Role of fistulography in evaluating pancreatic fistula after pancreaticoduodenectomy

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Objective: To evaluate the usefulness of fistulography as a diagnostic and management tool for clinically suspected pancreatic fistulas (PF) after pancreaticoduodenectomy (PD).

Methods: 84 consecutive fistulographies were performed for clinical suspicion of PF and retrospectively analysed. We radiologically defined two types of PF by means of fistulography, PF1 in the case of primary filling with contrast agent of the jejunal loop or stomach and PF2 in the case of secondary filling of the jejunal loop or stomach through a fistulous tract or a fluid collection.

Results: In 35/84 (41.7%) of the fistulograms, a PF1 was demonstrated owing to an instantaneous opacification of the intestinal lumen or the stomach, without evidence of a fistulous tract or fluid collection. In 49/84 (58.3%) fistulograms, a PF2 was demonstrated by the depiction of a fluid collection and/or a fistulous tract and a communication with the intestinal loop or the stomach anastomosed with the pancreas. The mean healing time of a PF after PD was 2.7 days for PF1, and 9.8 days for PF2.

Conclusion: Fistulography helps in the confirmation of clinically suspect PF, and can distinguish PF1 and PF2, thus decreasing post-operative morbidity significantly.

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Pancreaticoduodenectomy (PD) is a complex surgical procedure with less than 5% mortality in high-volume centres [1–9]. However, morbidity remains high, with consequent prolonged hospitalisation and high costs [2].

Pancreatic–intestinal leakage and subsequent pancreatic fistula (PF) is the most frequent complication of PD, and occurs when a pancreatic anastomosis fails to heal, with an incidence that ranges from 9.9% to 28.5% [1–10]. The occurrence of PF is related to pre-operative, intra-operative and technical predictive risk factors [3, 7, 8]. Not least important of these is the post-operative management of the drainage catheters used to detect fluid collections, abscesses and bleeding [9].

The International Study Group on Pancreatic Fistula (ISGPF) defined a PF as “a leakage from the drainage catheter of every measurable volume of fluid during or after the third post-operative day with an amylase content three times higher than the serum amylase concentration”. A clinical impact grading was also proposed as follows: Grade A for a transitory leak without any clinical consequence (biochemical leak); Grade B for the need of clinical treatment consisting in fasting, parenteral nutrition, antibiotics and somatostatin analogues; and Grade C for the need of further invasive measures implying prolonged hospitalisation time and life hazard [1]. However, no radiological parameters are reported in this definition.

In the surgical and radiological literature the role of conventional fistulography in the management of PF after PD is not clearly stated but is considered useful, and has been suggested as a first-line imaging method for a morphological study of clinically suspected PF [3, 11–14].

Fistulography is a cost-effective and readily available dynamic study with a low radiation dose. The purpose of this study was to evaluate the usefulness of fistulography as a diagnostic and management tool for clinically suspected PFs after a pancreaticoduodenectomy.

Methods and materials

Patient population

The study was approved by the Institutional Review Board and all patients gave written informed consent.

A retrospective analysis of 84 consecutive fistulograms was performed between January 2002 and December 2008 (overall duration, 84 months) in 84 patients [63 males and 21 females; average age, 57.3 years; standard deviation (SD), 8.5 years; range, 39–77 years]. The inclusion criteria were the presence of a PF of Grade B or C after PD, according to the definition proposed by the ISGPF [1]. The total number of PDs performed in the same period was 733.

Surgical indications and procedures

Patients underwent a pylorus-preserving PD for different pathological conditions that were histologically

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proven as 62 ductal adenocarcinomas (73.8%), 14 cystic neoplasms (16.7%) and 8 neuroendocrine neoplasms (9.5%). In all cases the texture of the pancreatic remnant was soft.

A pancreaticojejunostomy (PJ) was performed in 67 patients (80.0%), and a pancreaticogastrostomy (PG) in 17 patients (20.0%), depending on the surgeon's experience. One drainage catheter, with radio-opaque markers along its entire length (soft-type easy-flow 12 mm; Chimed R, Livorno, Italy), was positioned behind the hepaticojejunostomy and one behind the PJ or PG [1, 3, 6, 9, 10]. The post-operative anatomy after PD, with either a PJ or PG, is shown in Figure 1.

