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Comparative clinical impact of endoscopic pancreatography, grey-scale ultrasonography, and computed tomography (EMI scanning) in pancreatic disease: preliminary report

P. B. COTTON, M. E. DENYER, L. KREEL, J. HUSBAND, H. B. MEIRE, AND W. LEES

From the Gastrointestinal Unit and Department of Clinical Measurement, The Middlesex Hospital, London; Division of Radiology, Clinical Research Centre, Northwick Park Hospital, Harrow, Middlesex

SUMMARY Grey-scale ultrasound scanning (US), computed tomography (CT), and endoscopic retrograde cholangiopancreatography (ERCP) were performed in a series of 50 patients with known or suspected pancreatic disease. The impact of the individual tests were assessed in the relevant clinical context. With a maximum of 100, the overall clinical impact score of ERCP (75) exceeded that of CT (63) and US (36). In patients with obscure pain, and in those with relapsing pancreatitis, a combination of US and ERCP provides good clinical guidance. Computed tomography scanning can currently be reserved for documentation of patients with a major mass lesion. None of the techniques can detect early pancreatic cancer, except of the papilla of Vater, where ERCP is diagnostic. Recommendations for future diagnostic strategies may alter as grey-scale ultrasonography and computed tomography develop, and, in any case, depend on many factors including local expertise, availability, and cost.

The incidence of chronic pancreatitis and carcinoma appears to be increasing in Britain. Investigative methods have long been inadequate. Isotope scanning has been disappointing (Cotton *et al.*, 1978); formal pancreatic function tests and angiography have been restricted to a few major centres. Diagnosis is often made at a late stage when therapeutic scope is restricted.

During the last five years there have been major developments in pancreatic imaging. Fibreoptic duodenoscopy allows access to the papilla of Vater for retrograde cholangiography and pancreatography (ERCP). Despite its complexity, ERCP is finding increasing application in the documentation and management of patients with pancreatic and biliary problems (Cotton, 1977). Ultrasound scanning is simple and non-invasive (Wells, 1972); the grey-scale refinement has improved picture quality and diagnostic definition (Doust, 1976; Haber *et al.*, 1976; *Lancet*, 1977). Even more recently, whole body computed tomography (Hounsfield, 1973) (CT scanning) has emerged as an imaging technique of major potential, allowing pancreatic visualisation (Haaga *et al.*, 1976; Kreel, 1976a; Husband and Kreel, 1977).

We have made a preliminary assessment of the relative clinical impact of these three new techniques in 58 consecutive patients referred to The Middlesex Hospital with known or suspected pancreatic disease.

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Methods

PATIENTS

Fifty-eight patients (age range 13-72 years) entered the study between December 1975 and February 1977. The follow-up period for many patients was short; at the time of final assessment, the precise pancreatic status remained in doubt in eight patients, leaving 50 for analysis. Patients were divided into three groups, according to the reason for referral and the clinical question to be answered. Twenty patients (group 1) presented with pain; the question was whether or not pancreatic disease was present. Group 2 consisted of nine patients who were known to have a pancreatic mass lesion (five after inconclusive

laparotomy), and the clinical problem was to distinguish cancer from pancreatitis. The third group of 21 patients were all firmly diagnosed as suffering from relapsing pancreatitis, of acute and chronic forms; the clinical question was whether or not there was a local lesion (blocked duct, local mass or cyst) requiring consideration of surgery.

The three investigations were almost always performed during a single brief hospital admission, and were never separated by more than two weeks. ERCP was performed in the standard manner (Cotton, 1977), and reports of endoscopic and radiographic findings were issued in the knowledge of the clinical picture, but without the results of scans. For organisational reasons, ERCP usually preceded ultrasonography and computed tomography.

