Complications of Biliary and Gastrointestinal Stents: MDCT of the Cancer Patient

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OBJECTIVE. The goal of this article is to discuss and show the common complications of biliary and gastrointestinal stents as depicted by MDCT in cancer patients. Major complications include stent misplacement or displacement, bleeding, obstruction, perforation, stent fracture or collapse, and infection. This topic encompasses several relevant issues, including interpretative difficulties, therapeutic decisions, and potential malpractice concerns.

CONCLUSION. Awareness and methodical assessment of stents could allow detection of stenting complications, potentially sparing the patient from associated morbidity and mortality.

Stents and endoprostheses are used with increasing frequency not only to reestablish patency in malignant and refractory benign stenoses of the biliary and gastrointestinal tract, but also to seal perforations (iatrogenic) and divert flow (fistulas and leaks) [1–3]. This minimally invasive approach, carried out radiologically as well as endoscopically, allows the narrowed viscus lumen to be kept patent, decreasing the obstructive impairment of the hepatobiliary and gastrointestinal function, with consequent relief of patient symptoms and improvement in quality of life [1–3]. Placing stents in cancer patients is usually performed to treat advanced nonresectable tumors, but in some cases the stent is placed as a "bridge" to surgery (Table 1).

Stents are placed with high success rates (> 90%) [4, 5]. However, complications may develop during positioning, usually being recognized immediately by the operator, or may be detected after placement by diagnostic imaging as early (first 30 days after placement) or late (> 30 days) events [2, 3, 6, 7] (Table 2). Malignant stenoses are more prone to most complications than benign stenoses, although the clinical failure of a stent procedure is not always caused by tumor-related factors [7]. Chemotherapy, antiangiogenic therapy, and radiation therapy may increase the likelihood that complications will develop [7]. Consequently, for adequate treatment planning, the eligibility of the patient to undergo chemotherapy or radiotherapy should be considered before a stent is placed.

MDCT provides a comprehensive display of the stent and of the anatomic area in which the stent has been placed, thereby revealing possible complications. The purpose of this article is to illustrate the MDCT findings in patients with complicated biliary and gastrointestinal stents.

CT Technique

CT has several distinct advantages over endoscopic and conventional radiographic studies for visualizing stents and diagnosing associated complications. MDCT provides high-resolution images not only of the stent, but also of the wall of the biliary or enteric segment where the stent is allocated and the surrounding fat planes, organs, and structures. Whereas endoscopy and conventional radiologic studies show only intraluminal changes, CT depicts extraluminal signs of complications such as free peritoneal air, retroperitoneal gas, or fluid collections. The major limitations of MDCT include radiation dose, which is cumulative, and financial costs, especially if it is used solely to survey an indwelling stent.

IV contrast medium injection should be performed in all cases, although sometimes emergency scanning may be performed without contrast injection. Rapid contrast delivery (> 4 mL/s) is needed to detect active bleeding (CT angiography), but an injection rate of 2–3 mL/s is adequate for routine imaging. In our institution, two acquisition phases are used—arterial and venous—to optimally assess the stent by showing the

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TABLE 1: Indications for Stent Placement in Various Anatomic Sites, According to [1–3, 9]

Anatomic Site	Indication for Stent Placement	Possible Cause
Biliary tract	Inoperable malignant obstruction of the extrahepatic bile ducts and ampulla	Hilar cholangiocellular carcinoma, gallbladder carcinoma, pancreatic head carcinoma
	Benign extrahepatic stricture	Surgery, chronic pancreatitis, iatrogenic ampullary injury
	Bile duct stone refractory to extraction	
	Postsurgical fistula	Bile leak
Esophagus	Inoperable malignant stricture	Esophageal carcinoma, tumor recurrence, mediastinal tumors
	Iatrogenic perforation	
	Actual or impeding tracheal fistula	
	Benign stricture refractory to balloon dilation and not amenable to surgery	
Stomach and duodenum	Inoperable malignant outlet obstruction	Gastroduodenal tumors, compressing extrinsic tumors or nodal masses, anastomotic recurrence
	Malignant fistula to adjacent organs	
	Postsurgical fistula	
	Benign stricture refractory to balloon dilation and not amenable to surgery	
Colon	Inoperable malignant stricture	Sigmoid-rectal carcinoma, pelvic masses, anastomotic recurrence
	Malignant fistula to vagina or bladder	
	Resectable acute malignant obstruction (bridge to surgery)	
	Postsurgical fistula	
	Iatrogenic perforation	

presence and extent of residual or recurring tumor tissue and to identify, at the same time, any regional and distant metastases.

Oral contrast medium should be administered routinely, whereas contrast material is given rectally only occasionally in the case of a colorectal stent complication. Water contrast medium allows better visualization of the gastrointestinal wall and the stent by providing the best contrast gradient. However, positive contrast medium (i.e., iodine based) may be useful in cases of suspected perforation or fistula because it is easier to identify extraluminal contrast material.

Coronal, sagittal, and oblique views and curved images along the stent pathway are useful to show the anatomic relationships of the prosthesis [8]. Volume-rendering images are particularly helpful to analyze the position of the stent and detect any fracture or collapse.