Fistulography

All fistulographies were performed by two radiologists with 7 and 25 years' experience in abdominal radiology (Sireskop Axiom R200; Siemens, Erlangen, Germany). With the patient in a supine position, a plain radiograph of the abdomen was obtained, in order to locate the tip of the drainage catheter. 25 ml of a water-soluble contrast agent (Gastrografin, Schering, Germany) was injected through the drainage catheter from which fluid leakage was detected (left catheter in 66 patients, 78.6%; right catheter in 18 patients, 21.4%).

The trajectory of the contrast agent, injected through the drainage catheter, was dynamically followed during fluoroscopy. The dynamic phases of the fistulography were recorded on DVD. The degree of patient compliance and total examination time were recorded. The average time of resolution of the PF after fistulography was recorded.

Image analysis

The same two radiologists who performed the fistulography independently analysed the digital images and videos at a workstation. The great majority of readings were performed directly after the procedure by the same radiologist executing the study, and within 1 day by the second radiologist. Only in cases of discrepancies ($n=7$, 8.3%) was an additional combined review needed for the consensus reading.

Fistulograms were analysed to determine the position of the tip of the drainage catheter, the presence or absence of a communication with a jejunal loop or the stomach, a fistulous tract, fluid collections or communication with the main pancreatic duct or biliary tree. The correct position of the tip of the drainage catheter was considered to be near the presumed site of the PJ or PG (Figure 1), approximately over or lateral to the body of first lumbar vertebra in the supine position. The fistulous tract was defined as the contrast-filled channel between the tip of the drainage catheter and a gastrointestinal structure. The length of the fistulous tract, if present, was measured.

In conformity with the clinical definition of a PF by the ISGPF, we radiologically defined two types of PF by means of fistulography. In the first type (PF1) there is primary filling with contrast agent of the jejunal loop or stomach, whereas in the second type (PF2) there is secondary filling of the jejunal loop or stomach through a fistulous tract or a fluid collection. In PF1, amylase-rich fluid in the drainage catheter leaks directly from the gastric or intestinal lumen and is probably due to erosion and migration of the drainage catheter into the anastomosis, as suggested by several authors [1, 5, 10] and

Figure 1. Modified anatomy after pylorus-preserving pancreaticoduodenectomy with (a) a pancreaticojejunostomy or (b) a pancreaticogastrostomy. The three anastomoses for each of these kinds of pancreaticoduodenectomy are indicated: biliojejunal (1), pancreojejunal (2), gastrojejunal (3), pancreaticogastric (4). Also, the positions of the drainage catheters are shown.

Figure 2. A 37-year-old male with a Type 2 pancreatic fistula after pancreaticojejunostomy. (a) Anteroposterior radiograph obtained with the patient in the supine position and with water-soluble contrast medium injected through the left drainage catheter. A fistulous tract is visible (1) between the tip of the catheter (2) and the intestinal loop (3), (b) illustrated in more detail, where the leak site is evident (4). (c) In the late phase, a depiction of the biliary tree was obtained (5).

reported for other anatomical sites [15]. In PF2, leakage occurs from an intra-abdominal fluid collection. Clinically, however, PF1 and PF2 are indistinguishable.

In PF1 the intestinal loop used for the anastomosis is firstly opacified after the injection, and eventually a fluid collection is subsequently evident because of the passage of contrast material through the dehiscence into the abdominal cavity. PF2 is most likely to be recognised because of the presence of a fluid collection around the anastomosis, with or without the evidence of a fistulous tract, in which the injected contrast material pools before passing into the anastomosed loop through the dehiscence.

Statistical analysis

We divided the study population into two groups (Groups A and B) based on the presence or absence of a fistulous tract. Differences in absolute frequencies of parameters of fistulography were analysed using Fisher's exact probability test. Non-parametric tests (Kruskal–Wallis, Mann–Whitney *U*-test) were used to evaluate ordinal data. Values were expressed as mean $\pm$ SD.

A multivariate logistic regression analysis was performed considering PF as the dependent variable and sex, age, histology, type of anastomosis and side of drainage catheter as potentially predictive variables. A Wald test was used in backward method for the selection of variables. A $p < 0.05$ was considered statistically significant. Statistical analyses were performed with SPSS v.15.0 for Windows (Statistical Package for the Social Sciences, Chicago, IL).

