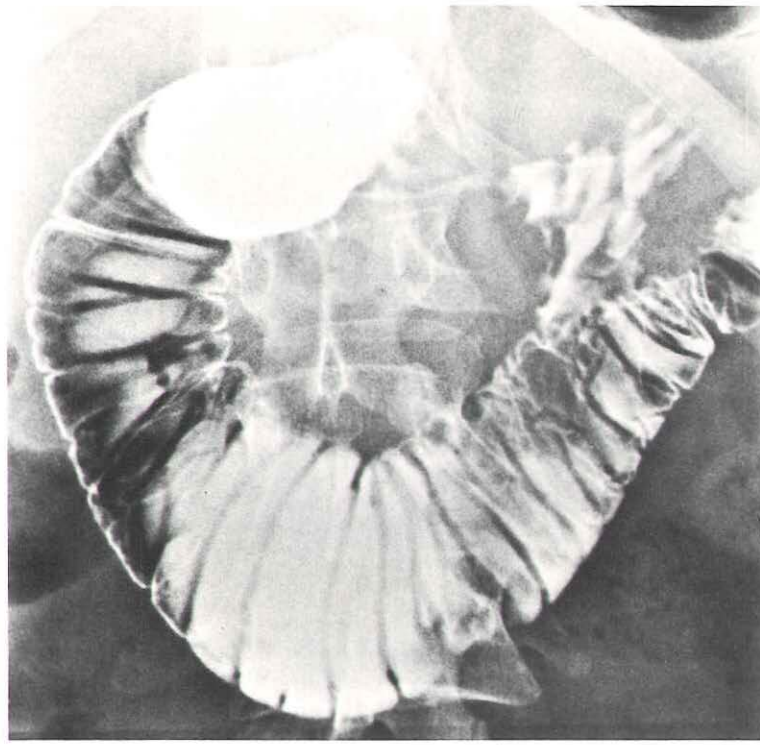
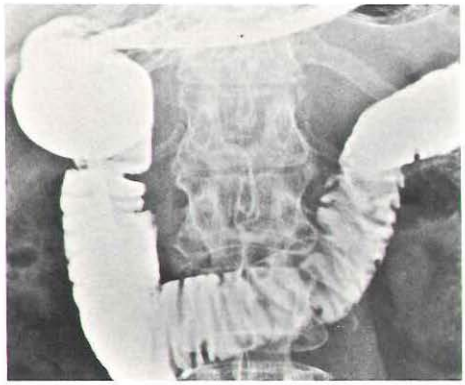


Fig. 6. — Patient with malignancy in the tail of the pancreas. Hypotonic duodenography: slight lateral and caudal deviation and local impression of the most distal part of the duodenum ascendens and the flexure of Treitz. Malignant spikes.



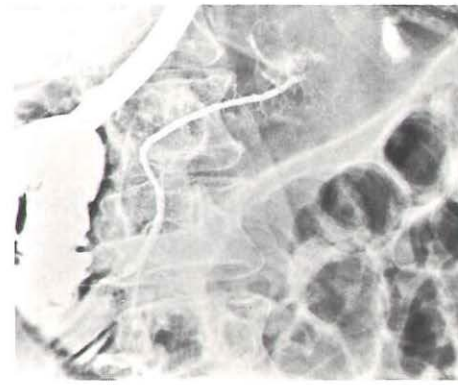


Fig. 7. — Patient with a nonruptured aneurysm of the splenic artery.
a. *Hypotonic duodenography: lateral and caudal deviation of the most distal part of the duodenum and the flexure of Treitz. No abnormality of the borders.*

b. *ERCP: pancreatic duct compressed by a density in the tail of the pancreas (SOL). Distal to this density the pancreatic duct has been displaced and is ectatic.*