Evaluating the Stent

Stents used to overcome malignant biliary and gastrointestinal stenoses are made of plastic or metal. Stents to treat the latter, usually made of nitinol or stainless steel, can be bare, partially covered (at the center), or covered. The internal nonporous membrane prevents tumor growth through the mesh. Uncovered stents migrate less frequently, but they have significantly higher obstruction rates because of tumor ingrowth. Some covered biliary stents are bare at the ends or have drainage holes at the extremities to prevent obstruction of the cystic duct or of the intrahepatic side ducts [9]. Finally, stents can be balloon expandable or, more frequently, self-expanding [1, 10]. Stents may have a variable diameter and length. These devices can be placed during endoscopy through the viscus lumen or under fluoroscopic or endosonographic guidance through the viscus lumen or percutaneously [9, 11]. Stents can be permanent or retrievable, the latter type being almost always fully covered. Drug-eluting and biodegradable stents have also been developed recently but have not entered clinical practice [9].

The checklist for radiologists interpreting images showing stents includes determining stent type, purpose, position, patency, and integrity and identifying persistent tissue (inflammation, free air, fluid or contrast material, enhancement, bleeding) if present. When evaluating a patient with a stent in place, radiologists should clearly indicate in their report the kind of device and its position even if the examination is being performed for indications other than suspected stent-related complications such as cancer staging or follow-up.

Plastic and metallic stents can be easily visualized and differentiated from one another on MDCT images. Plastic stents are used in the biliary tract and pancreatic duct and appear as thin tubes, straight or curved, with a continuous wall and with two or more struts anchoring their ends to prevent migration. Metallic stents are often larger than plastic ones and show a typical reticular wall (mesh) that can be readily recognized using very large window settings (Fig. 1). In the case of biliary stents, radiologists should describe the exact position of both the proximal extremity (i.e., within the right, left, or main bile duct) and the distal extremity (i.e., above the papilla, across it, or deeply below it and in the duodenal lumen) [12].

Misplacement and Displacement

Stents may be deployed incorrectly or may dislodge after a variable interval of time after placement. Migration seems to occur more frequently with covered stents, probably because of their weaker anchorage, than with uncovered stents [1]. Although usually spontaneous, stent migration may sometime be caused by surgical, endoscopic, or percutaneous maneuvers [13]. Stent migration may cause obstruction, hemorrhage, and perforation [14, 15] or may have no consequence;

TABLE 2: Frequency of Most Common Stent-Related Complications in Various Anatomic Sites

	% of Complications Reported[a]			
Stent Complications	Esophageal Stenting	Colorectal Stenting	Biliary Tract Stenting	Gastric and Duodenal Stenting
Primary complications				
Procedure-specific mortality	1.4			
Technical failure		4–11		
Stent fracture			8	
Stent collapse				4.6–11
Stent migration		22		
Migration of bare stents		4.4–11.8		
Migration of covered stents	25–32			
Secondary complications				
Stent obstruction		7.3–17		
Encrustation (sludge) in stent			2–6	
Hemorrhage	3–8			
Chest pain	12–14			
Abdominal pain	2.5			
Recurrent dysphagia	8.2			
Tumor regrowth with bare stents				17–50
Tumor regrowth with covered stents			13	
Biliary obstruction				1.3
Cholecystitis			1.9–12	
Cholangitis			0.3–22	
Liver abscess			0.3–0.5	
Pancreatitis			2	
Fistulization	2.8			
Perforation		2.5–7		
Tenesmus		5		
Gastroesophageal reflux	3.7			

[a]Data are from [2, 3, 5–7, 11, 17, 21].

for example, one of our patients had a plastic biliary stent that was passed with the feces.

The incorrect position of a misplaced or displaced stent is frequently overlooked, especially when the patient is asymptomatic [16]. However, prompt recognition of misplaced or displaced stents is important because percutaneous or endoscopic repositioning or removal of the device can be performed before irreversible injuries develop [14, 17] (Figs. 2 and 3). Radiologists should never assume that a device is in the correct position and should always ask themselves and write in their report: What kind of device is this? Does it follow the expected course? Are the extremities of the stent in the expected positions? May the misplaced device be still left in place or should it be repositioned or removed?

Other Complications

Fracture of a stent's wires, possibly causing gastrointestinal bleeding and recurrent biliary obstruction, has been described, but this complication is difficult to detect and is probably underreported [18, 19] (Fig. 4). The fracture can be spontaneous or can be caused by treatment of tumor regrowth such as balloon dilation or argon plasma coagulation. Perforation is an uncommon but possible complication secondary to stent migration or fracture. Anatomic abnormalities, such as diverticula, hernias, or strictures, can favor perforation induced by a migrated stent [20]. Perforation can be free or covered and, depending on the anatomic site, may cause free peritoneal air and effusion, retroperitoneal gas spread, or fistulization with other hollow organs and structures (Figs. 5 and 6).

Stent obstruction can result from several causes including tumor regrowth through the mesh of an uncovered stent (i.e., ingrowth) or at its extremities (i.e., outgrowth), tissue hyperplasia (granulation tissue), luminal impaction (sludge or stones, food, or feces depending on the anatomic site), stent collapse or angulation, insufficient stent diameter, stent fracture, and stent migration [4–6, 21]. The stent patency rate inevitably decreases with time depending on stent size and dwelling time [7, 9, 22]. Duodenal lesions, longer survival time, and a shorter length of stricture are independent predictors of tumor overgrowth in patients with malignant gastroduodenal obstruction treated with expandable metallic stents [22]. Recognition of enhancing tissue within the stent lumen allows a tumor recurrence to be diagnosed and differentiated from other causes of stent obstruction [8]. Diagnosis is important because tumor overgrowth can be efficaciously treated by placing a second stent in the obstructed one [22].

