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CASE REPORTS

Colonic Anastomotic Stenoses and Memotherm Stent Fracture: A Report of Three Cases

Allan Odurny

Department of Radiology, Southampton General Hospital, Tremona Road, Southampton SO16 6YD, UK

Abstract

Deployment of a Memotherm colonic stent (Bard, Angiomed, Karlsruhe, Germany) across anastomotic strictures, following anterior resection, is described in three patients. Two patients presented with symptoms of colonic obstruction. Two of the patients had previously undergone unsuccessful balloon dilatation of the stricture. In the third, in addition to the anastomotic stricture, there was local tumor recurrence. Initially, stenting provided effective relief of symptoms. However, in all three patients, fracture of the stents occurred at intervals of 3–7 months after insertion. This use and complication of colonic stenting has not been reported previously.

Key words: Colon, stenosis and obstruction—Stents and prostheses—Interventional procedures

Since the first descriptions of colonic stenting by Spinelli et al. [1] and Itabashi et al. [2] in 1993, there have been several recent reports of the success of endoluminal stenting in relieving the symptoms of acute colonic obstruction secondary to malignancy. Stenting can be used to achieve temporary decompression prior to definitive surgery [3] or as palliation in patients with colonic obstruction and inoperable disease [4].

Colonic obstruction can also occur following colonic resection, due to the development of benign anastomotic strictures or local tumor recurrence. While anastomotic strictures may respond to balloon dilatation [5], recurrent narrowing can occur. Further surgery in these circumstances can be difficult, particularly with low colorectal anastomoses. Permanent colostomy formation may be necessary.

Treatment of anastomotic strictures with stents is possibly an alternative course of management. The use of stents in colonic anastomotic strictures has not, to our knowledge, been reported previously and the durability of stents in this situation is unknown.

Case Reports

Case 1

A 63-year-old man had undergone an anterior resection 18 months previously for a Duke's B colonic carcinoma. An anastomotic stricture developed 10 months postoperatively. Balloon dilatation of the stricture was undertaken on five occasions over a 7-month period with temporary relief, but rapid recurrence of symptoms. Following an emergency admission for acute colonic obstruction an 80 × 30-mm Memotherm colonic stent (Bard, Angiomed, Karlsruhe, Germany) was deployed across the stricture using fluoroscopic guidance. Stenting produced immediate relief of symptoms with colonic decompression. Six months after stenting the patient complained of passing metallic fragments per rectum. Pelvic radiographs demonstrated stent fracture, although the position of the stent remained satisfactory (Fig. 1). Over the next 5 months further stent fragments were passed, although no recurrence of obstructive symptoms occurred.

Case 2

An 86-year-old man underwent an anterior resection for Duke's B adenocarcinoma. Two years postoperatively, symptoms of abdominal obstruction developed and contrast and CT examinations demonstrated an anastomotic stricture with local tumor recurrence. Curative resection was not possible (Fig. 2). A 100 × 30-mm Memotherm stent was deployed across the stricture. Three months after stenting the patient complained of abdominal pain and vomiting. Abdominal radiographs showed no obstruction, but demonstrated fracture of the mid-portion of the stent. After a further 2 months frank colonic obstruction developed with further stent fracture (Fig. 3). A second 100 × 30-mm Memotherm stent was deployed overlapping the initial stent, with relief of symptoms. The patient died 3 weeks later from cardiorespiratory failure.

Case 3

A 65-year-old man underwent an anterior resection for a large tubovillous adenoma with a defunctioning ileostomy. An anastomotic stricture developed which was treated by balloon dilatation on three occasions. Restenosis occurred following each dilatation. Following the third dilatation a local perforation at the anastomosis was identified. An 80 × 25-mm Memotherm stent was deployed across the stenosis (Fig. 4). Ileostomy closure was undertaken. Seven months following stenting the patient presented with tenesmus and rectal bleeding. Abdominal radiographs demonstrated fracture of the stent with distal migration into the rectum. The stent was removed under anesthesia (Fig. 5).

Discussion

In the three cases described, colonic stenting provided rapid relief of the symptoms of colonic obstruction. Due to the distal nature of the anastomotic strictures stenting was a technically easy procedure in all cases. The use of stents in benign colonic strictures has not been described.

Correspondence to: A. Odurny, FRCR; e-mail: allan.odurny@suht.swest.nhs.uk

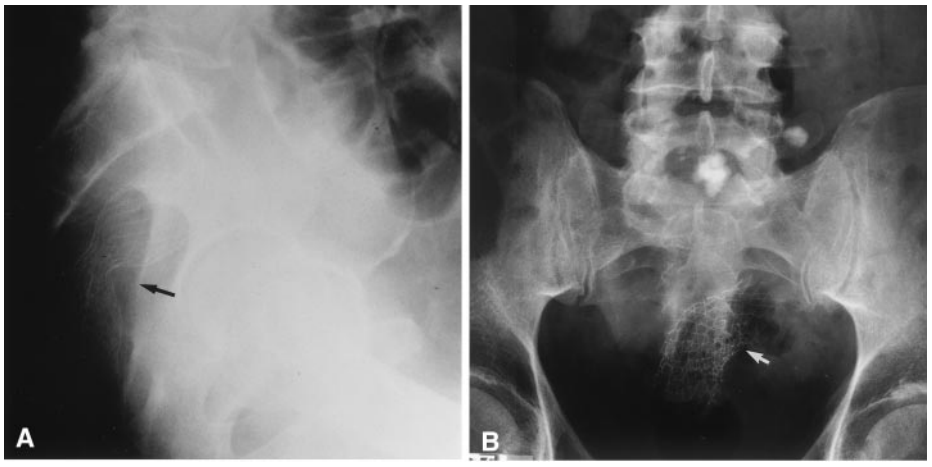

Fig. 1. *Case 1.* **A** Appearances following insertion of an 80 × 30-mm Memotherm stent. There is some residual narrowing of the stent at the site of the stricture (arrow).
B Anteroposterior pelvic view 5 months following insertion showing fragmentation and loss of part of the proximal aspect of the stent (arrow).