DISCUSSION

Changes in the tail of the pancreas occur more often in men than in women with a sex ratio of 3:2. Traumatic changes are seen mainly in young people, inflammatory tumors and malignancy in older people. Aneurysm of the splenic artery was mainly seen in older women. With regard to the symptomatology, the most surprising finding was that thrombophlebitis migrans and lung emboli mainly occurred in the presence of inflammatory changes and did not occur in the presence of malignancy of the pancreatic tail. Pancreatic carcinoma should also be considered in differential diagnosis of sudden onset of constipation. The various investigations described: plain X-ray of chest and abdomen, barium meal, hypotonic duodenography, IVP and barium enema may all show changes which are suggestible of a SOL. Changes in the contours of the stomach, duodenum or colon, which vary with changing position suggest an extrinsic lesion. The diagnostic accuracy can be increased by air insufflation into the stomach, duodenum and colon and by taking the films below the kV and in several positions. None of these investigations, however, are diagnostic in all patients. Angiography has not been used much in this group of patients, and it is therefore not described here. Gray scale ultrasound investigation was introduced during the course of this investigation. At the moment, however, ERCP remains the most suitable technique for demonstrating such lesions and for providing characteristic radiographs on which the diagnosis can be made.

ACKNOWLEDGEMENTS

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CHAPTER VII

DISCUSSION AND SUMMARY

Endoscopic retrograde cholangiopancreatography was introduced into clinical practice just 10 years ago and has become increasingly popular. The main advantage of ERCP is that it allows a clear definition of the pancreatic and biliary ducts, something which is not easily avaible by other means.
ERCP was performed for the first time in Dijkzigt Hospital in 1973, and during the past 8 years 903 such investigations have been done. The introduction of a new diagnostic technique should be followed by an evaluation of its place in various clinical situations. An evaluation of a diagnostic method can be concerned with various aspects of patient management- diagnostic accuracy, safety, cost, effect of the result on decision making and effect of the result on the prognosis,- all of these where possible in comparison with other available techniques. We therefore decided to perform a retrospective analysis of the Dijkzigt hospital series of ERCP's. By the nature of this analysis it was impossible to derive information on the cost-effectiveness aspects of the investigation. The monetary cost might with some difficulty, be computed for this hospital but it is extremely difficult to determine the effect of ERCP on decision making and well-nigh impossible to discover its effect, if any, on the prognosis of the patient. These latter two aspects could possibly be studied in a prospective fashion.

We decided to limit the study to an examination of the diagnostic value of ERCP in various biliary and pancreatic disorders. Where possible the final diagnosis with which the various radiological techniques are compared is that diagnosis which is obtained from histological examination of biopsy or autopsy material. One of the problems encountered in this study was that radiological diagnoses are usually based on the recognition of patterns of changes and are therefore subjective in nature. Measurements of the various structures are also liable to error due to variation in magnification. The second problem could largely be solved for the pancreatic and biliary ducts by comparing the diameter on the X-ray film with the diameter of the scope. It was also possible to derive objective criteria for the shape of the choledochus duct by comparing the diameter at various fixed points with total length of the duct.
When it became clear that single features or criteria were not sufficient to distinguish between various diseases, we turned to statistical methods - multivariate discriminant analysis - to see whether combination of criteria might lead to a higher degree of diagnostic accuracy.

Another aspect discussed in this thesis is the "feed back" effect of a new diagnostic aid on existing techniques. The clear definition provided by ERCP was followed by a closer look on previous radiological investigations in the same patients. Often changes could be seen which should lead to an awareness of the possibility of pathology. In this series it was possible to make a probable diagnosis, without the ERCP, on the basis of the previous investigations, in four fifths of the patients. ERCP was necessary for confirmation of the diagnosis and definition of the extent of the disease in these patients.
The safety remains an important aspect. An optimal cooperation between an experienced endoscopist and a radiologist is essential to give a maximal diagnostic yield and minimal incidence of complications. The method used for ERCP in this hospital is described in detail in chapter I. To reduce the chance of complications various procedures should be followed - introduction of a flow and pressure limiting system, injection only during fluoroscopy, prophylactic use of antibiotics - and a surgeon should be part of the team managing the patient. Whenever possible both biliary and pancreatic systems should be visualised, even though pathology is expected in only one system. One of the notable things in this

