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A Clinical Evaluation of the Method

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ABSTRACT

Angiography of the pancreas and the liver was performed in 69 patients, and in about 85 % there was a good correlation between the angiographic findings and the results of operations or autopsies. The difficulties are greatest in diagnosis of carcinoma of the pancreas and of small metastasis of the liver. A relatively low concentration of the contrast medium was used and did not diminish the angiographic information.

INTRODUCTION

The roentgenological methods that are used in the diagnosis of diseases of the pancreas and liver are all based either on an alteration of the shape or vascular anatomy of the involved organ or on changes of the anatomy of the adjacent organs.

Examinations of the stomach and duodenum with barium contrast medium are of limited value. Thus a barium meal examination of the stomach in carcinoma of the pancreas gives positive findings in only 25–30 %, in the form of dislocation or dilatation of the duodenal loop, and in some cases impression of the stomach (7). Percutaneous transhepatic cholangiography has been considered indicated only when the pathological condition is combined with icterus and is affecting the bile ducts.

Angiographic studies of the pancreas and liver have attracted increasing interest in recent years and as a result our knowledge of the normal and pathological vascular anatomy of these two organs has been widened. The arteriographies are usually performed selectively via the coeliac and superior mesenteric arteries. In certain cases a superselective technique with catheterization of

branches of these smaller arteries has been used, for example catheterization of the gastroduodenal artery. The preoperative angiographic examinations are, apart from being of diagnostic value, also of great value for the planning and performance of an explorative laparotomy.

However, the interpretation of the angiographic findings in both the arterial and venous phase in the regions of the pancreas and liver still offers considerable problems. We have therefore considered it motivated to report the angiographic findings in relation to clinical observations at surgical operations and autopsies at the University Hospital, Uppsala, during the years 1968–1970.

MATERIAL

The composition of the material can be seen in Tables I and II. In 20 cases the diagnosis was made clinically without operation and the patients were followed up for 1–3 years (Table I). In 49 cases the disease was verified at operation or autopsy. Of these, 33 were men of ages 39–75 years and 16 were women of ages 36–68 years (Table II).

The indications for angiography were obstructive jaundice, palpable tumour, severe diffuse abdominal pain and/or loss of weight. In one case gastric stenosis and colonic stricture, previously verified roentgenologically, led to further angiographic investigation. Finally, in one case angiography was performed consequent to a laparotomy at which carcinoma of the pancreas was suspected.

In one patient the angiographic examination was indicated by episodes of hypoglycaemia.

METHOD AND PROCEDURES

In all 69 patients the conventional arteriographic technique according to Seldinger was used. In 56 patients

Table I. *Age at investigation of male and female patients who did not undergo operation*

Age at investigation	Male	Female	Total
15–19		1	1
20–24			
25–29			
30–34	1		1
35–39			
40–44	2	1	3
45–49			
50–54	3	1	4
55–59	1	2	3
60–64	3	1	4
65–69	2	1	3
70–74	1		1
Total	13	7	20

selective arteriography of the coeliac and superior mesenteric arteries was performed, and in 26 of these the contrast medium was injected simultaneously into these arteries via a Y-tube. In 11 patients only the superior mesenteric artery was examined. In 2 patients aortography alone was performed.

A grey Ödman catheter was used in 64 catheterizations and a thin-walled red Ödman catheter in 15.

The contrast media varied during the investigation period. At the beginning of 1968, 76% Urografin® was used in 12 examinations, and this was followed by 60% and 45% Urografin in 21 and 30 cases, respectively. From the beginning of 1970 Angiografin® was used in 16 cases and in 2 cases a recently synthesized dimer, Rayodal® (Pharmacia), was used. In a few patients two different contrast media were used. The contrast injection was given with a Cisal II pressure syringe (3–5 kp/cm^2). The technical equipment, including the film changer and tube, was identical in all cases and a film-focus distance of 90 cm was used throughout the investigation period.

The angiographies were evaluated both at the time of the examination and at a further survey of the material. At the latter evaluation the examiner had no knowledge of the results of the autopsy or operation.