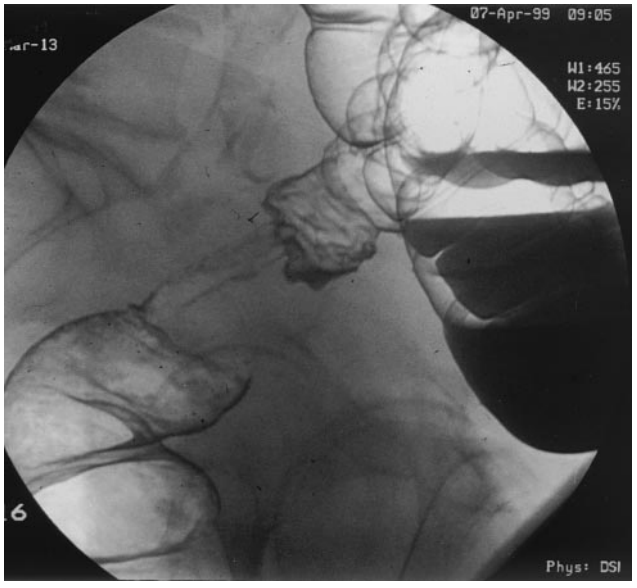

Fig. 2. *Case 2.* Colorectal anastomotic stricture and local tumor recurrence.

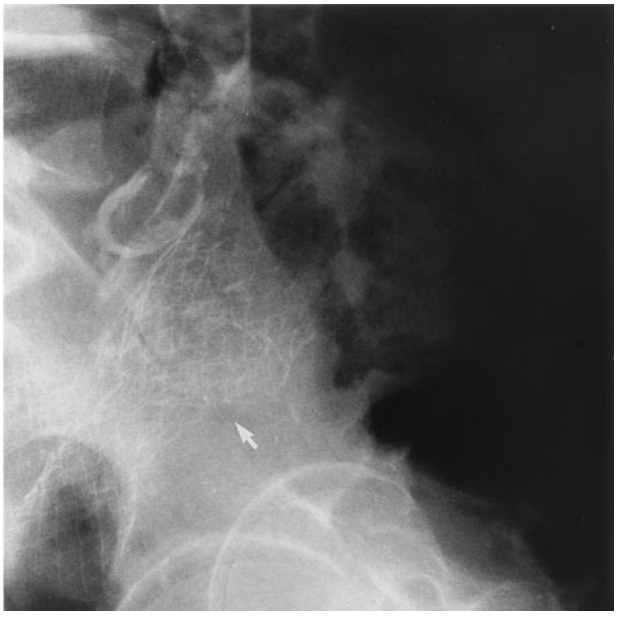

Fig. 3. *Case 2.* Lateral pelvic radiograph 6 months following stent insertion demonstrating a fracture of the middle third of the device (arrow).

Previous usage of colonic stents has been linked to short-term implantation, for preoperative use or for palliation. The mean survival in Diaz et al.'s series of palliative stent insertion was 130 days [4]. While one of our patients had tumor recurrence and a poor prognosis, the other two had no evidence of local recurrence and long-term stenting was envisioned. Stenting of benign anastomotic strictures has been described in the esophagus and gastroduodenal region [6, 7] but not, to our knowledge, in the colon. The two patients with benign strictures had both undergone multiple attempts at balloon dilatation with stricture recurrence developing after each attempt. One of the patients had had several admissions for colonic obstruction; in the other, closure of a defunctioning ileostomy was prevented by the anastomotic stricture. Surgical management of low colorectal anastomotic strictures is difficult. Resection and re-anastomosis may not be possible and a permanent colostomy may be required. As balloon dilatation was deemed to have been unsuccessful, anastomotic stenting was thought to be a reasonable option. The third patient had, in addition to the anastomotic stenosis, local, inoperable tumor recurrence and stenting was performed for palliation.

The durability of stents inserted across benign colonic anastomotic strictures is unknown. There are relatively few reports of fracture of stents made from either nitinol or other materials. However, fracture of Memotherm stents has been reported in the biliary system [9] and in vitro tests [10]. Fracture of non-nitinol stents has been reported in the venous system [11].

Peck and Wattam [9] have suggested that nitinol and stent design may predispose to fracture. Siegerstetter et al. [10] suggest that constant bending forces may be implicated in stent failure. The fibrotic process responsible for benign anastomotic strictures, which persists despite successful stent placement, could produce a constant compressive force. Similarly, acute stent angulation could produce a constant bending force. Although, following deployment, none of the stents in our series demonstrated acute angulation, the

