

Measurement of duodenal tryptic activity and ⁷⁵Se-selenomethionine pancreatic scanning compared as tests of pancreatic function

D. M. McCARTHY¹ AND PAMELA BROWN

From the Department of Medicine, Royal Free Hospital, and the Department of Gastroenterology, Central Middlesex Hospital, London

SUMMARY The results of a subjective assessment of pancreatic function, based on the appearance of a ⁷⁵Se-pancreatic scan, were compared with measurements of the tryptic activity of duodenal aspirates in 16 normal and 38 abnormal subjects. In normals and in abnormals whose scans showed a generalized rather than a localized abnormality there was close agreement between the results of the two sets. In patients with a localized abnormality of the pancreatic head on scanning the tryptic activity of the aspirate was useful in differentiating carcinoma of the pancreas from that of the common bile duct. In general the scan was the more discriminative test though otherwise the places of the two tests in diagnosis are rather similar. The particular situations in which each test is valuable, or in which one or other test can be omitted, are discussed.

The current methods of assessing pancreatic function and morphology are time-consuming and costly. No patient therefore should be subjected to more than an essential minimum number of such tests. Following reports by a number of workers that a normal pancreatic scan argues strongly against the presence of pancreatic disease (Sodee, 1966; Melmed, Agnew, and Bouchier, 1968; McCarthy, Kreel, Agnew, and Bouchier, 1969) scanning is now commonly employed as a screening test. Provision of scanning facilities is restricted to centres where high quality equipment is available and where a large number of patients, from a number of hospitals, can be tested. Reporting on the scan is largely a subjective art. The accuracy of reports is consequently related to the experience of the reporter and the adequacy of patient follow up. Nevertheless the information derived is of considerable value when examined by the clinician in the light of the case history, clinical findings, and the results of simple laboratory procedures.

Two studies (Lähdevirta, 1967; Brown, Sircus, Smith, Donaldson, Dymock, Falconer, and Small, 1968) have indicated some correlation between the results of scanning and those of routine exocrine function tests. However, the first study was restricted

to 19 diabetic patients who may be atypical with regard to pancreatic function. No actual details of the function studies were published in the second paper, but pancreatic function was assessed by means of a secretin-pancreozymin test in 20 subjects and the results were in 'good general agreement' with conclusions derived from the scan. The present study was aimed at examining the accuracy of subjective assessments of pancreatic function, as judged from the appearance of the scan, against an exocrine function test in each case. Furthermore it was hoped to define circumstances in which such tests were complementary or in which one or other test might be omitted.

As ⁷⁵Se-selenomethionine is incorporated into newly synthesized protein components of the pancreas (Hansson and Blau, 1963) and appears rapidly in secreted enzymes (Van Goidsenhoven, Denk, and Knight, 1965), it seemed logical to compare with the scan the result of a test of enzyme synthesis, and therefore acinar cell function, rather than a test of the volume and bicarbonate secretory capacity of the gland in which acinar function may be less important. The Lundh test (Lundh, 1962; Bramwell Cook, Lennard-Jones, Sherif, and Wiggins, 1967) seemed to satisfy this requirement. It is simple to perform and furthermore employs only the physiological stimulus of a standard meal before the test.

¹Request for reprints should be sent to D.M.McC., Department of Medicine, Royal Free Hospital, Gray's Inn Road, London, WC1.

This makes it more suitable for direct comparison with the appearance of the scan, before which patients are also fed and no pharmacological stimuli are employed. The results of scanning and measurements of duodenal tryptic activity were therefore compared in 54 patients with a variety of clinical conditions.