Stent collapse is an uncommon and usually late complication, occurring in patients with longer survival times, and is usually caused by extrinsic compression from tumor growth [5]. Clearly, a stent may always show a slightly reduced diameter through the tumor in comparison with its size above and below a stenosis. However, in cases of stent collapse, the lumen is overtly thin and irregular (Fig. 7). Sanyal et al. [20] reported a case of small-bowel obstruction from the olive of an esophageal stent deployment system.

Superinfection is another potential complication, particularly for patients with biliary stents. Superinfection includes cases of cholangitis and liver abscess [12]. Early infectious complications are less frequent with covered stents and in subjects with a stent in a transpapillary position [6, 12]. Other possible direct and indirect complications include intraluminal bleeding (Fig. 8), acute pancreatitis (Fig. 9), and acute cholecystitis (sometimes emphysematous) [7, 12, 21] (Fig. 10).

Caveats

When interpreting CT scans of patients with biliary and digestive tract stents, it is crucial to have adequate clinical information for correlation with the images, especially if the patient has developed new symptoms or laboratory abnormalities that suggest a stent-related complication. The type of stent, indication for its placement, onset of symptoms, and timing of CT in relation to stent placement are important factors to consider. The images should be obtained with a thin collimation to maximize spatial resolution and should be viewed on different reformatted planes and with different window settings. Wide window settings (i.e., lung window) are particularly useful to detect extraluminal air. Adequate timing of scanning is necessary to recognize the signs of bleeding: If a CT acquisition is performed too early or too late after starting contrast bolus injection, it may be possible, in theory, to miss active bleeding. When interpreting CT images of stents, a subtle reduction in the caliber of a stent while passing through the tumor stenosis should not be confused with stent collapse. Additionally, because nitinol stents do not expand fully until 24 hours after deployment, performing CT earlier could lead to incorrect diagnosis of stent collapse [9]. Finally, two adjacent or overlapping stents should not be confused with fracture of a single stent.

Conclusion

MDCT can detect early and late complications related to biliary and gastrointestinal stents, including stent misplacement and displacement, hemorrhage, obstruction, perforation, and infection. CT has an important role in the early detection of correctable complications of stents and prostheses to prevent further deterioration in biliary and gastrointestinal function. Radiologists should be able to recognize the kind of device in place, whether it is in the correct position, and whether there are any complications related directly or indirectly to the stent.

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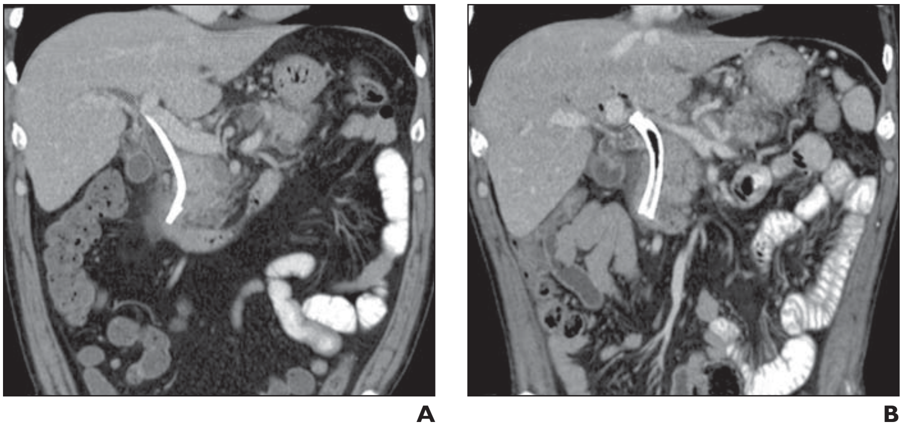


Fig. 1—60-year-old man with pancreatic head adenocarcinoma and noncomplicated biliary stenting.
A, Coronal reformatted CT image obtained 2 months after placement of plastic biliary stent shows noncomplicated biliary duct stenting and nondilated biliary tree.
B, Because of pain and reobstruction, stent was removed 2 months after **A** and metallic prosthesis stent was inserted. Coronal reformatted CT image shows noncomplicated biliary duct stenting and nondilated biliary tree.