Ultrasound scans (US) were performed by one of two investigators, using a Nuclear Enterprises Diasonograph with grey scale display. A transducer frequency of 2·5 mHz was employed and the pancreas located from vascular landmarks (Leopold, 1975a, b; Meire, 1977). Computed tomography was performed with the prototype model of the EMI whole body scanner (Kreel, 1976a, b).

A low residue diet was given for three days before scanning to reduce intestinal gas. Additional preparation was given for computed tomography but the exact schedule was still evolving during the study. Calcium phosphate tablets (400 mg tds) were given for three days to act as a marker in the colon. Approximately 15 minutes before the test, intestinal activity was reduced by an intramuscular injection of propantheline bromide (30-60 mg), and a contrast agent (sodium/meglumine diatrizoate, 2·5 ml diluted in 300 ml water) was given orally. This outlined the stomach and upper intestine and proved particularly helpful when scanning the tail of the pancreas. The site of the pancreas was established by reference to previous radiological studies (usually the barium meal) and a slit-beam radiograph to overcome parallax, called a scanogram. (Kreel, 1977). Transverse CT slices of 13 mm thickness were made through the pancreas at 1 cm intervals. The pancreas lies obliquely in the abdomen, and different parts were seen in different slices (usually 4-6). The superior mesenteric artery is an important landmark at the level of the pancreatic head. Other slices were usually taken to examine the liver. Reports of ultrasound and computed tomography scans were given in the knowledge of a clinical summary, and with access to previous radiology, usually excluding ERCP.

FINAL DIAGNOSIS AND METHOD OF SCORING

The final diagnosis was made by the investigating panel after the patient's death or discharge from hospital based on all available information including follow-up to the time of analysis.

Group 1 (20 patients, pain ?cause)
Laparotomy in 11 patients revealed: normal pancreas (nine), cancer (one), pancreatitis (one). Three of the unoperated patients had abnormal pancreatic function tests indicating pancreatitis; and in six the pancreas was finally judged to be normal. One is symptom free following treatment for thyrotoxicosis, and the remaining five are clinically well at follow-up beyond six months.

Group 2 (nine patients, pancreatic lesion ?cancer or pancreatitis)
Final diagnosis was confirmed in seven of the nine patients by laparotomy. The two patients who did not undergo surgery had a clinical course and abnormal function studies consistent with chronic pancreatitis.

Group 3 (21 patients, known pancreatis, ?local lesion)
The local lesions demonstrated by one or more of the tests in eight patients were all confirmed at laparotomy. In three patients absence of a local abnormality was also confirmed surgically. Of the nine unoperated patients, seven are well at follow-up; two continued to have pain and have undergone further negative investigations.

Each report for each patient was assessed by the panel at the end of the study, and scored on a simple scale:

+2	correct and clinically helpful
+1	correct but not clinically helpful
0	technical failure
−1	wrong but not seriously misleading
−2	wrong and clinically hazardous

A score of +1 indicated that the report tended to confirm the (correct) clinical view, but did not significantly advance it either in detail or in confidence. A score of −1 indicated that the report was incorrect, but had not been sufficiently definite to lead to a major error in clinical management, such as unnecessary surgery; the latter situation (scoring −2) only occurred in one patient.

Results

Individual results from all patients are shown in Tables 1 to 3. The first requirement of any test is that it should produce an answer. Some information was given about the pancreas in every patient subjected to CT scanning. In six patients pancreatography failed; three were subsequently shown to have disease at or near the papilla. Inadequate US views of the pancreas were reported in 10 patients, usually due to excessive