study was that pathology in either system was associated with changes in the other. The appearances of the normal pancreatic and biliary system are described in chapter I.
The complications associated with ERCP are also discussed in chapter I, and are mainly due to infection or the occurrence of acute pancreatitis. Only the serious complications were registered in this survey. Two patients died - giving a mortality rate of 0.2% in this series.
Therapeutic ERCP has broadened the possible field of application during the past years. This aspect - papillotomy, stone removal or dissolution - has not been covered in this thesis.
A number of specific aspects of ERCP are discussed in the subsequent chapters.
Pathology of the ampulla or papilla of Vater is a subject which has gained a new dimension since the introduction of ERCP. In this series we examined 12 patients with early carcinomas of this region, and the findings are presented in chapter II. An irregularly bordered obstruction in the ampulla or papilla of Vater is characteristic of carcinoma. The presence of an inflamed, rounded or prolapsed papilla or delayed efflux of contrast from the bile and pancreatic ducts and local inflammatory changes in the head of the pancreas are indirect signs of a tumor in this region.
The appearance of the common bile duct in health and disease is described in chapter III. The diameter of the normal bile duct was found to be less variable than reported in the literature. By comparing the shape of the CBD in patients with various diseases with the shape of the normal common bile duct it was possible to define pathognomonic signs of various diseases of the extrahepatic biliary system.
Indirect signs of pathology of the extrahepatic bile ducts are discussed.
The radiological aspects of pancreatic fistulas have rarely been described. In chapter IV we report our findings in 14 patients. There is a relationship between proximal stenosis of the pancreatic duct, inflammatory cavities of the pancreas and the development of fistulas. Pancreatic fistulas can be blind, can open into various spaces in the body or can be attached to the abdominal wall. The associated pathology in patients with pancreatic fistulas is often severe and involves the whole pancreas. Injection of the fistulas during ERCP can often help the surgeon in planning an operation.
It is often very difficult to determine the nature of a stenosis in the pancreatic duct from the shape of the stenosis. In chapter V we report the changes in the ERCP which allow a discrimination between a benign or malignant stenosis or chronic pancreatitis. The criteria are mainly derived from changes in the ductuli distal to the stenosis. The calculation used to arrive at a combination of criteria which can be used for diagnostic purposes are also presented.
Previous investigations were often found to suggest a diagnosis which was confirmed by ERCP. An example of this is to be found in chapter VI. The changes found with more conventional techniques were reevaluated in the light of the ERCP and pathological investigation in patients with pathology of the tail of the pancreas. Attention to this aspect of the evaluation of ERCP should lead to an earlier detection of various disorders and to an even more effective us of ERCP.