METHODS

CLASSIFICATION OF PATIENTS All patients studied were originally regarded as possibly suffering from pancreatic disease. Final classification of the patients was undertaken on the basis of all the information available, other than the results of the Lundh test and the ^{75}Se scan. Investigation of the patients in all cases included a full clinical assessment, white cell count, serum amylase, glucose tolerance test (50g), and barium meal in addition to the tests under examination. In the 16 cases recorded as having neoplastic disease, the diagnosis was established at laparotomy in all cases. In 22 cases recorded as having 'chronic' or 'relapsing chronic' pancreatitis (Marseilles classification) the diagnosis was established at laparotomy in 16 cases, extensive pancreatic calcification was present in a further three cases, and well documented recurrences of pancreatitis were recorded in the final three. Of the last, one had duodenographic evidence of pancreatic disease; one had radiographic evidence of the presence of a pancreatic pseudo cyst; and one had clinical diabetes that developed after to the attacks of pancreatic pain and with no family history of diabetes. Supplementary investigations included hypotonic duodenography in 14 and pancreatic angiography in five cases. Faecal fat excretion (three-day, ward diet) was examined in 24 cases suspected of having steatorrhoea. Using the above approach to diagnosis there remained 16 patients in whom investigation had failed to establish the presence of any pancreatic abnormality at the time of the tests, in whom some other clinical diagnosis had been clearly established or in whom the state of the pancreas had been established at laparotomy (seven cases). As the primary purpose of the study was to compare results of the two tests, arbitrarily included with the 'normals' were two diabetics, with no other evidence of pancreatic disease, and three patients who had recovered fully from acute pancreatitis. This grouping is discussed in later sections. No case of pancreatitis was studied within three weeks of an acute attack. For reasons of radiation dosimetry the study only allowed one administration of isotope per patient, so that as far as possible patients were studied only while in a functional steady state. In this department when mild to moderate impairment of isotopic uptake is noted on the scan of a diabetic patient, the scan is ordinarily reported as 'within normal limits' as no deduction can be made about the presence of pancreatic disease (Melmed *et al*, 1968).

SCANNING PROCEDURE Fed patients, whose drugs apart from insulin had been discontinued 48 hours before scanning, were injected within one hour of eating, with intravenous ^{75}Se -selenomethionine in a dosage of $3\mu\text{Ci}$ per kilogram body weight, 30 minutes before scanning.

Scans were performed with the patient lying absolutely flat using a Pichker magna-Scanner¹, with a 5 in. sodium iodide crystal, an 85-hole collimator of nominal focal length 5 in., and a standard scanning speed of 24 cm/min, and using a pulse height analyzer setting of 210-310 KeV. The machine gives a photoscan, audio signal, and colour-coded printout (scintigram) for each run and allows the position of external reference markers to be typed on the prints at the time of scanning. A liver scan was subsequently performed in all cases, related to the same marker system, after intravenous injection of $150\mu\text{Ci}$ ^{198}Au colloidal gold. Visual rather than automatic subtraction of the two images was employed as there seems to be little practical benefit from the use of subtraction units in the majority of cases and they may lead to the production of additional artefacts (Eaton, Fleischli, Pollard, Nebesar, and Portsaid, 1968). High-residue foods and excessive fats were avoided in the diet in an effort to minimize gastric retention but in general no special preparations, drugs, diets, or shields were employed.

LUNDH TESTS *Clinical methods* Patients were fasted overnight and intubated next morning with a 12-Fr gauge radioopaque tube, perforated by four holes in its terminal 6 cm and weighted by means of a mercury bag at its tip. After anaesthetization with 1% xylocaine this was passed through the nose and its progress monitored fluoroscopically until its tip reached the duodenojejunal flexure, just distal to the ligament of Treitz, from which aspiration was performed. The tube having been filled with the help of a syringe the patient was allowed to lie comfortably on his right side. Duodenal juice was drained by siphonage into a measuring cylinder, surrounded by ice, about 80 cm below the level of the patient. This 'fasting specimen' was collected until tube recovery fell off; the volume, pH, tryptic activity, and bile contamination were recorded. A standardized meal identical to that of Bramwell Cook *et al* (1967) was then given and consisted of corn or soya-bean oil 18g, Casilan (dried milk protein powder) 15g, glucose 40g, syrup for flavouring 15g, and hot water to 300ml giving a composition in the resulting meal of 5% protein, 6% fat, and 15% carbohydrate. The patient drank this. Duodenal aspiration was then begun and continued for a two-hour period. Measurements, other than tryptic activity, were recorded immediately and aliquots were deep frozen at -20°C for later determination of the enzyme content.

Biochemical methods Tryptic activities of the aspirates were measured by the method of Wiggins (1967) using the synthetic substrate N-benzoyl-arginine-ethyl-ester, and results expressed as μ -equiv substrate (hydrolysed) /ml/min, equivalent to μ -equiv/ml/min of released hydrogen ion, which is measured. The values quoted here are mean values for the whole two-hour period. The clinical applications of this method have been reviewed by Bramwell Cook *et al* (1967).