Table 1 *Detailed results in patients of group 1—pain ?pancreatic problems*

Patient	*Final diagnosis*		*Lap.*	*US*		*CT*		*ERCP*	
	Pancreas	*Other*			*Score*		*Score*		*Score*
1	N	Munchausen	+	N	2	Abn. head	−1	N	2
2	N	Stones	+	N	2	N	2	N (+ stones)	2
3	N		+	N	2	N	2	N	2
4	N			N	2	N	2	Failed	0
5	N	Ulcer	+	Poor ?N	1	N	2	N (+ ulcer)	2
6	CP		+	N	−1	N	−1	Ventral	1
7	N			Failed (gas)	0	N	2	N	2
8	N		+	Large ?CP	−1	?Tail mass	−1	?Early CP	−1
9	N			Large ?CP	−1	N	2	N	2
10	N			N	2	N	2	?Early CP	−1
11	CP			Slightly large	1	N	−1	Ventral	1
12	CP			?Mild CP	1	?Bulky head	1	Ventral	1
13	Ca		+	Failed (thin)	0	Big duct	1	Ca (biopsy +)	2
14	N	Stones	+	?CP	−1	N	2	N	2
15	N	Thyrotoxic		N	2	N	2	N	2
16	N	Retroperit. tumour	+	N	2	N	2	N	2
17	N			N	2	N	2	N	2
18	CP			N	−1	Bulky head	1	Ventral	1
19	N	Stones + PBC	+	Large panc.	−1	Large panc.	−1	N (+ stones)	2
20	N	PBC	+	Large head	−2	Large head ?nodes	−2	N	2

N: normal, CP: pancreatitis, Ca: cancer, PBC: primary biliary cirrhosis. Lap + indicates laparotomy after investigations.

Table 2 *Detailed results in group 2 patients—known pancreatic lesion ?cancer (Ca) or pancreatitis (CP)*

Patient	*Final diagnosis pancreas*	*Lap.*	*US*		*CT*		*ERCP*	
				Score		*Score*		*Score*
21	Ca	+	Mass = pseudocyst	−1	Mass = Ca	2	Failed	0
22	Ca	+	Mass + Ca	2	Mass = Ca	2	Ca	2
23	CP	+	Mass ?cause	1	Mass ?cause	1	Failed	0
24	Ca	+	Failed (gas)	0	Ca	2	Ca (biopsy +)	2
25	Ca	+	Failed (gas)	0	Head mass (+ mets.)	2	Block (biopsy +)	2
26	CP + haematoma	+	Mass = cyst	2	Mass ?haematoma	2	CP + mass ?cause	1
27	CP		Failed (gas)	0	Mass ?cause 1	1	Mass + stricture ?cause	1
28	Ca	+	Ca tail	2	Ca tail	2	Block = Ca	2
29	CP		CP	2	Fibrosis ?previous CP	1	Gross CP	2

intestinal gas. Technical failures are relevant and clinically unhelpful but they are not clinically misleading.

None of the tests came close to answering the clinical question in all 50 patients. With a maximum of 100, ERCP scored 75, CT 63, and US only 36 (Table 4). The average impact scores in the different clinical groups are shown in Table 5, and are also expressed in terms of the successful examinations.

Grey-scale US proved inferior to the other techniques in all three clinical groups, even when technical failures were excluded. In this study, US was particularly disappointing in detecting the normal pancreas and in its contribution in patients with relapsing pancreatitis (Table 4). Although US (and the other tests) detected the one pseudocyst, it provided little management guidance in the other pancreatitis patients. ERCP scored well in this context, and in detecting and excluding pancreatic disease. CT scanning scored higher than US and ERCP in the Group 2 patients with a known pancreatic lesion (usually a mass found at surgery) where the clinical problem was to separate cancer from pancreatitis; as an invasive technique, only ERCP could provide histological proof of cancer (patients 24 and 25, Table 2).