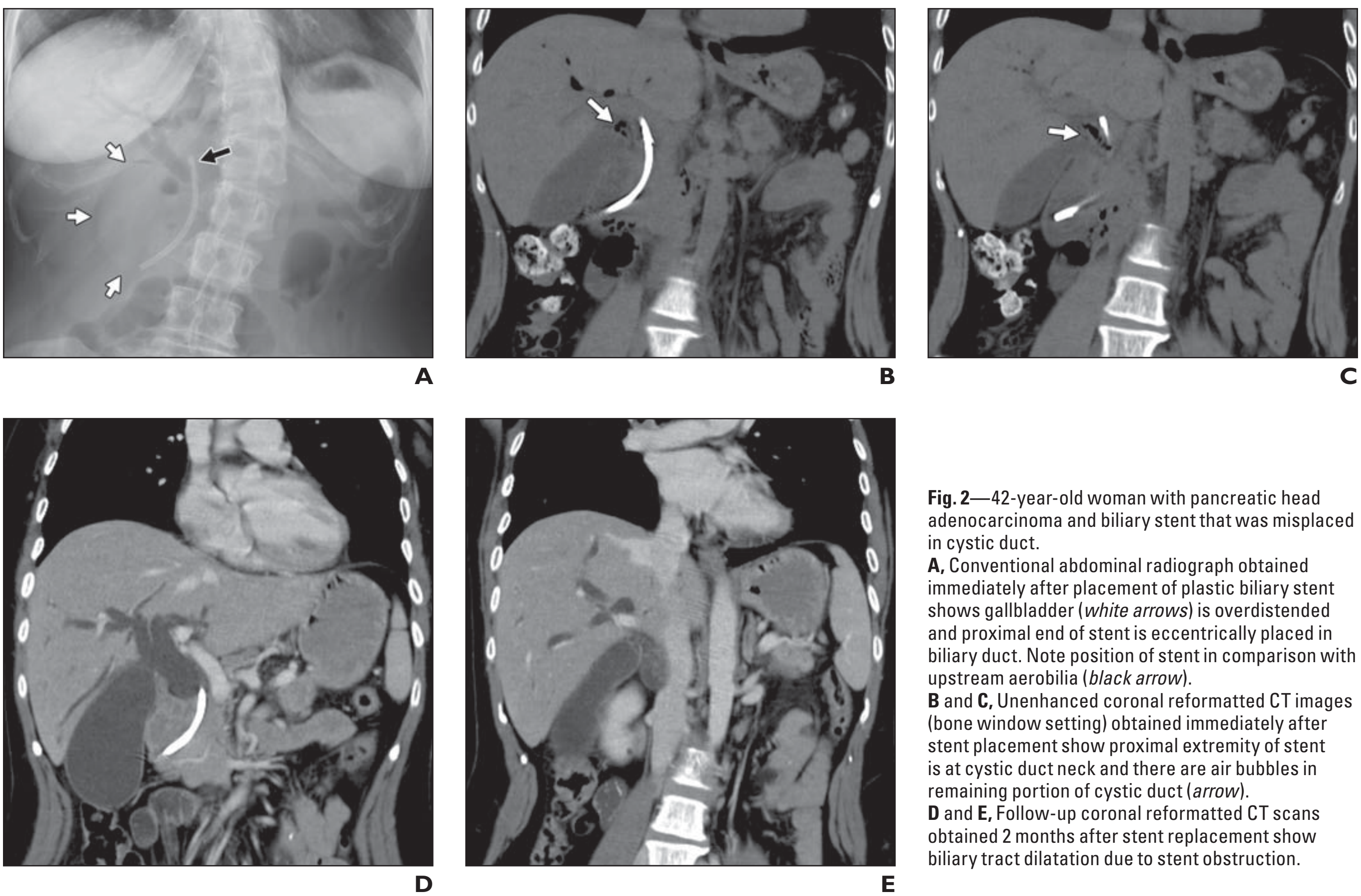


Fig. 2—42-year-old woman with pancreatic head adenocarcinoma and biliary stent that was misplaced in cystic duct.
A, Conventional abdominal radiograph obtained immediately after placement of plastic biliary stent shows gallbladder (*white arrows*) is overdistended and proximal end of stent is eccentrically placed in biliary duct. Note position of stent in comparison with upstream aerobilia (*black arrow*).
B and **C,** Unenhanced coronal reformatted CT images (bone window setting) obtained immediately after stent placement show proximal extremity of stent is at cystic duct neck and there are air bubbles in remaining portion of cystic duct (*arrow*).
D and **E,** Follow-up coronal reformatted CT scans obtained 2 months after stent replacement show biliary tract dilatation due to stent obstruction.