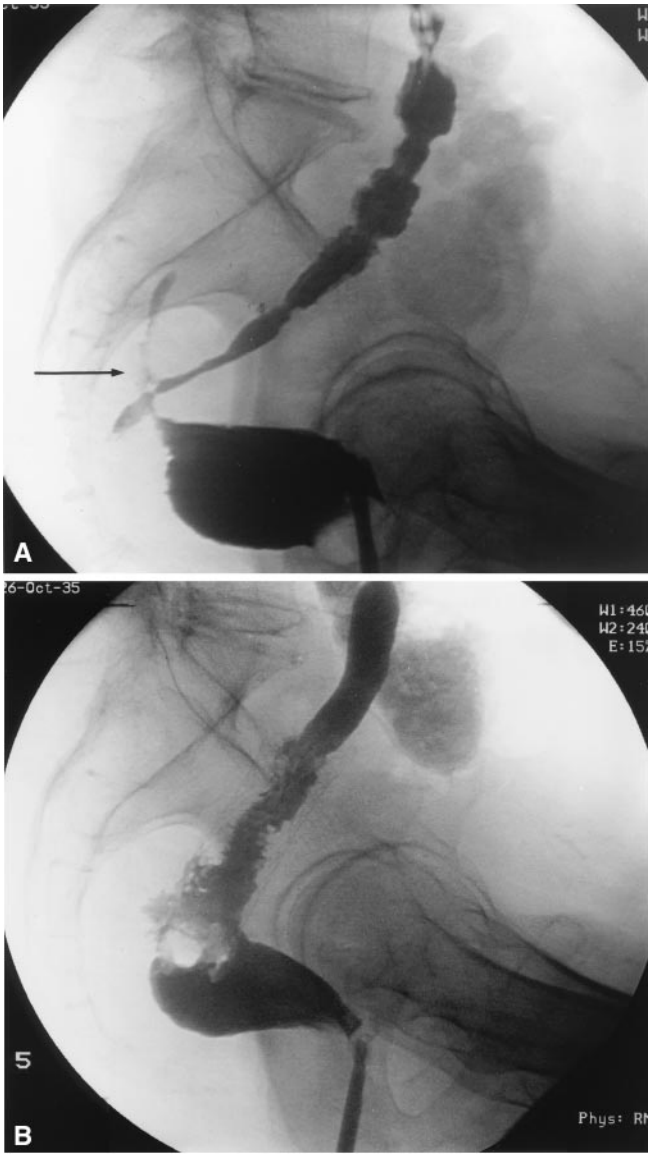

Fig. 4. *Case 3.* **A** Contrast study following balloon dilatation demonstrating persistent anastomotic narrowing with leakage of contrast from the anastomosis into the pre-sacral space (arrow). **B** Following stent insertion, the lumen diameter has improved with minimal contrast leak.

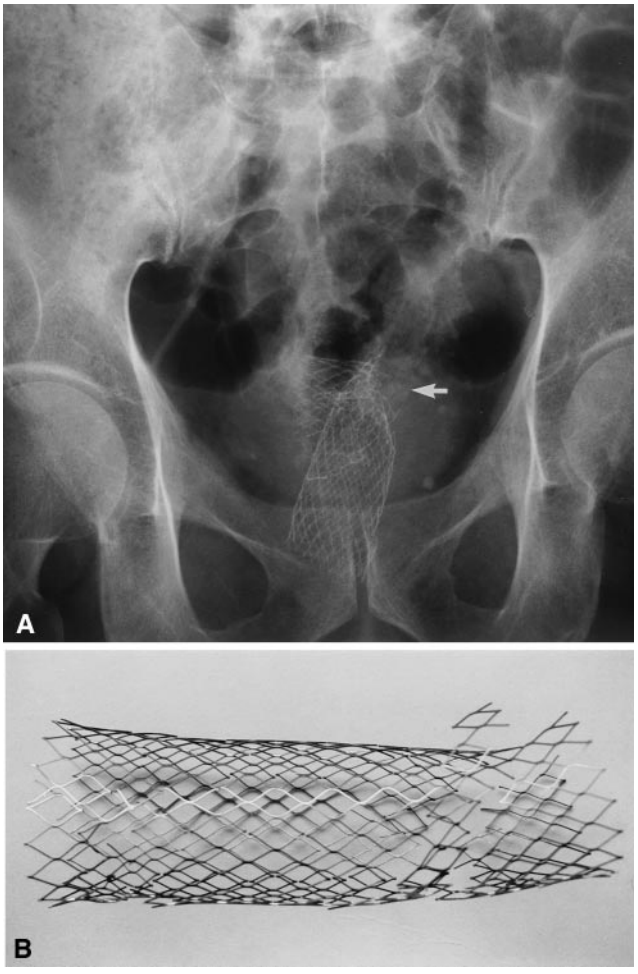

Fig. 5. *Case 3.* **A** Seven months following stent insertion there is evidence of stent fracture (arrow) with migration into the rectum. **B** The stent following removal at EUA showing multiple sites of disruption.

anastomotic stricture in two of our patients was situated at an angled section of the bowel, which was straightened by stent insertion. A bending force on the stent may have persisted. However, we have implanted several nitinol stents in patients with primary malignant strictures and similar angulation with no instances of stent fracture in the short term. Anatomic factors peculiar to anastomotic colonic strictures producing constant compression and the length of time of stent implantation may therefore be the major factors influencing stent fracture. We have not inserted any non-nitinol stents across benign strictures and the durability of such devices in this situation is unclear.

In summary, three cases of fracture of Memotherm stents implanted in patients with colonic anastomotic strictures have been described. While short-term relief of symptoms can be achieved with this stent it seems unsuitable for long-term management. The use of stents in the management of colonic anastomotic strictures is of uncertain benefit.

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Percutaneous Biliary Reconstruction: A Report of Two Cases Utilizing "Blunt" Recanalization and "Rendezvous" Techniques

Michael Wallace, Michael Middlebrook

Section of Vascular/Interventional Radiology, Memorial Hermann Hospital and The University of Texas Health Science Center at Houston, 6431 Fannin Street, Houston, TX 77030, USA

Abstract

We present two cases where percutaneous transhepatic intervention provided initial and definitive therapy following early and late diagnosis of bile duct transection by blunt abdominal trauma.

Key words: Bile ducts, injury—Interventional procedure—Catheters and catheterization

Injury involving the biliary tract is an uncommon complication following blunt abdominal trauma [1, 2]. Its diagnosis can often be difficult in the early days following presentation as 12% of extrahepatic bile duct injuries may go undetected at initial exploration [3]. Surgical intervention remains the treatment of choice for these complex injuries. Endoscopic retrograde cholangiopancreatography (ERCP) and stenting may be helpful in the diagnosis and management of partial bile duct injury [4–6], but its therapeutic role as a stand alone technique is limited for complex lesions involving bile duct transection. The percutaneous transhepatic approach still plays a crucial role in difficult circumstances where hilar or intrahepatic duct injuries or obstructions are encountered. We report two cases of complete bile duct transection that were managed with different percutaneous transhepatic techniques as definitive therapy.

Case Reports

Case 1

A 58-year-old man presented with a liver laceration and gallbladder avulsion following crush injury to his abdomen. He underwent partial right liver resection and cholecystectomy. Postoperative bile ascites was discovered and a bile leak was confirmed by hepatobiliary scintigraphy but failed to localize the site of injury.