The following anatomical changes in the vascular system were noted as criteria of pathological processes:

1. luminal changes
2. displacement of vessels
3. pathological vessels
4. pathological filling with contrast medium (in some cases defects in a contrast-filled organ)
5. changes in the venous system.

COMPARISON BETWEEN CLINICAL FINDINGS (OPERATION/AUTOPSY) AND ARTERIOGRAPHY

Table III shows the results of comparison between the findings at operation and/or autopsy and angiographic observations. In 36 patients there was full agreement between the primary roentgenological diagnosis and the operation or autopsy findings. In 11 patients the arteriographic result was interpreted as negative, while operation and/or autopsy revealed pathological changes. In 2 patients, on the other hand, the arterio-

Table II. *The diagnoses of the 49 laparotomized patients, grouped according to sex and age at investigation*

The same patient could thus have several diagnoses, e.g. carcinoma of pancreas and metastases in the liver

	35–39		40–44		45–49		50–54		55–59		60–64		65–69		70–74		75–79		Total		
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂+♀
Ca of pancreas					1		1		2		3	1	1	1			2		10	2	12
Insuloma				1			1												1	1	2
Pancreatic metastases (melanoma)														1					—	1	1
Pancreatitis			1		1				1										3	—	3
Liver metastases		1			1		1	2	2		2	2	1	1			2		9	6	15
Primary liver tumour					1						1								2	—	2
Cirrhosis of liver															1				1	—	1
Ca of bile ducts					1					1		1							1	2	3
Chronic cholecystitis															1				1	—	1
Neurofibroma in mesentery													1						1	—	1
Mesenteric metastases									1		1								2	—	2
Abd. wall abscess														1					—	1	1
Sarcoma of stomach									1										1		1
Ca of stomach						1														1	1

Table III. *Number of patients with agreement and with dis-agreement between the findings at operation (autopsy) and arteriography at the primary evaluation*

0, the operation or roentgenological finding was normal; +, pathological changes were seen at operation or arteriography

No. of patients	Findings at	
	Operation (autopsy)	Arteriography (primary evaluation)
13	0	0
23	+	+
11	+	0
2	0	+

graphic findings were regarded as positive while no pathological changes were noted at operation.

The 20 patients who were only assessed clinically, without operation, and whose arteriographies showed normal conditions were followed up clinically for 1–3 years and appeared healthy on physical examination.

The diagnosis in those patients in whom positive findings were made both at the primary roentgenological examination and at the following operation or autopsy can be seen in Table IV, which also shows the results of secondary evaluation of the angiograms. The follow-up examination gave no additional information over and above that obtained at the primary evaluation.

It can be seen in Table IV that carcinoma of the pancreas and tumour of the liver (metastases mostly from the pancreatic tumour) comprised the largest groups in this material. The other diagnosis were found only in isolated cases. The predominant angiographic changes in carcinoma of the pancreas were luminal changes in the arteries and occlusion of the splenic vein. Liver tumours (metastases) gave rise to displacement of the arteries in the liver in all cases. Contrast filling of (in some cases defects in contrastfilled) liver parenchyma occurred in 2/3 of the cases. In 2 of the patients with liver tumours occlusion of the splenic vein was observed. These liver tumours were metastases from carcinoma of the pancreas. Pancreatitis was present in 3 cases and gave rise to varying degrees of vascular changes and pathological vessels but in no case was there any occlusion of the splenic vein.

Patients for whom poor agreement was obtained between the primary arteriographies and the operation or autopsy findings are presented in Table V. On secondary evaluation of the arteriograms in these cases changes in arteries or veins were observed in only a few of them. In the 5 patients with carcinoma of the pancreas the angiographies were not selective in 2 cases and were thus not of sufficiently high quality. Among 8 patients with liver metastases, pathological

Table IV. *Diagnoses and numbers of patients for whom there was agreement between the primary angiographic diagnosis and the findings at operation or autopsy*

The findings made on secondary evaluation of the angiograms are noted in the table