All three techniques provide diagnostic information outside the pancreas. US and CT scans demonstrated metastatic deposits and other primary tumours (for example Table 1, 16), as well as the effect of pancreatic disease on surrounding organs. The endoscopic and cholangiographic aspects of ERCP also provided diagnostic information in some cases. One patient (Table 1, 5) had been diagnosed as suffering from chronic pancreatitis for many years on the basis of upper abdominal calcification. The calci-

Table 3 *Results of US/CT/ERCP in group 3 patients (relapsing pancreatitis ?local lesion)*

Patient	*Conclusion*	*Lap.*	*US*	*Score*	*CT*	*Score*	*ERCP*	*Score*
30	NLL	+	N	2	N	2	Failed	0
31	Block in head	+	Large panc.	1	Large body and tail	1	Failed	0
32	Block + stones	+	Failed	0	Duct stones	1	Block + stones	2
33	NLL		NLL	2	Large NLL	2	N	2
34	Block + stones	+	Dilated duct	2	Dilated + stones	2	Dilated + stones	2
35	NLL		Poor	0	Large NLL	2	CP. NLL	2
36	NLL		N	2	N	2	N	2
37	NLL		Failed (gas)	0	Large head. NLL	2	CP. NLL	2
38	NLL	+	Failed (gas)	0	CP. NLL	2	CP. NLL	2
39	NLL	+	Failed (gas)	0	Inflamm. ?tail Cyst	−1	NLL to tail	1
40	NLL	+	?Cyst	−1	?Cyst	−1	NLL	2
41	NLL		NLL	2	N	2	Failed	0
42	Block in head	+	Large body	1	Large + calc.	2	Head mass	2
43	Congenital	+	Difficult. NLL	−1	Large head	2	CP + congenital	2
44	Cysts	+	Cysts	2	Cysts	2	CP + cysts	2
45	NLL		CP. NLL	2	NLL	2	N	2
46	Congenital. No cyst	+	Large + cyst	−1	Cyst	−1	Congenital	2
47	NLL		N	2	N	2	CP. NLL	2
48	NLL		N	2	N	2	Early CP. NLL	2
49	Block body	+	NLL	−1	Large body and tail	2	Block body	2
50	Congenital	+	CP. No cyst	1	Difficult. No cyst	1	Congenital	2

NLL: no local lesion, N: normal.

Table 4 *Final conclusion and scores in groups 1, 2, and 3*

Group	*Final conclusion*	*Total patients*	*Scores*		
			US	*CT*	*ERCP*
1	Normal	15	11	17	22
	Pancreatitis	4	0	0	4
	Cancer	1	0	1	2
	Totals	20	11	18	28
2	Cancer	5	3	10	8
	Pancreatitis	4	5	5	4
	Totals	9	8	15	12
3	No local lesion	12	13	18	19
	Blocked duct	5	3	8	8
	Cyst	1	2	2	2
	Congenital duct anomaly	3	−1	2	6
	Totals	21	17	30	35
Grand Totals		50	36	63	75

Table 5 *Average scores for clinical impact of US/CT/ERCP in three different clinical contexts (maximum score 2)*

Clinical question	*Average impact scores*		
	US	*CT*	*ERCP*
1. ?Pancreatic problem	0·6 (0·7)	0·9	1·4 (1·5)
2. ?Cancer or pancreatitis	0·9 (1·3)	1·7	1·3 (1·7)
3. Pancreatic ?local lesion	0·8 (1·1)	1·4	1·7 (1·9)
Total	0·7 (0·9)	1·3	1·5 (1·7)

Figures in parentheses indicate average scores for successful studies—that is, excluding the six technical failures of ERCP, and 10 inadequate views on US. There were no technical failures of CT scanning.

fication was shown to lie outside the pancreas on CT scanning and pancreatography, and endoscopy demonstrated a large anastomotic ulcer, with a calcified base. Retrograde cholangiography showed clinically relevant and previously undetected gallstones in several patients with recurrent pancreatitis.

Discussion

Pancreatic diagnostic tests are often assessed out of the clinical context, and with the assumption that all reports carry equal conviction; imaging reports in particular are often qualified. In this study we have attempted a crude value judgement of the clinical impact of the three imaging methods according to the confidence and accuracy of the answer provided to the relevant clinical question. The importance of starting from known facts can be further illustrated. Patients with recurrent pancreatitis may have normal scans and pancreatograms between attacks; these results are misleading if the patient presents with obscure pain, but clinically helpful, in excluding a major local lesion, if pancreatitis has already been established by another method—for example, raised serum amylases.