Percutaneous fine-needle transhepatic cholangiography demonstrated an intrahepatic duct injury and biloma in the region of the surgical defect (Fig. 1). No duct injury near the biliary confluence was recognized at that time, but the left hepatic duct was not opacified. A right transhepatic internal/external drain was placed but a separate biloma drain was not deemed necessary as side holes of the transhepatic drain were in direct communication with the intrahepatic collection to provide adequate decompression. Over the next month the intrahepatic biloma resolved and bile ascites markedly improved, except for a residual walled-off second extrahepatic biloma in the subhepatic space that drained through an existing surgical drain placed during a laparotomy shortly after the initial partial liver resection (Fig. 1). During this period, follow-up cholangiography via the transhepatic drain showed resolution of the intrahepatic biloma but failed to demonstrate the source of the leak and failed to adequately delineate the left bile ducts. Contrast injection through a surgically placed extrahepatic biloma drain demonstrated a tract communicating with isolated left bile ducts (Fig. 2). A left percutaneous transhepatic cholangiogram (PTC) confirmed the presence of an isolated left bile duct with communication into the

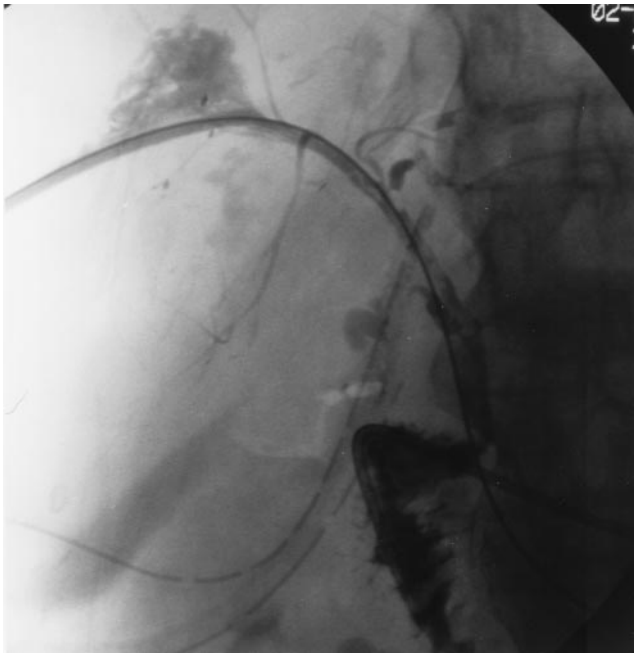

Fig. 1. Initial percutaneous transhepatic cholangiogram through a sheath in the right biliary system with the guidewire tip positioned in the small bowel. Note the extravasation of contrast into an intrahepatic biloma in the region of partial right liver resection and note the subhepatic surgical drains.

Correspondence to: M. Wallace, M.D., The University of Texas M. D. Anderson Cancer Center, 1515 Holcombe Boulevard, Box 57, Houston, TX 77030-4009, USA; e-mail: mwallace@di.mdacc.tmc.edu

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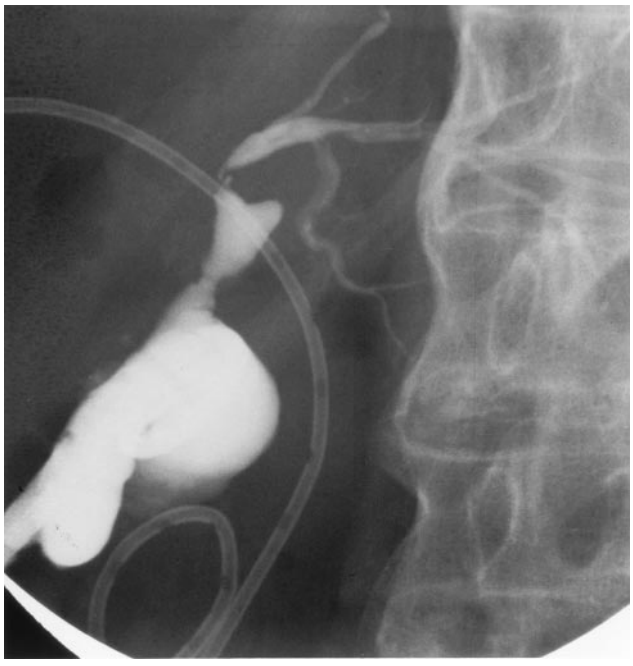

Fig. 2. Contrast injection of right-upper-quadrant drain demonstrates an isolated left biliary ductal system and free communication with a subhepatic biloma. Note the close anatomic relationship between the right transhepatic drain and the medial extent of the left main duct.

subhepatic biloma but no communication with the central ducts. Probing with a 5 Fr Kumpe catheter (Angiodynamics, Queensbury, NY, USA) and a 0.035-inch angled hydrophilic guidewire (glidewire; Medi-Tech/Boston Scientific, Watertown, MA, USA) to locate and re-establish a communication with the main biliary tree was unsuccessful but manipulations of the Kumpe catheter within the left duct caused deflection of the right biliary drain. Using the stiff end of a glidewire as a blunt instrument, the right duct was punctured from the left duct and the Kumpe 5 Fr catheter was advanced over the wire until it reached the guidewire tip. Contrast injection confirmed the location of the catheter tip within the right duct. The soft angled portion of the glidewire was then advanced (Fig. 3) down the common bile duct into the duodenum and an 8 Fr biliary internal/external drain was inserted to re-establish left-to-right communication. Over the following month the bile leak resolved, and the subhepatic drain and subsequently the right biliary drain were removed. Follow-up cholangiography via the left biliary drain revealed no residual leak but did show a focal stricture in the region of the duct reconstruction. This was treated by cholangioplasty with a 6-mm balloon. After 4 weeks a follow-up cholangiogram demonstrated good flow of contrast across this segment with only mild residual narrowing (Fig. 4), and the final percutaneous biliary drain was removed. The patient remains asymptomatic at 17 months following catheter removal.