METHOD OF COMPARISON The results of the scans, with minor variations, fell into three categories, namely, 'normal', 'generalized reduction in uptake' throughout the gland, and 'filling defect' or localized abnormality,

¹Pichker X-ray Corp. N.Y.

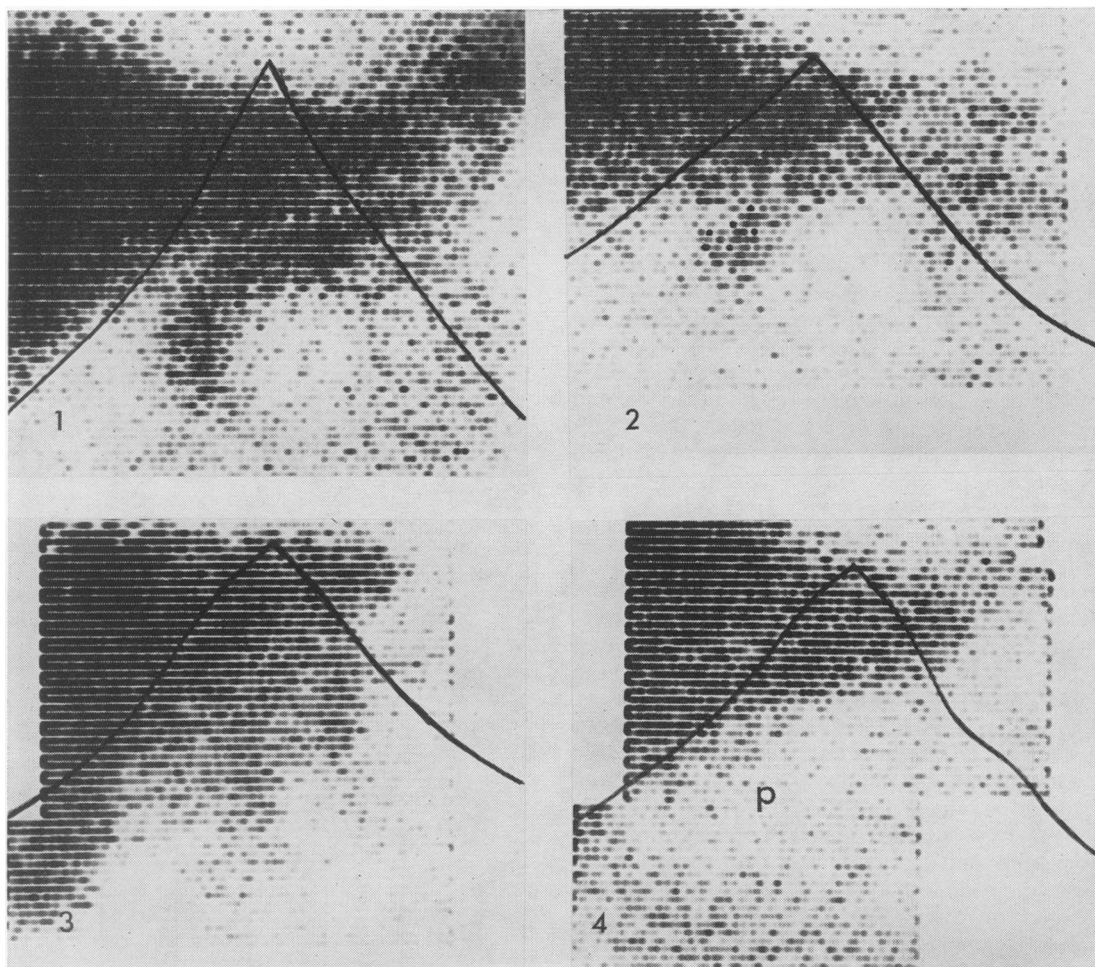


FIG. 1. A normal scan (1) shown for comparison with scans demonstrating 'mild' (2), 'moderate' (3), and 'severe' (4) generalized reductions in isotopic uptake. At p in (4), the area in which pancreatic uptake should be noted, the actual recorded activity is less than the background.

all but two of which were in the head of the pancreas. This subdivision was used as a basis for comparison with the Lundh test in three main groups of patients. Other features of the scan such as displacement of the pancreas, enlargement of the liver, filling defects in the liver, isotopic uptake by the spleen, or radioactivity over loops of bowel were all taken into account, when reporting on the scan from a diagnostic point of view, but did not influence the category into which the scan was allocated for comparison with the Lundh test. Clinical details of the patient were also known to the person reporting on the scans, though the results of the Lundh test were not. For many reasons, taken up in the discussion, we do not advocate 'blind' reporting of the scan, as there are many factors other than the presence or absence of pancreatic disease which influence the quality of the scanned image. The results of laparotomy were not known at the time of

either test except in three of the cases of 'pancreatitis' and five of the 'normals'.