Results

A PF, Grade B or C, occurred in 84/733 patients (11.5%). 84 patients underwent fistulography with a median interval after PD of 9.2 days (range 5–15 days). At the time of the plain radiograph, before the injection of contrast medium, the drainage catheter was located near the presumed site of anastomosis (PJ or PG) in all patients. Communication with the jejunal loop or the

stomach (Figures 1–5) was visualised after injection of contrast agent in 76/84 patients (90.5%). A fistulous tract (Figure 2), representing the most reliable imaging finding for diagnosis of PF2, was visualised in 41/84 patients (48.8%). In 40/84 patients (47.6%) a fluid collection (Figures 3 and 4) was visible following the injection of contrast material, and represented the only evident finding in 8 cases. A communication with the main pancreatic duct (Figure 4) or biliary tree (Figures 3 and 4) was recognisable in 18/84 patients (21.4%) or in 36/84 patients (42.8%), respectively.

In 35/84 patients (41.7%) fistulography demonstrated an instantaneous communication with the intestinal loop or the stomach without evidence of a fistulous tract (PF1). In the other 49/84 patients (58.3%), a clinically

Figure 3. A 66-year-old male with a Type 2 pancreatic fistula after a pancreaticojejunostomy. The tip of the drainage catheter is inside a fluid collection (1) that communicates with the biliary tree (2) and the intestinal loop (3).

Figure 4. A 55-year-old female with a Type 2 pancreatic fistula after pancreaticojejunostomy. The tip of the drainage catheter (1) is near the successively opacified intestinal loop anastomosed with the pancreas (2): the fistulous tract was not evident because it is parallel to the X-rays and hidden by the contrast medium in the drainage catheter. The biliary tree (3), a fluid collection (4) and the main pancreatic duct (5) are depicted.

suspected PF was confirmed by fistulography with the depiction of a communication with the intestinal loop or the stomach, a fistulous tract and/or a fluid collection (PF2) (Figure 5).

The presence or absence of a fistulous tract proved to be the most important parameter to distinguish PF1 from PF2 ($p < 0.001$) (Table 1). Fluid collections are most frequently discovered in patients with PF2 (61.0%) ($p = 0.004$). The visualisation of the biliary duct and the main pancreatic duct did not prove significant in distinguishing PF1 from PF2.

The mean fistulous tract length was estimated to be 2.1 ± 1.5 cm (range 0.9–6.1 cm). 28/35 (80.0%) patients with PF1 were diagnosed at fistulography after PJ and 7/35 after PG (20.0%). 39/49 (79.5%) patients with PF2 were diagnosed at fistulography after PJ and 10/49 after PG (20.4%). There was no statistical difference between PJ and PG regarding the occurrence of PF1 or PF2. There was no difference between a right or left catheter injection regarding the prevalence of PF1 or PF2, despite injection by means of the left catheter being more prevalent.

The PF healed in a mean time of 2.7 days ($SD \pm 1.7$) after fistulography in the case of PF1, and 9.8 days ($SD \pm 2.9$) in the case of PF2 ($p < 0.001$). All patients did well after resolution of the fistula.

An additional dose of 25 ml of contrast medium was necessary in 33 patients (39.2%). The whole procedure lasted on average 5 min, with less than 20 s of fluoroscopy, and 2–5 spot films were obtained (mean 3.3), including the plain film before the injection of contrast medium. The procedure was well tolerated by 70 patients (83.4%), while 14 (16.6%) reported mild discomfort. In no case was the procedure terminated because of patient

(a)

(b)

Figure 5. A 57-year-old male with a Type 1 pancreatic fistula after (a) pancreaticojejunostomy and (b) pancreaticogastrostomy. In (a), a direct filling of the anastomotic intestinal loop was evident (1), because the tip of the drainage catheter was positioned inside the lumen (2). A depiction of the biliary tree (3) was also visible. In (b), a direct filling of the stomach was evident (4), because the tip of the drainage catheter was positioned inside the gastric lumen (5).