Case 2

A 40-year-old woman presented, following a motor vehicle accident, with thoraco-abdominal injuries including a liver laceration for which she underwent exploratory laparotomy. Three weeks later bilious drainage was identified via a midline surgical abdominal incision and bile ascites was confirmed by CT examination and percutaneous aspiration. Right PTC demonstrated a non-dilated ductal system with free extravasation of contrast material from the left main duct (Fig. 5). A right transhepatic internal/external biliary drain was subsequently inserted. Left percutaneous cholangiography confirmed the presence of a central left duct transection, and an external drain was inserted. The patient returned a few days later for further intervention. The right internal/external biliary drain was exchanged for an 8 Fr Pinnacle sheath (Medi-tech/Boston Scientific) with its tip situated above the biliary confluence. With the tip of a safety wire present within the small bowel, a 40-cm-long Kumpe catheter and a glidewire were inserted alongside the safety wire and used to cross from the right duct into the stump of the left main duct. The glidewire was advanced out of the injured left duct and looped within the surrounding cavity (Fig. 6). The left external drain was then exchanged for another 8 Fr Pinnacle sheath over an Amplatz guidewire (Medi-tech/Boston Scientific) and a 15-mm gooseneck snare (Microvena, White Bear Lake, MN, USA) was advanced into the left duct and out the transection. The snare was used to capture the glidewire (Fig. 6) entering from the contralateral side, and pull it out through the left transhepatic sheath producing through-and-through access from right-to-left. A 5 Fr angled diagnostic catheter was inserted over the glidewire and advanced into the right main bile duct from the left. The through-and-through glidewire was removed and re-inserted from the left. The diagnostic catheter was pulled back slightly and redirected downward to cross the ampulla of Vater. Both left and right transhepatic accesses were exchanged for 8 Fr internal/external biliary drains. The patient's clinical course improved, and she was discharged home within a week of the biliary intervention. During a 3-month follow-up visit the left drain was exchanged and the right drain was removed. Cholangiography at that time demonstrated continued contrast extravasation. On subsequent follow-up sessions continued improvement at the site of duct injury was identified with subsequent resolution of the perihepatic biloma. Cholangiography at 1 year demonstrated a focal area of irregularity and narrowing at the injury site with good drainage across the segment (Fig. 7). No further intervention was undertaken, and the catheter was removed. She remains symptom free at 12 months.

Discussion

Injuries of the extrahepatic bile ducts are rarely (0.03–0.5%) encountered following blunt abdominal trauma [1]. Iatrogenic trauma to the biliary tract most frequently complicates laparoscopic cholecystectomy and predominantly involves the common bile duct in approximately half of reported bile duct injuries [7]. The management of bile duct injury from blunt trauma is similar to the management of iatrogenic bile duct injury following cholecystectomy. The primary method of treatment for these complex lesions is surgical intervention to re-establish bile flow into the small bowel. Potential surgical treatments include simple drainage, ligation, stenting, T-tube placement, primary closure, primary end-to-end anastomoses and bilio-enteric anastomosis. In cases of partial bile duct injury non-operative management with endoscopic stenting has been utilized with increasing frequency as the definitive therapy following both blunt and iatrogenic trauma [4–6]. In circumstances of complete bile duct transection, biliary reconstruction or bilioenteric anastomoses are usually advocated. Complex rendezvous procedures using combined percutaneous and endoscopic techniques have been reported as non-surgical alternatives to manage these difficult injuries [8]. Surgical intervention in both our cases was considered difficult due to the delay in diagnosis and multiple prior abdominal explorations resulting in adhesions or a "frozen" abdomen.

Percutaneous treatment options for these ductal injuries are complex. When the injury is intrahepatic and associated with an intraparenchymal biloma, conservative therapy may be adequate. If the biloma fails to resolve or becomes infected, simple placement of a drainage catheter into the collection may allow the communication with the biliary tree to close. If an extrahepatic biloma or bile ascites is present, then biliary decompression along with biloma drainage is necessary for healing of the duct injury. In our two cases transection of the left main bile duct was encountered, resulting in an isolated left biliary system. In both cases the goal was to re-establish communication between the left duct and the remainder

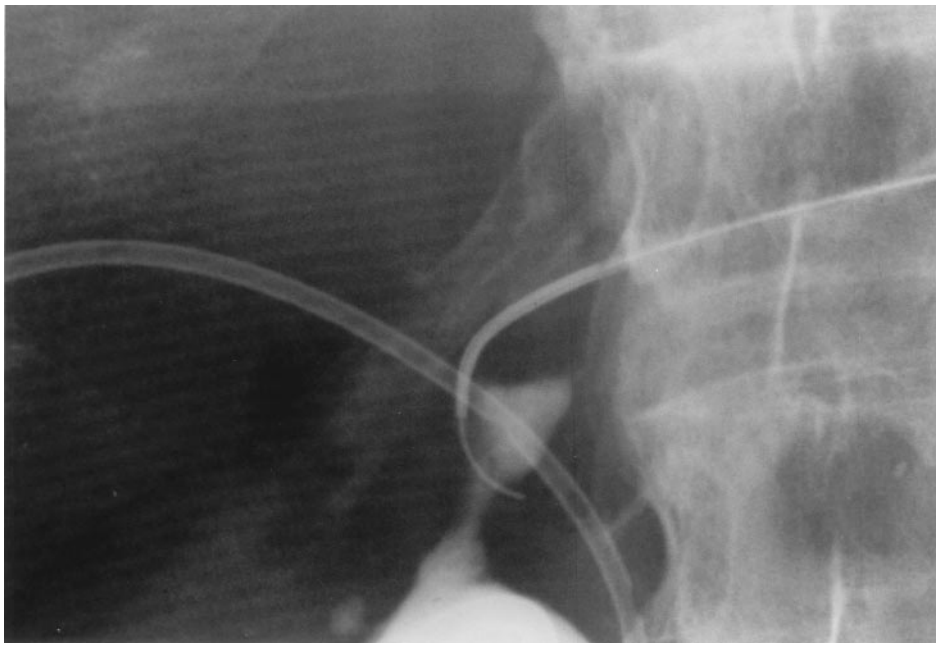

Fig. 3. Spot radiographic image during blunt recanalization. The Kumpe catheter has already been advanced over the stiff end of the glidewire, and the glidewire has been removed and re-inserted with the soft angle tip directed into the hepatic duct.