All the scans which reported 'generalized reduction in uptake' were finally subdivided at a single session into three subjective grades of abnormality, namely, 'mild', 'moderate', and 'severe' impairment of isotopic uptake. This was done before correlation without knowledge of the result of the Lundh test. An example of each grade is shown in Fig. 1 with a normal scan included for comparison. Other studies being performed in the department (Agnew, McCarthy, Melmed, and Bouchier, 1969) indicated that count rates recorded over various areas of the scan were too unpredictable to serve as an objective basis for comparison with the result of the Lundh test. Nevertheless an attempt was made to correlate the two parameters mathematically in 20 cases, but the scatter of the count rates was too wide to be of use in a meaning-

ful way and this approach was abandoned. Other aspects of the value of combining the two tests are examined in the discussion.

RESULTS

DUODENAL TRYPTIC ACTIVITY RELATED TO FINAL DIAGNOSIS The duodenal tryptic activity in the various groups of patients is shown in Fig. 2 related to the final diagnosis. It can be seen readily that overlap occurs between all ranges. The total number of such tests, performed here or reported in the literature (Lundh, 1962; Hartley, Gambill, Engstrom, and Summerskill, 1966; Bramwell Cook *et al*, 1967) is not large and at present the ranges of normal and abnormal results are loosely defined. The test is therefore employed in an overall assessment of glandular function but does not distinguish between the various disease processes involving the gland.

In this study the lower limit of 'normal' is $11.2 \mu\text{-equiv/ml/min}$, if calculated as the mean normal minus 2 standard deviations (*ie*, $22.8 - 2 \times 5.8$). On the other hand the upper limit for the 'pancreatitis' range, calculated as the mean plus 2SD ($6.73 + 2 \times 4.34$) is $15.4 \mu\text{-equiv/ml/min}$. Values of 11 to $15 \mu\text{-equiv/ml/min}$ are therefore difficult to assess. Only one case of pancreatitis out of 22 had a value greater than $15.4 \mu\text{-equiv/ml/min}$, and three exceeded $11.2 \mu\text{-equiv/ml/min}$. Similarly only one 'normal' out of 16 had a value of less than $15.4 \mu\text{-equiv/ml/min}$. The three patients who had recovered from acute pancreatitis had values high in the normal range (Fig. 3); no abnormality was detected in the two diabetics or three other normals with impaired glucose tolerance. Clearly carcinomata of the common bile duct ($M = 15.73$, $SD = 7.63$) or of the body of the pancreas could not be readily differentiated from normals or from cases of mild pancreatitis.

The six cases of carcinoma of the head of the pancreas are grouped with one extensive carcinoma of the body, which also involved the head, and the mean for this group was $2.0 \mu\text{-equiv/ml/min}$ with a standard deviation of ± 1.5 . The range for carcinoma of the head can therefore be regarded as 0 to $5.0 \mu\text{-equiv/ml/min}$. Seven of 22 patients with pancreatitis fell within this range, four of whom had pancreatic duct obstruction from biliary disease and three of whom had generalized pancreatic calcification. The correlation of steatorrhoea and tryptic activity of less than $2.0 \mu\text{-equiv/ml/min}$ was confirmed in seven patients. Our conclusion about the test may thus be summarized:

1 Tryptic activity of less than $15 \mu\text{-equiv/ml/min}$ is unlikely in normals and increasingly associated with abnormality as the value falls. Less than $11.0 \mu\text{-equiv/ml/min}$ is definitely abnormal but non-