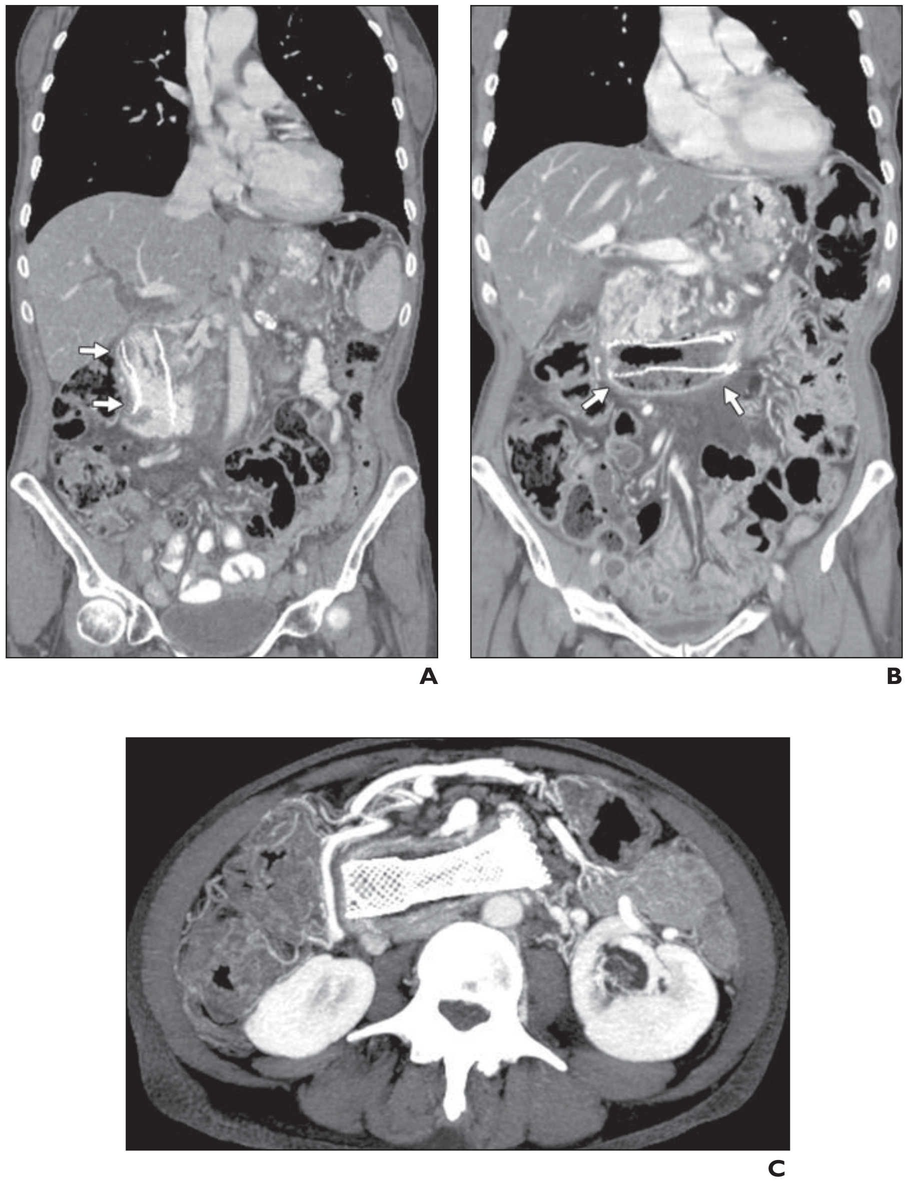


Fig. 3—65-year-old woman with pancreatic head carcinoma and with metallic duodenal stent that became dislodged.
A, Follow-up coronal reformatted CT scan obtained 2 months after stent placement shows stent (*arrows*) is within descending duodenum.
B and **C,** Follow-up coronal reformatted CT scan (**B**) and axial thin-slice maximum-intensity-projection image (**C**) obtained 2 months after **A** show stent is dislodged within third portion of duodenum (*arrows*, **B**).

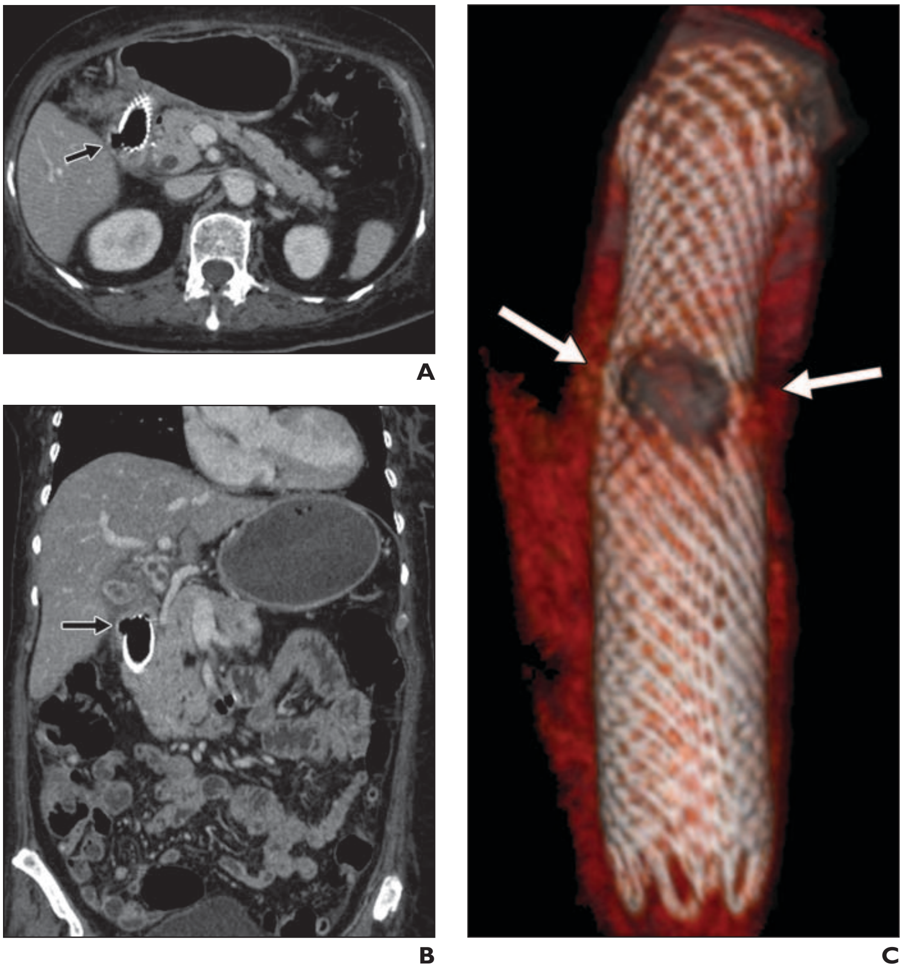


Fig. 4—66-year-old woman with duodenal carcinoma and duodenal stent that underwent fissuration.
A and **B,** Axial (**A**) and paracoronal oblique (**B**) contrast-enhanced CT scans show air-filled recess (*arrow*) adjacent to duodenal stent.
C, Volume-rendering image clearly shows mesh defect (*arrows*).