Diagnosis at operation/autopsy	n	Secondary evaluation				
		Displaced vessels	Luminal changes	Pathol. vessels	Contrast filling/ filling defect	Occlusion splenic vein
Ca of pancreas	7	2	7	2	2	6[a]
Insuloma	1	0	0	0	1	0
Pancreatitis	3	1	2	2	1	0
Liver tumour/metastases	9	9	4	5	6	2[b]
Gall bladder disease	1	0	0[c]	0	0	0
Ca of gall bladder	1	1	0	0	0	1
Mesenteric tumour	2	2	2	0	0	0
Tumour of stomach	1	1	1	1	0	0

[a] One case with occlusion of splenic artery.
[b] Carcinoma of pancreas present in both cases.
[c] Profuse vascularization and tortuous vessels corresponding to gall bladder.

Table V. *Diagnoses and numbers of patients for whom no agreement was obtained between the primary angiographic diagnosis and the findings at operation or autopsy*

The findings made on secondary evaluation of the angiograms are noted in the table

Diagnosis at operation/autopsy	n	Secondary evaluation				
		Displaced vessels	Luminal changes	Pathol. vessels	Contrast filling/ filling defect	Occlusion splenic vein
Ca of pancreas	5[a]	0	3	0	0	2[b]
Melanomal metastases in pancreas	1	0	0	0	0	0
Insuloma	1	0	0	0	0	0
Liver metastases	8	0	0	0	2	6[c]
Ca of bile ducts	2	0	1	0	0	0
Cirrhosis of liver	1	0	0	0	0	1[d]
Ca of colon	1	0	1	1	1	0
Sarcoma of stomach	1	0	1	1	1	0
Negative operation	3	0	0	1[e]	0	0

[a] Two cases not examined selectively, only aortographies.
[b] Not evaluable in one of the cases.
[c] Ca of pancreas present in 5 cases.
[d] Splenic vein thrombosis also present.
[e] Pathological vessels in the liver.

changes in the form of relatively blurred defects in the contrast-filled liver parenchyma were noted in only two of them on secondary evaluation of the angiograms. In 6 of the patients with liver metastases, on the other hand, occlusion of the splenic vein was seen, and in 5 of these there was associated carcinoma of the pancreas. Two

Table VI. *Numbers of patients in whom the angiographic diagnosis was erroneous and thus was not verified at subsequent operation or autopsy*

The final diagnosis is given in the table, as well as the primary roentgenological diagnosis

Diagnosis at operation/autopsy	n	Primary roentgenological diagnosis
Ca of pancreas	5	Not evaluable (2), arteriosclerosis (1), 0 pathol. (1), status post op. (1)
Melanomal metastasis in pancreas	1	0 pathol.
Insuloma	1	0 pathol.
Liver metastasis	8	0 pathol.
Ca of bile ducts	2	0 pathol.
Cirrhosis of liver	1	0 pathol.
Ca of colon	1	Ca pancreas
Sarcoma of stomach	1	Pancreatic tumour
Neg. operation	3	Pancreatic tumour (2), liver metastasis (2)

patients with carcinoma of the bile ducts could not be diagnosed at the primary examination, and on secondary evaluation of the angiograms a minor change in the lumen of the gastroduodenal artery was observed in only one of them. An insuloma which was not diagnosed at the primary examination but which was found at operation, was not observed on secondary evaluation of the angiograms either. In one patient the changes seen on primary assessment of the angiograms were interpreted as due to carcinoma of the pancreas, but at the secondary evaluation the lesion was localized to the colon, which had also been verified at operation. In one patient with sarcoma of the stomach the angiographic findings were interpreted primarily as being due to carcinoma of the pancreas, but on secondary evaluation of the angiograms there was difficulty in deciding which organ gave rise to the changes.

The primarily erroneous roentgenological diagnoses are presented in Table VI, where the clinical and pathologico-anatomical diagnoses are given.