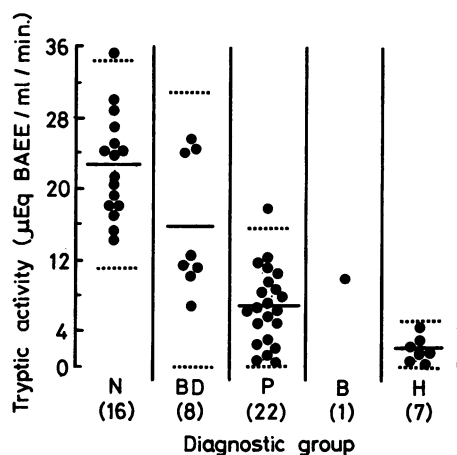


FIG. 2. The results of the Lundh test in 54 subjects shown in relation to the final diagnosis, continuous horizontal lines indicating the mean of each group and broken lines showing values of 2 SD above and below the mean. The diagnostic groups are indicated as follows: N = normal, BD = carcinoma of the common bile duct, P = pancreatitis, B = carcinoma of the body of the pancreas, H = carcinoma of the head of the pancreas.

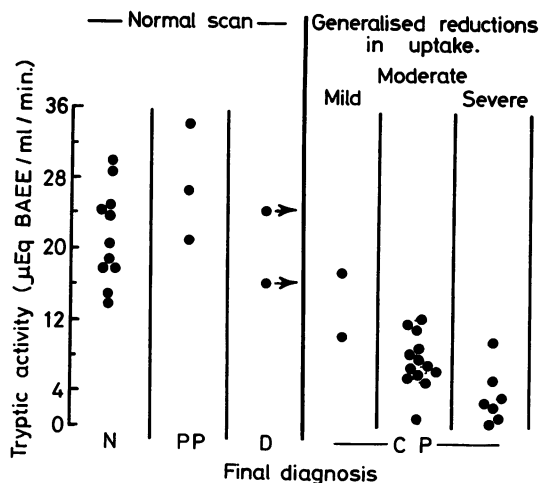


FIG. 3. The general agreement between the measured tryptic activity and the subjective assessment of intensity of isotopic uptake in the scans of normal subjects and those with a generalized rather than a localized abnormality of the pancreas. The diabetics are plotted as reported though the grouping is arbitrary, and the two arrowed scans were not strictly normal (*see text*). The final diagram is indicated as follows: N = normal, PP = past acute pancreatitis, D = diabetic, CP = chronic or relapsing pancreatitis (non-neoplastic disease).

specific. Normal values have been recorded following acute pancreatitis, in diabetics and in normals with impaired glucose tolerance.

2 Tryptic activity is predictably affected by carcinoma of the pancreas only when the lesion lies in the head and unpredictably by carcinoma of the common bile duct.

3 Tryptic activity of less than 5 μ -equiv/ml/min is equally likely to be due to carcinoma of the head of the pancreas, pancreatic duct obstruction, or severe chronic pancreatitis.

4 Tryptic activity of less than 2.0 μ -equiv/ml/min is usually associated with pancreatic steatorrhoea.

SCAN APPEARANCE RELATED TO FINAL DIAGNOSIS Of the eight cases with pancreatic carcinoma five were accurately predicted as lying in the head on the basis of a 'filling defect' or localized abnormality being present on the scan. A further two in the head and one extensive carcinoma of the head and body also gave rise to a 'generalized reduction in uptake' and could not be differentiated from pancreatitis on the basis of the scan alone. Periapillary obstruction, irrespective of cause, often gave rise to a picture identical to that seen in severe chronic pancreatitis, and interpreting a scan is particularly difficult in this situation, even when additional factors such as the splenic uptake and liver patterns are taken into account.

The scan was abnormal in all eight cases of carcinoma of the lower end of the common bile duct. Five cases presented solely as localized filling defects in the head. Two cases had particularly poor isotopic uptake in the head associated with a less striking but definite generalized reduction. The remaining case had downward and medial displacement of the head of a normal gland with indentation of its perimeter on the duodenal side. The possibility of the diagnosis was raised preoperatively in two of the cases, solely on the basis of the appearance of the scan, which showed extension of a filling defect upwards towards the hilum of the liver of a degree not usually seen in obstructive jaundice. In six the abnormality was thought to be due to carcinoma of the head of the pancreas, and in two of these the diagnosis of severe pancreatitis was also considered.