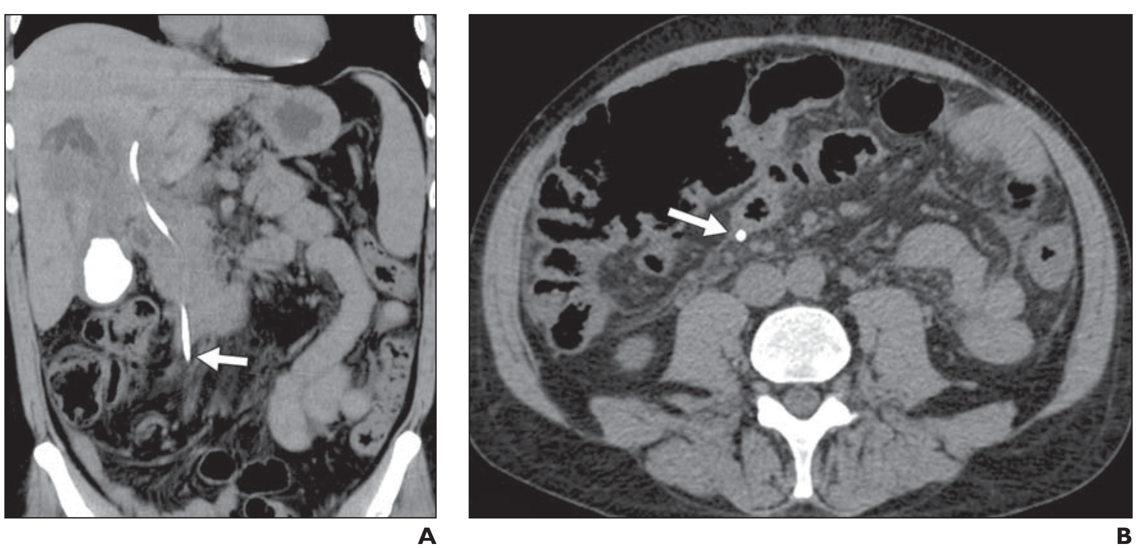


Fig. 5—40-year-old man with hilar cholangiocellular carcinoma and plastic biliary stent that was perforating duodenum.
A and **B,** Unenhanced CT scan shows stent is dislodged distally and is perforating lower duodenal knee (*arrow*). However, there was no indirect CT sign of perforation, such as free peritoneal air, retroperitoneal air, fluid collection, or inhomogeneity of periduodenal fat.

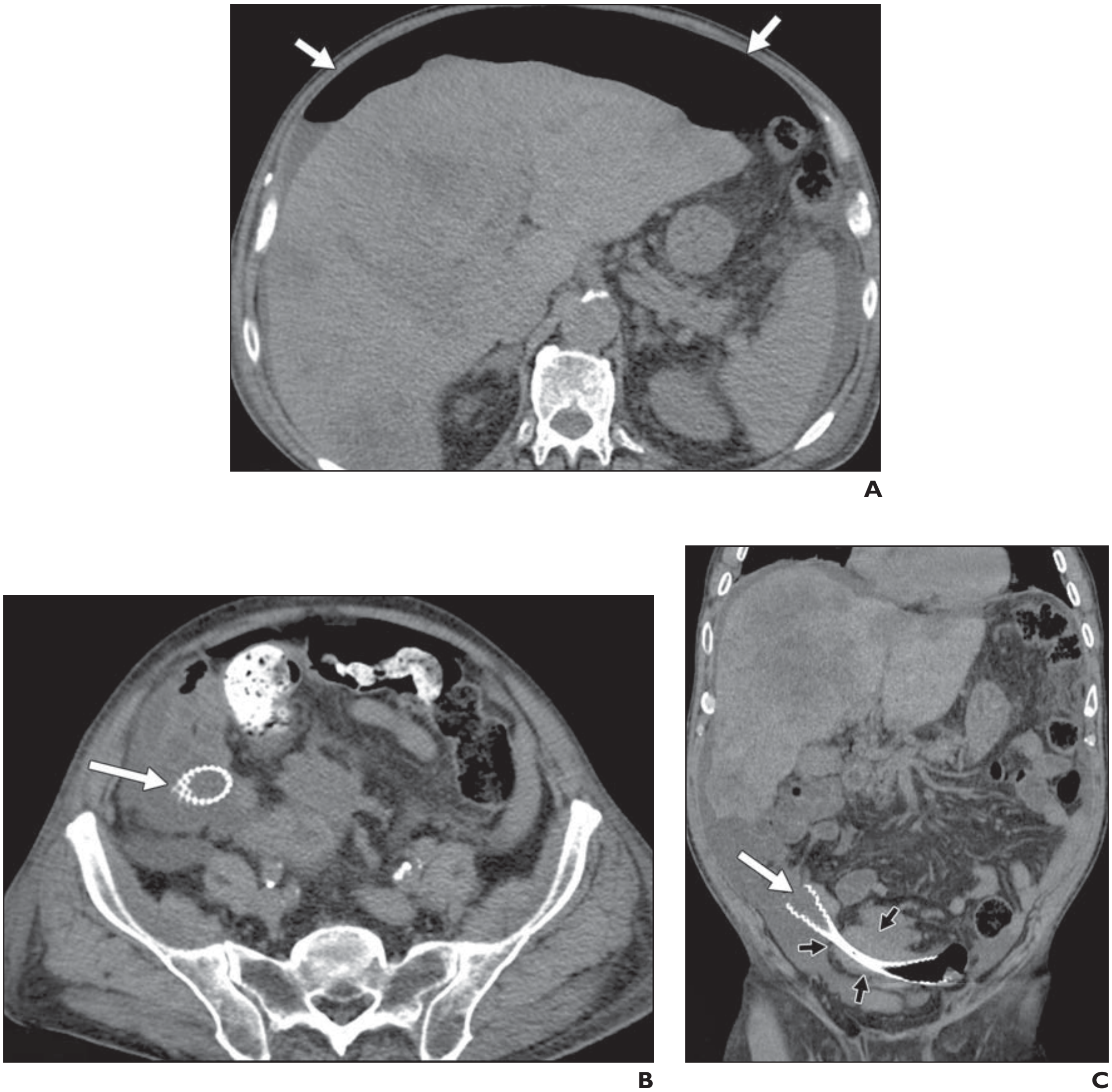


Fig. 6—66-year-old man with sigmoid colon carcinoma, liver metastasis, and perforating sigmoid stent. Emergent unenhanced CT scans were obtained because of sudden onset of abdominal pain and distention 2 months after colonic stenting.
A, CT scan shows free peritoneal air (*arrows*).
B and **C,** CT scans show sigmoid colon thickening (*black arrows*, **C**) and that prosthesis (*white arrow*) is perforating colonic wall and abutting peritoneal cavity.
D, Photograph of surgical specimen shows uncovered metallic prosthesis has perforated colonic wall.