Table VII presents patients for whom agreement was obtained between the angiographical and clinical findings, and for whom the final diagnosis was carcinoma of the pancreas. The most common changes in carcinoma of the pan-

Table VII. *The findings on secondary inspection of the angiograms from patients in all of whom both the primary diagnosis and the operation diagnosis was carcinoma of the pancreas*

Secondary evaluation	Case no.						
	1	2	3	4	5	6	7
Occlusion of splenic vein	−	+	+	+	+	+[a]	+
Pathological parenchymal phase	+	−	+	−	−	−	−
Pathological vessels	+	−	+	−	−	−	−
Luminal changes	+	+	+	+	+	+	+
Vessel displacement	+	−	+	−	−	−	−

[a] Occlusion of splenic artery also.

Table VIII. *Results of secondary evaluation of the angiograms in those cases where operation and autopsy showed carcinoma of the pancreas but where this diagnosis could not be made at the primary angiographic evaluation*

Secondary evaluation	Case no.				
	1	2	3	4	5
Occlusion of splenic vein	+	−	*	**	−
Pathological parenchymal phase	−	*	*	−	−
Pathological vessels	−	*	*	−	−
Luminal changes	+	*	*	+	+
Vessel displacement	−	*	*	−	−

* Not evaluable.
** Spleen extirpated.

creas were luminal alterations and occlusion of the splenic vein.

The 5 patients who showed disagreement between the primary angiography and the final diagnosis, which was carcinoma of the pancreas, are presented in Table VIII. Further evaluation of the angiograms have only sparse additional information. The angiograms were of deficient quality to a strikingly large extent in these patients, which rendered the assessment difficult. A similar detailed analysis is presented for the liver tumours (primary or secondary) (Tables IX and X). When tumours were observed at the time of the angiographic examination, which was the case in 9 patients, displacement of blood vessels was the most usual manifestation of the tumour and the further evaluation of the angiograms also verified this finding. As seen in Table IX there was no displacement of vessels in 8 patients, in whom, however, metastases were found at operation or autopsy even though the primary arteriography was considered normal.

DISCUSSION

In many studies that have dealt with the results of arteriography in diseases of the pancreas and liver, the number of patients reported has varied greatly. Alfidi et al. (1) described a material of 195 patients in whom arteriography was used in the diagnosis of diseases of the liver. Of these, however, half of the examinations revealed normal conditions. In an extensive study mainly concerning pancreatic diseases, Sammons et al. (13)

reported the results of selective arteriographies of the coeliac and superior mesenteric arteries in 900 cases, performed over a period of 10 years. In about 400 of these cases the diagnosis was confirmed at laparotomy or autopsy. Many of the patients, however, were in the terminal stage and died outside the hospital, so that no definite frequency of positive findings was obtainable from this large material.

Our material is small but in all of our cases the diagnosis was confirmed either at operation, autopsy or clinical follow-up examination. About 30 % of the angiographies in our series showed normal conditions. This is probably an expression of the fact that we had relatively stringent indications for abdominal angiography.

The criteria which we used and which have

Table IX. *The angiographic findings in those patients in whom the angiograms primarily showed liver tumours (metastases) and where this diagnosis was verified at subsequent operation or autopsy*

Secondary evaluation	Case no.								
	1	2	3	4	5	6	7	8	9
Occlusion/no filling of splenic vein	−	−	−	−	+[a]	−	+[a]	−	−
Pathological parenchymal phase	+	+	−	−	+	−	+	+	+
Pathological vessels	+	−	+	−	+	+	+	−	−
Luminal changes	+	−	+	+	−	−	+	−	−
Vessel displacement	+	+	+	+	+	+	+	+	+

[a] Ca of pancreas.

Table X. *The findings at secondary inspection of angiograms from patients in whom no metastases or other liver tumour were observed at the primary evaluation, but where such metastases or tumours in the liver were observed at operation or autopsy*

Secondary evaluation	Case no.							
	1	2	3	4	5	6	7	8
Occlusion/no filling of splenic vein	+[a]	−	+[b]	+[a]	+[a]	−	+[a]	+[a]
Pathological parenchymal phase	+	−	−	−	−	−	−	+
Pathological vessels	−	−	−	−	−	−	−	−
Luminal changes	−	−	−	−	−	−	−	−
Vessel displacement	−	−	−	−	−	−	−	−

[a] Ca of pancreas.
[b] Liver metastases with unknown primary tumour.

been used by other authors for evaluating the arteriographic changes are, however, relatively similar in the different roentgenological investigations: arterial luminal changes, newly formed abnormal vessels, pathological contrast-filling or filling defects in the liver or pancreas, changes in the venous system and occlusions of any form, and displacement of blood vessels.