None of the 22 cases of pancreatitis, excluding the three recovered cases grouped with the normals, had a normal scan. No case of pancreatitis was diagnosed as 'probable carcinoma' though in six the possibility of carcinoma could not be excluded on the report of the scan alone. The appearance of 'generalized reduction in isotopic uptake', normally a feature of pancreatitis, was noted in a total of 28 cases, which included 22 with pancreatitis, two 'normals' with diabetes, two cases of common duct carcinoma, and

two cases of carcinoma of the pancreas. One diabetic had 'mild' and the other had 'moderate' reduction in radioactivity, but were actually reported as 'normal if allowance is made for the diabetes'.

Eleven of 16 normal patients were reported as having normal scans, as were three patients recovered from acute pancreatitis and the two diabetics described above.

The overall impression from these results was that while a localized abnormality was more likely to be caused by a neoplastic lesion in the pancreas or in an adjacent structure, and 'generalized reduction in uptake' more likely to indicate pancreatitis, both patterns are nonspecific. Accurate distinction of the two cannot be made with confidence solely on the appearance of the scan.

CORRELATION OF THE TWO TESTS In general there was close correlation between the results of the two tests. Some discrepancies existed in all the groups studied.

Fourteen out of the 16 normal patients, including the three with previous acute pancreatitis, were reported as normal on both tests. The two diabetic patients included in the normals had mild and moderate abnormalities on scanning in association with normal Lundh tests. These findings are shown on the left of Figure 3. The two patients are plotted as they were actually reported, the arrows indicating that they could have been plotted in the next and second next columns to the right respectively if the scan had been reported blind.

The scan was reported as showing 'generalized reduction in uptake' in all of the 22 patients with pancreatitis. Their subdivision into 'mild', 'moderate', and 'severe' cases on the basis of the scan is shown related to the duodenal tryptic activity in each case on the right of Figure 3. As can be seen there was again good general agreement between the results of both tests. Depending on whether one regards 15.4 μ -equiv/ml/min, or 11.2 μ -equiv/ml/min as the critical level for differentiating normal from abnormal patients by the Lundh test, either one or three cases of pancreatitis had normal Lundh tests, though the scan was abnormal in all of them.

In neoplastic disease, excluding the isolated case of carcinoma of the body of the pancreas, the results of correlation of the Lundh test and the scans in seven cases of carcinoma of the head and eight cases of carcinoma of the lower part of the common bile duct are shown in Figure 4. In all of these the scan report was of a 'filling defect' or a 'selectively poor uptake' in the head of the pancreas, and in nearly all of them no distinction between the two possible causes was possible on the basis of the scan alone. However, examining the results of the Lundh tests

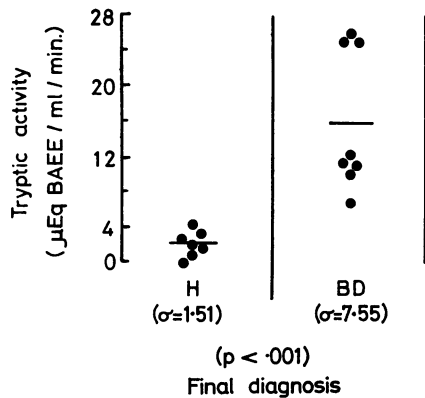


FIG. 4. The mean tryptic activity (horizontal continuous lines) is significantly reduced in the patients with carcinoma of the head of the pancreas (mean = 2.0) when compared with that in patients with carcinoma of the common bile duct (mean = 15.7) by means of a Student *t* test. Both groups had similar localized abnormalities of the scan. Final diagnosis is indicated as follows: H = carcinoma of the head of the pancreas, BD = carcinoma of the common bile duct.

it may be seen that all of the cases of pancreatic carcinoma and none of those with carcinoma of the bile duct had a duodenal tryptic activity of less than 5.0 μ -equiv/ml/min and this difference between the groups was highly significant ($P < 0.001$). This characteristic disparity was noted after six cases had been studied and used to predict the correct diagnosis of bile duct carcinoma in two remaining cases, before surgery. None of the patients with either type of carcinoma were reported as having normal scans but six out of eight of the common duct tumours were associated with tryptic activity $> 11.2 \mu$ -equiv/ml/min. Three of those who had high normal values of tryptic activity also had very good uptake in the main bulk of the pancreas as scanned, but 'mild' or 'moderate' impairment of uptake was additionally noted in the other three cases.