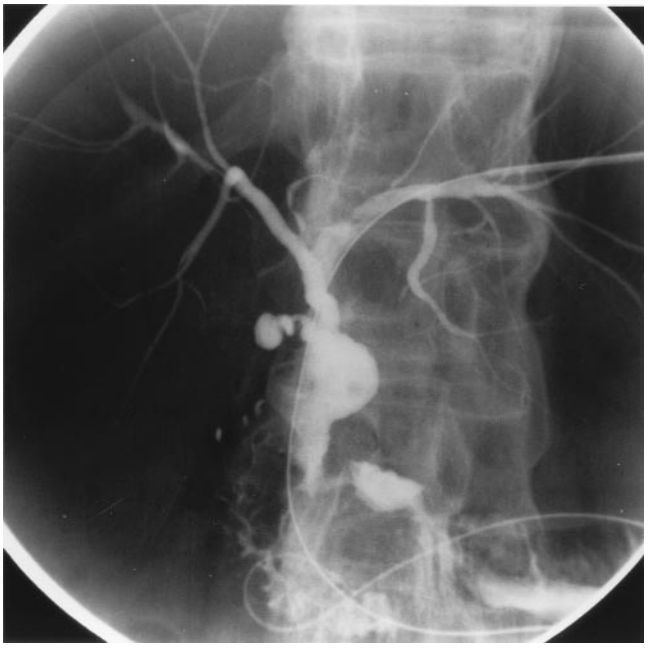

Fig. 4. Cholangiogram 4 weeks after balloon cholangioplasty demonstrating good primary flow of contrast across the injury site with minimal residual irregularity of the ductal lumen.

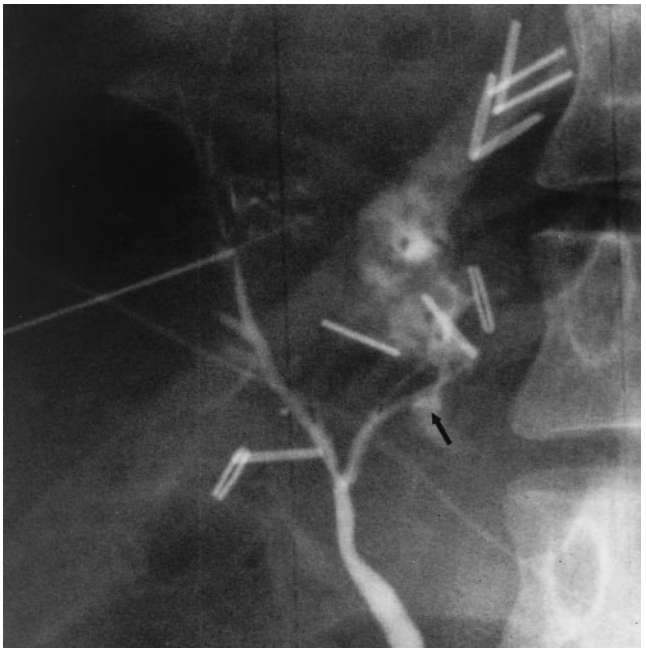

Fig. 5. Percutaneous right transhepatic cholangiogram demonstrating a central left bile duct transection (arrow).

of the biliary system to resolve the bile leak. Two different percutaneous techniques were used to cross the injured ductal segment and re-establish communication.

In the first case the diagnosis was made late in the patient's hospital course; the left duct communicated directly with a subhepatic biloma. Potentially a balloon tamponade technique, described by Lynn et al. [9], may have been useful to define the duct injury earlier, allowing the use of the rendezvous technique for bile duct reconstruction. The duct-to-duct puncture technique used was adopted from other maneuvers used to recanalize short segment chronic central venous occlusions [10]. This technique is best suited for recanalization of straight vessels where the vessels above and below the occlusion are in alignment. Knowledge of the anatomy above and below the occluded segment is essential to assure a high level of confidence when advancing the stiff end of a guidewire. An additional key element was the presence of an internal landmark, the right transhepatic drain, which provided a target to aim at. In our second patient the injury was diagnosed relatively early fol-

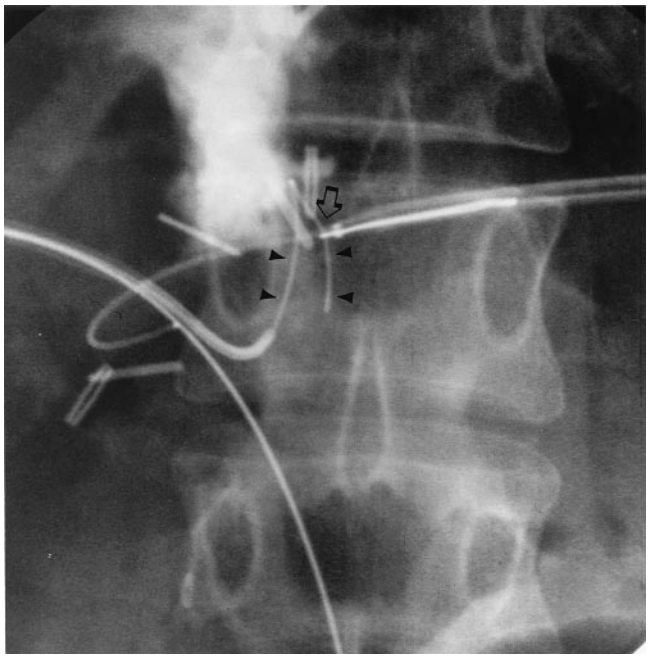

Fig. 6. Following bilateral transhepatic biliary access a glidewire (arrowheads) was advanced, from the right, into the cavity surrounding the duct injury and a snare (open arrow) was used to capture the tip of the wire.