Pancreas

Pathological filling with contrast medium means, as a rule, a richly vascularized tumour. We found a case of insuloma in this way. On the other hand, displacement of a blood vessel within the pancreas is a relatively uncertain sign of a tumour, provided that no very large pancreatic tumour is present, for example a pancreatic cyst. In agreement with Sammons et al. (13) and Lunderquist (6), our study confirms that the variation in the vascular anatomy is considerable.

Like Bookstein et al. (4), we have found that occlusions of arteries and veins are common in carcinoma of the pancreas. Moskowitz et al. (8) claim that arteriosclerosis gives irregular changes of blood vessels, whose irregular segments are shorter than those seen when a tumour is infiltrating the vessel wall. They point out that the effect on the splenic vein is a relatively early sign of carcinoma of the pancreas, perhaps earlier than an arterial occlusion. However, chronic pancreatitis can result in fibrosis, which also can affect the splenic vein.

Reuter et al. (11) discuss the differential diagnosis between carcinoma of the pancreas and pancreatitis and consider that there are relatively good possibilities of distinguishing between them angiographically. The arterial changes seen in most patients with pancreatitis are, however, unspecific and are often found also in arteriosclerosis. Relatively little interest has been devoted to the occurrence of arteriosclerosis in, for example the intrapancreatic branches. In the splenic artery, however, arteriosclerotic changes are most common in the middle part, and this artery is then often very long and tortuous. Our material cannot, however, contribute with further information on the differential diagnosis between pancreatitis and carcinoma of the pancreas. In all the cases with a primary carcinoma of the pancreas and positive angiographic findings the lesions were found unresectable at laparotomy. In one case with a metastasis in the pancreas with luminal changes of the vessels but no occlusion of the splenic vein a radical pancreatic-duodenectomy could be performed.

Liver

Nebesar & Pollard (9) reported a certainty of 92 % in the angiographic diagnosis of a liver tumour, but they pointed out that a negative angiogram did not exclude the presence of a tumour in the liver. Their material consisted mainly, however, of richly vascularized, primary liver tumours and cholangiocarcinomas. In cases where liver tumours were demonstrated angiographically in our material the liver was usually greatly infiltrated by metastases or the tumours were very large. In one patient not only did angiography reveal large metastases in the right liver lobe but also suspected metastases in the left lobe. At subsequent operation large metastases were found in both lobes, but in the left lobe they were considerably smaller. In another patient large metastases were diagnosed correctly in the right lobe, but walnut-sized metastases in the left lobe escaped angiographic detection.

Margita Freedens et al. (5), on the basis of a study of 71 patients, point out the difficulties of observing liver metastases in carcinoma of the pancreas. They state that in only about half of their patients could metastases be observed on the angiograms. Similarly, Alfidi et al. (1) found that the metastases often gave rise to only very

minor changes on the hepatograms. This is probably due to the fact that they are avascular. Baum et al. (2) point out that metastatic tumours in the liver can be diagnosed mainly by the fact that they affect and displace blood vessels. Boijsen & Abrams (3) mention the value of splenoportography for localization of extensive liver tumours and point out the frequent simultaneous presence of liver cirrhosis. In our material there was one patient with cirrhosis of the liver, but no tumour was found in this liver; an occlusion of the splenic vein was the only finding.

Autopsy was performed in 10 of the liver tumour cases in our material. As a rule the metastases had been found at operation. In one patient in whom the liver was seen to be full of metastases, only enlargement of the liver had been diagnosed at operation 2 months previously. Another patient with central carcinoma of the liver was diagnosed at operation as liver cirrhosis. Sammons et al. (13), similarly, point out the difficulty of observing a tumour at laparotomy, even if it has been possible to localize it at a preoperative angiography.