SAMENVATTING

Ruim 10 jaar geleden werd de ERCP in de kliniek geïntroduceerd en is sindsdien toenemend populair geworden. De kombinatie van galwegen en pancreasgangen kan hiermee beter dan met welke andere methode worden afgebeeld.
De eerste ERCP in het Academisch Ziekenhuis Rotterdam-Dijkzigt vond in 1973 plaats. In de daarop volgende periode van 8 jaar werden 903 ERCP's verricht.
Evaluatie van een nieuwe diagnostische methode kan op verschillende aspekten betrekking hebben bij voorbeeld op diagnostische trefzekerheid, veiligheid, kosten en baten, invloed op het te voeren beleid en op de prognose van de patienten. Op deze punten zullen ook vergelijkingen met andere onderzoekmethoden gemaakt moeten worden.
Onze retrospectieve studie heeft zich in hoofdzaak moeten beperken tot een onderzoek naar de diagnostische waarde bij de verschillende afwijkingen van galwegen en pancreas, waarbij vooral aandacht werd besteed aan direkte en indirekte kriteria. Zo mogelijk werd de radiologische diagnose vergeleken met de histologische, verkregen door biopsie of autopsie.
Vaak berust de radiologische diagnose op soms geringe veranderingen in het ductussysteem en is zij in zekere zin subjectief. "Objectieve" metingen kunnen echter weer vertroebeld worden door variatie in de vergrotingsfaktoren. Bij de ductus pancreaticus kan dit laatste o.m. worden ondervangen door de diameter van de ductus te vergelijken met die van de endoscoop. Voor de ductus hepatocholedochus werden op een andere wijze redelijk objectieve kriteria ontwikkeld. De diameter, op 5 vaste punten bepaald, werd gehanteerd in procentuele relatie tot de eveneens op de röntgenfoto gemeten lengte van de ductus. Omdat de afzonderlijke kriteria bij de differentiaal diagnostische analyse van het chronisch pancreatitis beeld distaal van een maligne of benigne stenose van de ductus pancreaticus en een chronische pancreaticus zonder een oorzakelijke stenose te kort schoten, werd de toevlucht genomen tot een statistische multivariant analyse, waardoor een maximale diagnostische trefzekerheid bereikt kon worden.
Patiënten met een pancreasproces hebben veelal, soms zeer vele, andere röntgenonderzoeken ondergaan alvorens te worden voorgedragen voor een ERCP. Vaak, zelfs in 80% van de gevallen, was het mogelijk afwijkingen aan te wijzen op voorafgaande onderzoeken, die het proces deden vermoeden. De ERCP was echter noodzakelijk om de bestaande diagnose te bevestigen en de uitbreiding van de afwijking nader te definiëren.
Optimale samenwerking tussen een ervaren endoscopist en radiodiagnost is onontbeerlijk om een maximale diagnostische trefzekerheid en een minimaal aantal komplikaties te bewerkstelligen. De door ons toegepaste ERCP-techniek is in hoofdstuk I uitvoerig beschreven.
Om de kans op komplikaties zo klein mogelijk te houden, hebben we de volgende voorzorgsmaatregelen ingevoerd.
— Door middel van een intracannulair ventielsysteem wordt de injectiedruk op de contrastvloeistof onder controle gehouden.
— Het opspuiten van een ductussysteem vindt alleen onder doorlichting plaats.
— Antibiotica worden profylactisch voor, tijdens en na het onderzoek toegediend.
— De chirurg behoort tot het team, dat de patient begeleidt.
Indien mogelijk worden zowel de galwegen als de afvoergangen van het pancreas afgebeeld, ook als slechts in één der systemen afwijkingen verwacht worden.
Eén van de markante bevindingen van deze studie was namelijk, dat pathologie in het ene systeem zeer vaak gepaard gaat met veranderingen in het andere.
Ook is in hoofdstuk I het normale aspekt van gal- en pancreasgangen beschreven.
De mortaliteit in onze serie bedroeg 0,2%. De komplikaties berusten over het algemeen op infekties en acute pancreatitis. Pas kortgeleden zijn we met de opsporing van eventuele, niet klinisch tot uiting komende, verwikkelingen begonnen. Deze opsporing vindt plaats door middel van laboratoriumbepalingen (amylase-, lipase-bepalingen in het bloed).