RELATIONSHIP OF IMPAIRED GLUCOSE TOLERANCE, PANCREATIC UPTAKE OF 75 SELENOMETHIONINE, AND DUODENAL TRYPTIC ACTIVITY In a previous study (unpublished) of 23 diabetics, without evidence of pancreatic disease but not subjected to rigorous investigation, 12 had normal scans and 11 had a generalized reduction in isotopic uptake graded 'mild' in six and 'moderate' in five cases. While the relationship between diabetes and abnormality of the scan was therefore unpredictable and inconsistent, nevertheless in the present study the results of a glucose tolerance test were always taken into account

before scan reporting as a possible source of confusion. This problem is taken up more fully in the discussion.

In this study the incidence of abnormal glucose tolerance (a two-hour blood sugar more than 25 mg% above the fasting level) was comparable in all the groups, occurring in six out of 16 patients with carcinoma, in eight out of 22 patients with pancreatitis, and in five out of 16 patients thought to have a normal pancreas. Two of these latter were diabetics, one was recovering from infective hepatitis, and two had had prolonged anorexia and vomiting. Overt clinical diabetes, however, only occurred in one case of carcinoma of the pancreas but occurred in six cases of pancreatitis. Glucose tolerance tests provided no information of discriminative value. There was no correlation between the results of the Lundh test and that of the glucose tolerance test. The glucose tolerance test was normal in 14 patients with proven severe pancreatic disease, duodenal tryptic activity of 0.2 to 10.0 μ -equiv/ml/min, and a generalized abnormality on the scan. The result of the Lundh test was normal in the two uncomplicated moderately severe diabetics whose scans were abnormal. The result of a glucose tolerance test cannot be used therefore to predict the probable presence or absence of pancreatic disease but if abnormal the finding of 'mild' or 'moderate' impairment of uptake on the scan may have no bearing on the presence or absence of pancreatic disease. In patients who had both pancreatitis and diabetes the severity of the scan abnormality appeared to be related to the former rather than the latter but the effects are not easily separated.

DISCUSSION

The study confirmed the value of a normal scan in excluding pancreatic disease in uncomplicated cases. It also illustrated the close correlation between the results of the Lundh test and the scan, in normals and in abnormal with a generalized rather than a localized disease process. In certain defined circumstances the scan is less reliable as a screening test as it is affected by factors unrelated to the severity of disease. This situation arises in diabetics (Lähdevirta, 1967), after vagotomy and gastric surgery (Melmed *et al*, 1968), in starvation (Blau, 1964, Lähdevirta, and Haikonen, 1965), in advanced age or in the presence of gross hepatomegaly (McCarthy *et al*, 1969). Radioactivity may appear diminished in the presence of gross obesity or tense ascites due to increase in the collimator-to-gland distance and comparable emission may arise from isotopic uptake in adjacent structures, such as lymphosarcomata (Herrera, Gonzalez, Schwartz, Diggs, and Belsky,

1965), not easily separated from the gland on scanning. In these situations the Lundh test can be used to obtain more direct information on the exocrine function of the gland. Recent observations in the Department also suggest that anticholinergic compounds, including many antidepressants, should not be administered for 48 hours before scanning.

In assessing the severity of pancreatic disease the places of the two tests are broadly similar; as the scan may yield morphological in addition to functional information in many cases, it has a slight discriminative advantage over the Lundh test in differentiating between neoplastic and inflammatory disease. Provided that the circumstances listed above (10 to 15% of cases) do not render scan interpretation unreliable, the finding of 'generalized reduction in uptake' of isotope is very suggestive of pancreatitis and often associated with cholelithiasis. Furthermore it indicates the severity of functional impairment fairly well. A minority of cases will turn out to have a carcinoma but this problem is not solved by the performance of a Lundh test, and discriminative information is probably best obtained from gas-distension duodenography (Raia and Kreel, 1966), arteriography (Rosch, 1967; Eaton *et al*, 1968), or percutaneous cholangiography in those who are jaundiced (George, Young, Walker, and Sherlock, 1965). In patients shown to have a localized abnormality in the head of the pancreas on scanning, measurement of duodenal tryptic activity may give a very good indication as to whether or not the abnormality is due primarily to a pancreatic tumour, provided that other rare causes of filling defects, *eg*, penetration of an area of the head by a peptic ulcer, mesenteric fibrosis, and mesenteric aneurysms (Melmed *et al*, 1968), can be excluded on other grounds.