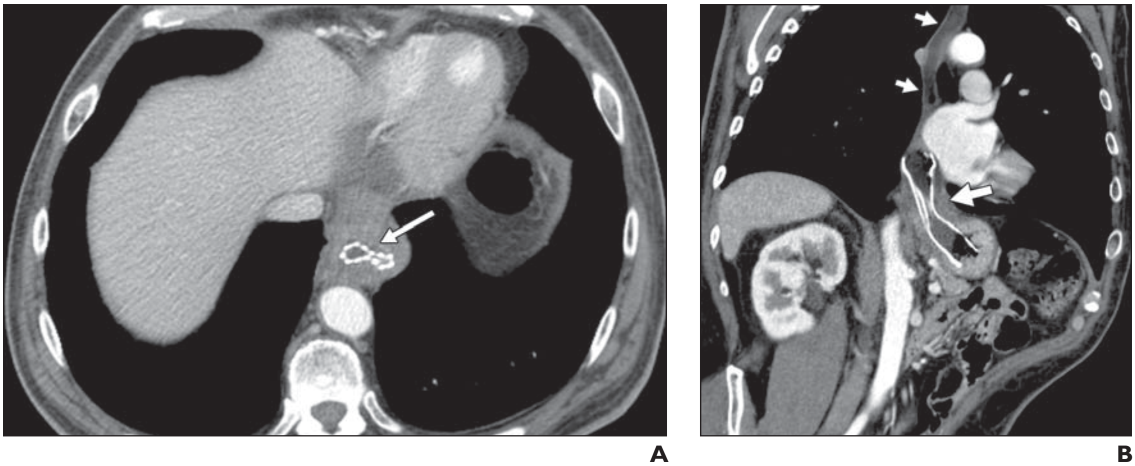
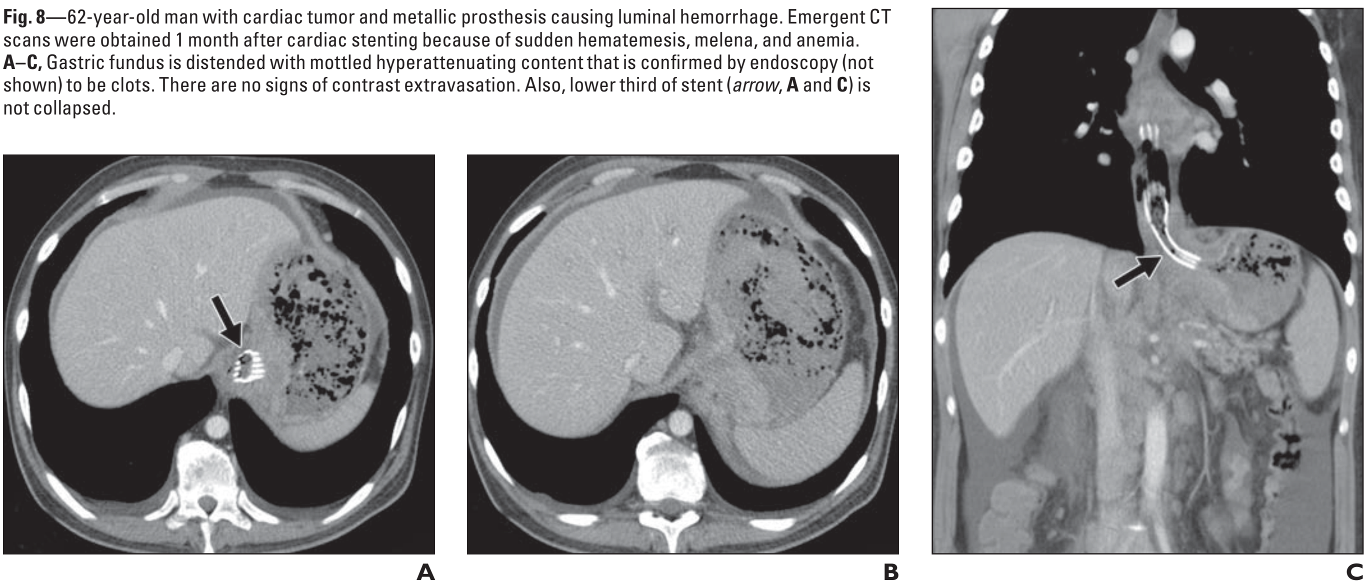


Fig. 7—58-year-old man with cardial tumor and collapsing metallic prosthesis.
A and **B,** CT scans show middle third of stent (*long arrows*) is collapsed with fluid stasis in esophagus (*short arrows*, **B**).