Overall in this study, ERCP had greater clinical impact than US or CT scanning. However, the number of patients in each clinical group was small; more important, ERCP was already established, whereas the scanning techniques and interpretative skills were developing. Imaging methods are not

mutually exclusive; results are often complementary, and the aim should be to find a logical sequence in each clinical context, minimising cost and discomfort. Patients with recurrent pancreatitis need ERCP to provide a map of the duct systems (Cotton and Beales, 1974). However, scanning is also important to show or exclude pseudocysts, particularly since ERCP may introduce infection (Bilbao *et al.*, 1976). Scanning techniques have inherent advantages over ERCP in patients with mass lesions, since they provide more data about surrounding organs. In this study, CT proved superior to US. However, the techniques do not provide identical information and depend on different tissue characteristics (Husband *et al.*, 1977); for example, CT scanning is more difficult in wasted patients without intra-abdominal fat, whereas US is facilitated. None of the techniques can always distinguish pancreatitis from cancer on the pictures alone. ERCP can provide a tissue diagnosis through endoscopic biopsy and cytology and both US and CT have been used to guide percutaneous aspiration biopsy needles (Hancke *et al.*, 1975; Haaga and Alfidi, 1976). Only one of the cancers in this study (case 13, a papillary lesion diagnosed at ERCP) proved resectable. Neither US nor CT scans can detect small tumours, since diagnosis currently depends on recognising a major change in organ size or contour. However, the ability to show inoperable tumours accurately and sequentially should stimulate progress in chemotherapy and radiotherapy.

Patients with recurrent pancreatitis and those known to have mass lesions (our groups 2 and 3) are relatively few in number, and can easily be referred to specialist centres. Patients with obscure abdominal pain (group 1) are far more common, and cannot all be referred elsewhere. In this study, ERCP proved markedly superior to US and CT in these patients, particularly in detecting the abnormal pancreas. Subsequently, US results have improved (Lees *et al.*, 1978) and our policy is to perform US *and* ERCP in virtually all patients, usually on the same day. When clinical suspicion of pancreatic disease is low, a normal US report is often sufficient; however, many patients require gastroduodenoscopy to exclude ulcer disease, and pancreatography requires little additional effort for the experienced. CT scanning is reserved for the few patients in whom this combination does not provide precise data. There was only one patient in this study in whom CT was more valuable than US and ERCP combined.

The value of a diagnostic test does not rely on its accuracy in expert hands—indeed the more it requires an expert, the less valuable it becomes in national terms. Both ERCP and US are dependent upon individual skills; CT scans can be provided by technicians, leaving reporting to an expert. US and CT scans are non-invasive, and can be performed without major discomfort. ERCP is an ordeal for some patients, if only in prospect, and complications occur (Bilbao *et al.*, 1976). However, we have seen no complications of diagnostic ERCP in our last 600 examinations. Geographic convenience is also important, and CT scanning is least likely to be accessible because of its cost. Although currently relatively cheap, ultrasound machines are becoming more sophisticated and expensive. Despite this, and despite the dependence of results on individual expertise, we expect ultrasound to become the major screening method for pancreatic lesions, as agreed by DiMagno *et al.* (1977). Isotope scanning should be discarded for diagnostic purposes (Cotton *et al.*, 1978). ERCP is necessary in patients with recurrent pancreatitis, and in all those with obscure abdominal pain suggestive of pancreatic origin whatever the results of scans. Computed tomography scanning can be reserved for the documentation of mass lesions and their operability, a role previously reserved for angiography.

This assessment is based on small numbers of patients in two hospitals, at a particular stage in the development of the methods. Greater experience and technical improvements may well alter future conclusions.

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