Table 1. Prevalence of radiological parameters in case of pancreatic fistula of Type 1 (PF1) and Type 2 (PF2)

Parameter	PF1	%	p-value	PF2	%
Fistulous tract	0/35	0	<0.001	41/49	83.7
Instantaneous filling of an intestinal structure	35/35	100	<0.001	0/49	0
Fluid collection	10/35	28.6	0.004	30/49	61.2
Fluid collection without fistulous tract	10/35	28.6	n.s.	8/49	16.3
Main pancreatic duct visualisation	7/35	20.0	n.s.	11/49	22.5
Biliary tree visualisation	15/35	42.8	n.s.	21/49	42.8
Mean post-operative days ($\pm$ SD) before fistulography	9.4 ($\pm$ 5.9)	–	n.s.	9.1 ($\pm$ 6.3)	–
Mean resolution time of the complication [days ($\pm$ SD)] after fistulography	2.7 ($\pm$ 1.2)	–	<0.001	9.8 ($\pm$ 3.7)	–

n.s., not significant; SD, standard deviation.

intolerance. No patients had an increased fluid output from the drainage catheter after fistulography.

Discussion

We relied on different diagnostic criteria for evaluating different radiological scenarios of clinically suspect PF with fistulography: if, while injecting the contrast medium through the drainage catheter, a fistulous tract with the intestinal lumen and/or a fluid collection was highlighted, then the diagnosis of PF1 was confirmed; if an intestinal structure was observed to fill with contrast medium instantaneously without the presence of a fistulous tract, then the diagnosis of PF2 was assigned.

The radiological diagnosis of a PF1 due to dislocation of the drainage catheter into the anastomosed loop had important consequences for treatment of the patient, since such a diagnosis leads to a 3–5 cm retraction of the drainage catheter and to recovery of the clinical complication within 2.7 days [3].

PF1, with the catheter in the gastrointestinal lumen, and PF2, with a fistulous trajectory, are clinically indistinguishable, as confirmed by our multivariate analysis that did not recognise any predictive parameter of PF1 or PF2 subsequently identified by fistulography: in the case of PF2, the amylase-rich fluid in the drainage catheter leaks from an intra-abdominal fluid collection; in PF1, it originates directly from the lumen and is probably due to the erosion and migration of the drainage catheter into the anastomosis, as suggested by several authors [1, 5, 10] and reported for other anatomical sites [15].

Often, migration of the drainage catheter into the gastrointestinal lumen occurs after the fifth post-operative day if the catheter has not yet been removed [1, 3, 9]. It is unlikely that the drainage catheter has an intraluminal location at the time of placement by the surgeon. Instead, we suspect that it migrates into the lumen at the site of a pre-existing anastomotic leak due to dehiscence [1, 3, 9].

Fistulo-CT is able to identify the relationship of a PF with anatomical structures and the presence of other non-communicating fluid collections [12, 16, 17]. However, fistulo-CT has some limitations: it is not a dynamic study; it cannot visualise with certainty the site of the leak and whether the drainage catheter is placed inside the intestinal lumen [16, 17]; and it has higher

costs and a high dose to the patient [18]. Also, endoscopic retrograde cholangiopancreatography and gastrointestinal tract series can sometimes be complementary to fistulography [3, 11–13, 16, 17, 19, 20].

It is therefore important for radiologists to be familiar with fistulography and to be aware of the radiographic features of intraluminal drainage catheter migration, particularly in patients with persistent anastomotic leaks, so appropriate management can be implemented for their expeditious resolution.

Fistulography could be performed as the sole examination in the case of PF1, or prior to CT in the case of PF2 with suspicion of other non-communicating fluid collections [3, 20].

Admittedly, our study had some limitations, including a selection and interpretation bias. Some factors can influence the visualisation of the progression of contrast medium in the abdomen, in particular the amount and the pressure of injection.

Fistulography has advantages, such as its ease of performance, low cost and high availability, as well as limitations, such as its inability to depict the real volume of fluid collections and to study the whole abdomen. Furthermore, reliability of the fistulography technique is related to rigorous adherence to proper execution methods and to operator skill.

In conclusion, our data show that, in expert hands, fistulography can help to confirm the clinical suspicion of post-operative PF and can distinguish between a PF 1 and a PF2, with clinically relevant consequences. In cases of PF1, with an intraluminal position of the drainage catheter itself, the catheter should be retracted by 3–5 cm.