Fig. 8—62-year-old man with cardiac tumor and metallic prosthesis causing luminal hemorrhage. Emergent CT scans were obtained 1 month after cardiac stenting because of sudden hematemesis, melena, and anemia.
A–**C,** Gastric fundus is distended with mottled hyperattenuating content that is confirmed by endoscopy (not shown) to be clots. There are no signs of contrast extravasation. Also, lower third of stent (*arrow*, **A** and **C**) is not collapsed.



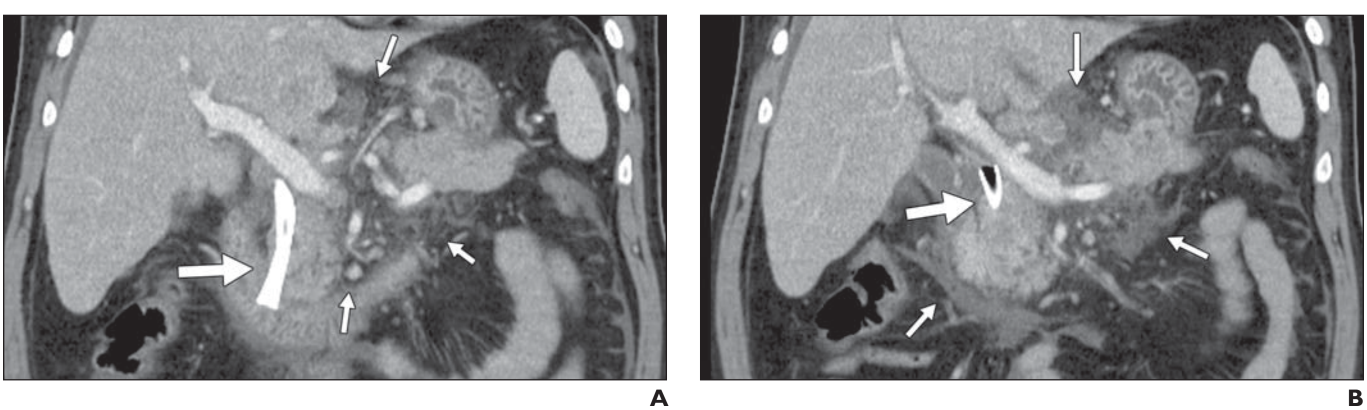
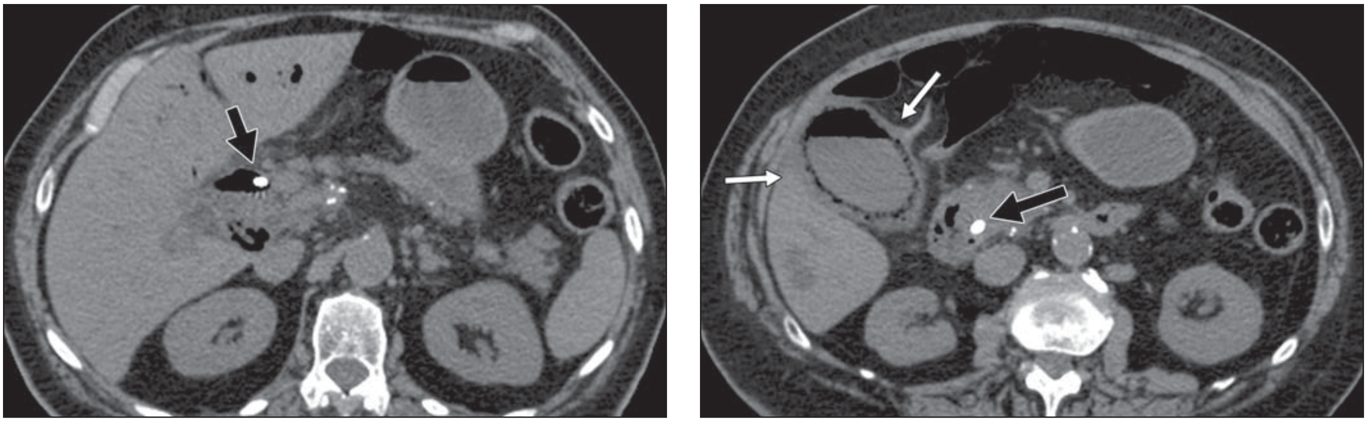


Fig. 9—47-year-old man with pancreatic head carcinoma and stent-related pancreatitis. CT was performed because of sudden onset of abdominal pain 3 days after metallic biliary stenting.
A and **B,** Images show pancreatic head swelling with biliary stenting (*thick arrows*). Diffuse fluid inhomogeneity of peripancreatic fat planes (*thin arrows*) due to acute pancreatitis is seen.



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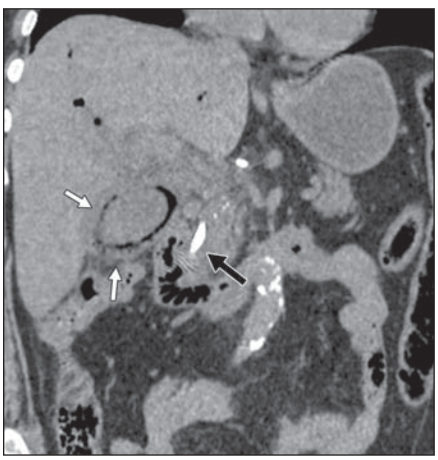

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Fig. 10—79-year-old nondiabetic woman with extrahepatic cholangiocellular carcinoma and biliary stent causing emphysematous cholecystitis. Emergency unenhanced CT was performed because of sudden onset of right upper quadrant pain 2 days after plastic biliary stenting.
A–**C,** Images show gallbladder is distended with luminal and parietal air (*white arrows*, **B** and **C**). Black arrows point to biliary stent.