Het therapeutisch aspekt van de ERCP (papillotomie, extraheren of tot oplossing brengen van stenen) heeft de toepassingsmogelijkheden nog vergroot, doch dit valt buiten het bestek van dit proefschrift.
In de hoofdstukken II tot en met VI zijn een aantal specifieke aspekten van de ERCP beschreven.
De diagnostiek van de afwijkingen van de ampul of papil van Vater heeft een nieuwe dimensie bijgekregen zoals blijkt uit hoofdstuk II. Een irregulaire, gefixeerde "opheldering" in de ampul van Vater of een irregulaire, starre stenose in de papil van Vater is kenmerkend voor maligniteit. Secundaire verschijnselen zijn een ontstoken, vergrote of in het duodenum prolaberende papil van Vater, vertraagde efflux van de contrastvloeistof uit gal-en pancreasgangen en een lokale ontstekingsreaktie in de kop van het pancreas.
Het aspekt van de normale en verwijde ductus hepatocholedochus is beschreven in hoofdstuk III. De diameter van de normale ductus bleek minder variabel dan in de litteratuur wordt aangenomen. Verschillende typen van ductusverwijdingen zijn te onderscheiden, afhankelijk van de primaire aandoening. Deze typen zijn dermate pathognomonisch, dat ze een diagnose zouden wetttigen, ook als de primaire aandoening niet in beeld te brengen zou zijn. De indirekte tekenen van galgangpathologie zijn wat betreft de ductus pancreaticus eveneens geëvalueerd.
De radiologische aspekten van pancreasfistels zijn in de litteratuur vrijwel niet beschreven. Onze bevindingen zijn in hoofdstuk IV weergegeven. Het voorkomen van fistels is onmiskenbaar gerelateerd aan een stenose van de ductus pancreaticus of een holte in het pancreas. Pancreasfistels kunnen blind eindigen, uitmonden in verschillende ruimten in het lichaam en zelfs in verbinding staan met de huid.
De afwijkingen in het pancreas zelf plegen zeer ernstig te zijn, veelal is het hele orgaan aangetast. Het is duidelijk, dat het preoperatief in beeld brengen van de fistelkanalen de chirurg tot grote steun kan zijn bij het bepalen van de operatietechniek. Het vaststellen van de aard van een ductus pancreaticusstenose op grond van zijn aspect is vaak moeilijk. In hoofdstuk V is beschreven hoe men kan differentiëren tussen een ontstekingsbeeld distaal van een benigne stenose, distaal van een maligne stenose en een chronisch pancreatitis beeld zonder een oorzakelijke stenose. De kriteria zijn vooral gebaseerd op de veranderingen in de ductuli distaal van de stenose. De berekeningen, die dienen om tot een kombinatie van kriteria te komen met een maximale diagnostische trefzekerheid zijn eveneens weergegeven.
Zoals reeds opgemerkt kunnen allerlei voorafgaande radiologische onderzoeken vaak al een aanwijzing geven voor het bestaan van een pancreasproces. In hoofdstuk VI wordt dit voor de pancreasstaartprocessen nader uitgewerkt.
Een nadere analyse van deze secundaire afwijkingen, gegeven aard en uitbreiding van het pancreasproces blijkens de ERCP, heeft meerdere kriteria van deze afwijkingen aan het licht gebracht. Tijdig onderkennen van deze beelden zal het diagnostisch proces dikwijls belangrijk kunnen versnellen, waardoor eerder tot de specifieke pancreasonderzoeken als de ERCP kan worden overgegaan.

CURRICULUM VITAE

De schrijver van dit proefschrift werd op 29 februari 1940 geboren te Heerlen. In 1962 behaalde hij het diploma gymnasium alpha en beta. Vervolgens studeerde hij geneeskunde aan de Katholieke Universiteit te Nijmegen en werd hij op 22 januari 1971 bevorderd tot arts.
Zijn opleiding tot radiodiagnost begon op 1 april 1971 in het St. Annadal Ziekenhuis te Maastricht (Opleiders: Prof. Dr. G.J.van der Plaats en Dr. G.J.van der Plaats) en werd in december 1972 voortgezet in het Academisch Ziekenhuis Rotterdam-Dijkzigt (Opleider: Prof. K. Hoornstra).
Op 1 april 1975 werd hij ingeschreven in het specialistenregister en sindsdien is hij verbonden aan de afdeling radiodiagnostiek van het Academisch Ziekenhuis Rotterdam-Dijkzigt.