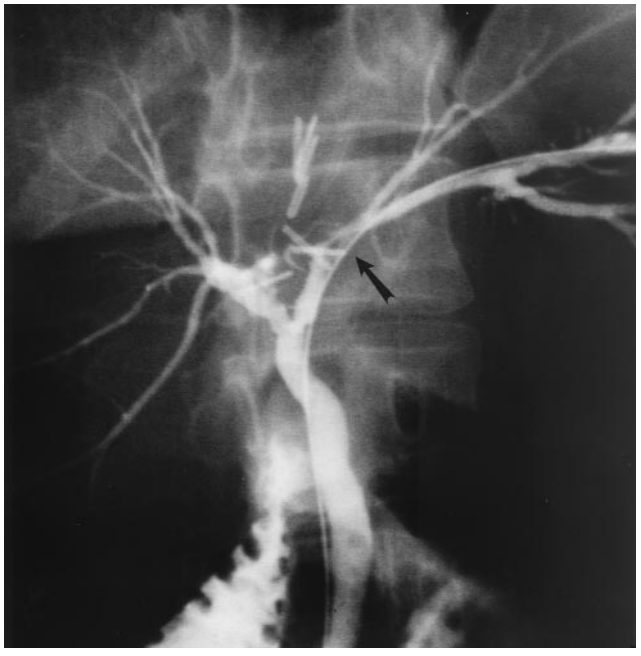

Fig. 7. Final cholangiogram demonstrating good flow across the injury site (large arrow) with minimal residual irregularity of the bile duct.

lowing her initial insult, with bile leakage present from both ends of the transected left central duct. Bilateral access allowed the use of a stand-alone percutaneous rendezvous to obtain through-and-through guidewire access. A similar technique with percutaneous and endoscopic biliary access has been used in several cases for reconstruction in the presence of bile duct transection [8]. Despite the different techniques used, left-to-right communication was re-established and managed by the insertion of a transhepatic internal/external drainage catheter to allow the tract at the injury site to heal and mature around the drain. This management technique was used effectively in a case report by Cloonan et al. [11] where an intrahepatic biloma in a liver transplant patient failed to resolve with simple drainage and T-tube decompression. Left hepatic access was accomplished, the site of intrahepatic duct injury was crossed, and a transhepatic drain was left in place until the biloma and the duct laceration healed. In this report the authors were able to negotiate the injured segment with standard guidewire and catheter technique in contrast to the approach taken in this report. The techniques used in both cases could be considered in other complex circumstances where bile duct obstruction or iatrogenic transection is encountered.

We were prepared to deal with potential biliary strictures following biloma resolution and duct healing. This occurred in our first patient who subsequently underwent successful cholangioplasty. This technique has been used with reasonable results for benign bile duct strictures in liver transplant patients [12].

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Renal Branch Artery Occlusion in a 13-Year-Old Hypertensive Girl: Initial Treatment and Treatment of Recurrent Stenosis by Balloon Angioplasty

Orhan Konez,[1] Patricia E. Burrows,[1] William E. Harmon[2]

[1]Division of Vascular and Interventional Radiology, Department of Radiology, Children's Hospital, Harvard Medical School, 300 Longwood Avenue, Boston, MA 02115, USA
[2]Department of Nephrology, Children's Hospital, Harvard Medical School, 300 Longwood Avenue, Boston, MA 02115, USA

Abstract

A 13-year-old girl who recently developed hypertension was diagnosed to have an occluded right renal branch artery and was treated successfully with percutaneous transluminal angioplasty (PTA). To our knowledge, PTA has not been reported as a treatment for totally occluded renal branch arteries, and there is no data available regarding the success rate and possible complications.

Key words: Percutaneous transluminal angioplasty—Renal branch artery—Occlusion—Segmental artery—Embolization—Stent

Hypertension affects 1–3% of all children; 3–10% of those children have hypertension due to renal artery stenosis [1–3]. While renal artery stenosis usually affects the main renal artery or its ostium, isolated stenosis or occlusion of a segmental or renal branch artery, usually presumed to be due to fibromuscular dysplasia (FMD), can be a source of hypertension. Percutaneous transluminal angioplasty (PTA) is a well-established, safe procedure for correcting hypertension resulting from stenoses of the main renal artery or one of its main branches (segmental renal artery or renal branch artery) [4], but is not feasible in patients with obstruction of very small peripheral branches. Embolization of the stenotic vessel and/or collateral circulation is often effective in obliterating the source of renin and correcting the hypertension, and the volume of renal parenchyma destroyed by this technique is usually small. However, in the presence of occlusion of a major branch supplying a large volume of kidney, it would be preferable to reestablish arterial patency. This is especially true in children, in whom fibromuscular dysplasia is often multifocal and bilateral. There is no data in the literature regarding the efficacy of PTA to recanalize totally occluded renal branch arteries. We present a case of a single renal branch artery occlusion, in which PTA was used as a primary treatment modality. The patient required a second PTA procedure due to restenosis, but had an excellent long-term response after the second procedure.

Case Report

A previously healthy 13-year-old girl was referred to our hospital for management of recently diagnosed, poorly controlled hypertension. Her weight was 36.5 kg (5^{th} percentile), her height 154 cm (25^{th} percentile). She had a 1-month history of occasional headaches and vomiting, and a possible episode of hypertensive encephalopathy with severe headache and vomiting. She was subsequently found unconscious in the bathroom. Her complaints persisted despite antihypertensive medication (labetolol 50 mg tid and nifedipine 15 mg qid). Renal angiography performed at another institution showed occlusion of an upper-pole branch of the right renal artery, with a large collateral from the lower branch supplying the ischemic kidney. Therapeutic options considered by the referring physicians initially included embolization of the collateral branch, and partial nephrectomy. She was, however, referred to our hospital to explore the possibility of balloon dilatation of the occluded renal branch artery. Although the patient's blood pressure during her pre-procedure assessment was mildly elevated (120–130/80–90 mmHg), her previous random pressure readings were noted to be as high as 150/110 mmHg.