References

1. Bassi C, Dervenis C, Butturini G, Fingerhut A, Yeo C, Izbicki J, et al. International Study Group on Pancreatic Fistula Definition. Post-operative pancreatic fistula: an international study group (ISGPF) definition. *Surgery* 2005;138:8–13.
2. Balzano G, Zerbi A, Capretti G, Rocchetti S, Capitanio V, Di Carlo V. Effect of hospital volume on outcome of pancreaticoduodenectomy in Italy. *Br J Surg* 2008;95: 357–62.
3. Molinari E, Bassi C, Salvia R, Butturini G, Crippa S, Talamini G, et al. Amylase value in drains after pancreatic resection as predictive factor of post-operative pancreatic

- fistula: results of a prospective study in 137 patients. *Ann Surg* 2007;246:281–7.
4. Butturini G, Daskalaki D, Molinari E, Scopelliti F, Casarotto A, Bassi C. Pancreatic fistula: definition and current problems. *J Hepatobiliary Pancreat Surg* 2008;15:247–51.
5. Butturini G, Marcucci S, Molinari E, Mascetta G, Landoni L, Crippa S, et al. Complications after pancreaticoduodenectomy: the problem of current definitions. *J Hepatobiliary Pancreat Surg* 2006;13:207–11.
6. Aranha GV, Aaron JM, Shoup M, Pickleman J. Current management of pancreatic fistula after pancreaticoduodenectomy. *Surgery* 2006;140:561–8.
7. Shrikhande SV, Qureshi SS, Rajneesh N, Shukla PJ. Pancreatic anastomoses after pancreaticoduodenectomy: do we need further studies? *World J Surgery* 2005;29:1642–9.
8. Muscari F, Sue B, Kirzin S, Hay JM, Fourtanier G, Fingerhut A, et al. Risk factors for mortality and intra-abdominal complications after pancreaticoduodenectomy: multivariate analysis in 300 patients. *Surgery* 2005;139:591–8.
9. Kawai M, Tani M, Terasawa H, Ina S, Hirano S, Nishioka R, et al. Early removal of prophylactic drains reduces the risk of intra-abdominal infections in patients with pancreatic head resection: prospective study for 104 consecutive patients. *Ann Surg* 2006;244:1–7.
10. Crippa S, Salvia R, Falconi M, Butturini G, Landoni L, Bassi C. Anastomotic leakage in pancreatic surgery. *HPB (Oxford)* 2007;9:8–15.
11. Tamm EP, Jones B, Yeo CJ, Maher MM, Cameron JL. Pancreaticogastrostomy and the Whipple procedure: radiographic appearance and complications. *Radiology* 1995;196:251–5.
12. Trerotola SO, Jones B, Crist DW, Cameron JL. Pylorus-preserving Whipple pancreaticoduodenectomy: post-operative evaluation. *Radiology* 1989;171:735–8.
13. Heiken JP, Balfe DM, Picus D, Scharp DW. Radical pancreatectomy: post-operative evaluation by CT. *Radiology* 1984;153:211–15.
14. Kwon SH, Oh JH, Kim HJ, Park SJ, Park HC. Interventional management of gastrointestinal fistulas. *Korean J Radiol* 2008;9:541–9.
15. Wilmot AS, Levine MS, Rubesin SE, Kucharczuk JC, Laufer I. Intraluminal migration of surgical drains after transhiatal esophagogastratomy: radiographic findings and clinical relevance. *AJR Am J Roentgenol* 2007;189:780–5.
16. Hashimoto M, Koga M, Ishiyama K, Watarai J, Shibata S, Sato T, et al. CT features of pancreatic fistula after pancreaticoduodenectomy. *AJR Am J Roentgenol* 2007;188:323–7.
17. Frick MP, Feinberg SB, Stenlund RR, Gedgaudas E. Evaluation of abdominal fistulas with computed body tomography (CT). *Comput Radiol* 1982;6:17–25.
18. Bauhs JA, Vrieze TJ, Primak AN, Bruesewitz MR, McCollough CH. CT dosimetry: comparison of measurement techniques and devices. *Radiographics* 2008;28:245–53.
19. Alexander ES, Weinberg S, Clark RA, Belkin RD. Fistulas and sinus tracts: radiographic evaluation, management, and outcome. *Gastrointest Radiol* 1982;7:135–40.
20. Stanley RJ. Commentary on two classic GI studies. *AJR Am J Roentgenol* 2007;189:24.