Technique

The technique in performing the arteriographies is of great importance. An injection into the aorta is completely insufficient. Our present method involves injection of contrast medium into one artery at a time, and the earlier method of simultaneous injection into the coeliac and superior mesenteric arteries has been abandoned. The so-called superselective technique recommended by Reuter et al. (11), among others, is not used routinely at present in our hospital. We consider that an exposure frequency of three frames per second during the first 3–4 seconds is necessary for visualization of the arterial branches, and in order to visualize the venous phase the examination time must be extended to 25–30 sec. This seems to be a generally accepted opinion nowadays. Stereo-angiography has been recommended by Baum et al. (2), but up to now we have not used this method. It seems, however, to be a technique that is well worth more general use.

We are using to an increasing extent relatively low-concentration contrast media and have completely abandoned the use of contrast media of high concentration (76% and higher) which we

and other authors used previously. No important information has been lost by the use of lower concentrations (45–60%), i.e. between 218–280 mg I/ml. The patients regard it a considerable advantage to have less discomfort caused by pain. That means less movement during the examination, which makes easier to use the subtraction technique.

Furthermore, in this way the endothelial damage that has been described in association with high concentrations of contrast media can probably be minimized.

The reliability of the angiographic method as regards the vascular anatomy of the pancreas and liver varies even when an optimal technique is employed. This is due partly to the pathological condition. Most easily diagnosed are richly vascular tumours and large dislocating processes. The difficulty is still greatest in diagnosis of carcinoma of the pancreas and of small metastases in the liver (diameter less than 2 cm). Long experience and large materials increase the certainty and give reason for the examinations to be carried out in large central departments or, alternatively, for the films to be evaluated by experienced roentgenologists. The angiographic technique is improved with the use of different drugs, and we have had especially good experience of bradykinin in studies of the liver and of the portal system.

REFERENCES

1. Alfidi, R. J., Rastogi, H., Buonocore, E. & Brown, C. H.: Hepatic arteriography. Radiology *90:* 1136, 1968.
2. Baum, S., Roy, R., Finkelstein, A. F. & Blakemore, W. S.: Clinical application of selective celiac and superior mesenteric arteriography. Radiology *84:* 279, 1965.
3. Boijsen, E. & Abrams, H. L.: Roentgenologic diagnosis of primary carcinoma of the liver. Acta Radiol *3:* 257, 1965.
4. Bookstein, J. J., Reuter, S. R. & Martel, W.: Angiographic evaluation of pancreatic carcinoma. Radiology *93:* 757, 1969.
5. Freedens, M., Egeblad, M. & Holst-Nielsen, F.: The value of selective angiography in the diagnosis of tumors in pancreas and liver. Radiology *93:* 765, 1969.
6. Lunderquist, A.: Angiography in carcinoma of the pancreas. Acta Radiol, Suppl. *235:* 1965.
7. Lundh, G.: Pankreascancer. Läkartidningen *65:* 47, 1968.

8. Moskowitz, H., Chait, A. & Mellins, H. Z.: "Tumor encasement" of the celiac axis due to chronic pancreatitis. Amer J Roentgenol *104:* 641, 1968.

9. Nebesar, R. A. & Pollard, J. J.: A critical evaluation of selec celiac and superior mesenteric angiography in the diagnosis of pancreatic diseases, particularly malignant tumor: facts and "artefacts". Radiology *89:* 10: 7, 1967.

10. Reuter, S. R.: Superselective pancreatic angiography. Radiology *92:* 74, 1969.

11. Reuter, S. R., Redman, H. C. & Joseph, R. R.: Angiographic findings in pancreatitis. Amer J Roentgenol *107:* 56, 1969.

12. Reuter, S. R., Redman, H. C. & Bookstein, J. J.: Differential problems in the angiographic diagnosis of carcinoma of the pancreas. Radiology *96:* 93, 1970.

13. Sammons, B. P., Neal Jr, M. P., Armstrong Jr, R. H. & Hager, H. E.: Ten years' experience with celiac and upper abdominal superior mesenteric arteriography. Amer J Roentgenol *101:* 345, 1967.

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