The interrelationship of exocrine and endocrine pancreatic function is controversial, but may have an important bearing on the whole subject. Reports on exocrine function in diabetics (Jones, Castle, Mullholland, and Bailey, 1925; Lagerlof, 1939; Pollard, Miller, and Brewer, 1943; Dreiling, 1951; Chey, Shay, and Shuman, 1963; Vacca, Henke, and Knight, 1964; Bock, Bank, Marks, and Jackson, 1967) indicate the presence of mild to moderate pancreatic exocrine insufficiency in 30% to 70% of cases, though in most cases the problem is subclinical. Pathological studies of the pancreas in diabetics (Vartiainen, 1944; Warren and Le Compte, 1952) reveal the presence of pancreatic fibrosis, fatty infiltration, organ shrinkage etc, but the problems underlying all these studies have been shortage of sufficiently critical diagnostic criteria and of aetiological data in the diabetic groups, with consequent failure to exclude occult pancreatic disease as a

primary cause of the diabetes. Again, but subject to similar reservations, several authors have documented the occurrence of abnormal pancreatic scans in diabetics (Sodee, 1966; L dhevirta, 1967; Melmed *et al*, 1968). In those patients studied by L dhevirta the severity of the impairment of isotopic uptake by the gland was partly correlated with the duration of the disease, with insulin dependence and was most noteworthy in 'juvenile' diabetics. This latter group have also been found to have a very high incidence of pancreatic exocrine insufficiency; abnormalities were found in 10 out of 13 patients studied by Chey *et al* (1963).

This poses a considerable problem when reporting on the scans of patients with diabetes and possible pancreatitis. Clearly a detailed study of the whole problem is needed, with particular attention being paid to family history, insulin requirements, serum levels of insulin, growth hormone, synalbumin antagonists, etc, in the diabetic group. Two patients in this study had longstanding diabetes, positive family histories, abnormal scans, and normal Lundh tests, suggesting that the two tests may be unequally affected. In six patients with pancreatitis and overt diabetes neither the results of the scans nor the Lundh tests differed significantly from findings in similar patients without diabetes. In both groups the two tests agreed well. No information is available on the results of the Lundh test in a well-studied group of diabetics. Up to now we have never seen gross impairment of isotopic uptake due to diabetes alone. Furthermore the scan is never very abnormal in patients with a short history of diabetes (L dhevirta, 1967) unless this be secondary to pancreatic disease. In the presence of diabetes and mild impairment of uptake, the scan may still be used to show up a localized abnormality. Otherwise, in the present state of uncertainty, the Lundh test gives a better indication of the adequacy of pancreatic function in the diabetic, especially when assessing the probable cause of steatorrhoea.

In acute pancreatitis neither test is of particular value and equally various glandular functions may return at different rates (Melmed *et al*, 1968) so that apart from the rare case where the diagnosis is in doubt, the tests are best performed following recovery. Because the radiation hazard involved in the Lundh test is negligible it is preferable for investigating the rare undiagnosed acute case or for assessing recovery. It is of interest that the three patients in our series who had recovered from acute pancreatitis not only had normal scans but also had three of the higher recorded levels of duodenal tryptic activity (Fig. 3) suggesting the existence of a phase of increased protein synthesis, possibly related to regeneration, following the acute attack.

CONCLUSION

In the light of this study it seems logical when investigating difficult cases of suspected pancreatic disease first to perform a pancreatic scan when such facilities are available. Patients judged 'normal' by this test do not need a further function study, even if the gland is displaced by an adjacent mass. If the scan shows a diffuse abnormality the Lundh test is unlikely to yield additional useful information except in the presence of diabetes, starvation, advanced age, cholinergic blockade, obesity, ascites, gross hepatomegaly with overlap of the pancreas, or after vagotomy. In all of these exocrine function must be studied directly though the choice of test and interpretation of the results may be difficult. In the presence of a localized abnormality of the head on scanning the results of the Lundh test may indicate whether the pancreas or the common bile duct is the more likely site of the causative lesion. The Lundh test is not reliable in the diagnosis of pancreatic tumours involving the body or tail of the gland. Neither test is of much value in acute pancreatitis. When clinical suspicion of carcinoma is associated with a generalized abnormality on the scan, angiography, duodenography, or cholangiography, rather than a further function test, are more likely to be of help in differentiating pancreatitis and carcinoma.

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