Renal angiography and renal vein sampling were carried out under general anesthesia. The left femoral artery and femoral vein were both cannulated percutaneously with 5 Fr arterial and 4 Fr venous introducer sheaths. Blood samples were obtained from the inferior vena cava, above and below the renal veins, from the left renal vein, and from several sites within the right renal venous system for renin assay. Plasma renin activity was found to be elevated in all of the collected blood samples (according to the pediatric reference range), although the activity in the right renal vein was almost twice that in the left renal vein (24 ng/ml/hr versus 13.5 ng/ml/hr). Abdominal aortography showed two renal arteries on the right. Selective renal arteriograms demonstrated an occlusion, approximately 1.5 cm in length, of the origin of the right upper renal arterial branch, which was shown on oblique projections to supply the upper and anterior one third of the right kidney (Fig. 1A, B). The distal portion of this vascular territory was opacified through tortuous collaterals from the posterior branch, as well as from the right lower renal artery branch and adjacent intercostal arteries. The right lower renal artery and its distal branches appeared normal, except for opacification of some small collaterals to the obstructed renal territory. Fibromuscular dysplasia (FMD) was considered foremost in the differential diagnosis based on the fact that FMD is the most common cause of branch artery stenosis or occlusion in children [4, 7]. The left renal arteriogram was essentially normal, aside from a slight kinking of the extrarenal portion of the main renal artery without any evidence of stenosis. After discussing the therapeutic options, it was felt that PTA should be attempted. The patient was systemically heparinized (100 units/kg i.v. bolus). Using a 0.035-inch hydrophilic guidewire (Boston Scientific, Natick, MA, USA), a 4 Fr catheter was advanced across the occluded right renal branch artery without difficulty. The main renal artery measured approximately 5 mm in diameter and the caliber of the occluded branch artery was expected to be 3 mm. The catheter was then exchanged over a 0.016-inch guidewire (Taper Stubbie Mandril wire, Boston Scientific) for a 3.8 Fr balloon angioplasty catheter (Boston Scientific) with a 3-mm × 2-cm balloon. The balloon was fully inflated to 10 atm across the area of the occlusion. Then, due to mild residual stenosis noted on the subsequent selective arteriogram, a balloon catheter with a 3.5-mm × 2-cm balloon was positioned across the stenosis and fully inflated to 10 atm. No significant residual stenosis was noted on repeat selective arteriography, and pressure recording made during catheter pull-back demonstrated no gradient following PTA. The patient was kept anticoagulated with heparin for 24 hr (20 U/kg/hr). Post-procedural blood pressure readings were 150/90 mmHg in the Post-Anesthesia Recovery Unit (PACU). The following day the patient's blood pressure decreased to 110–120/70–80 mmHg and she was discharged on continued anticoagulation (coumadin 2.5 mg/day, aspirin 81 mg/day) and antihypertensive medication (labetelol 100 mg/day).

Correspondence to: P.E. Burrows, M.D.; e-mail: patricia.burrows@tch.harvard.edu
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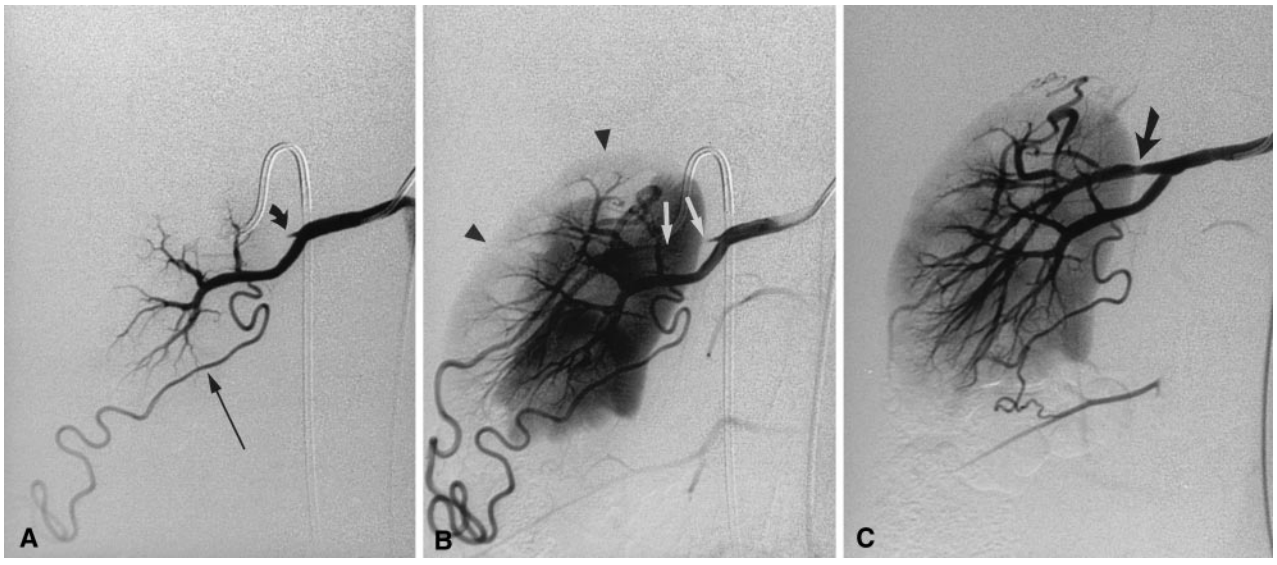

Fig. 1. Initial renal arteriogram and angioplasty. **A** Early arterial phase of selective right renal arteriogram shows occlusion of the posterior superior branch renal artery (curved arrow). Note the large collateral artery (long arrow). **B** Late arterial phase shows decreased perfusion of the supply territory of the occluded branch via the collateral artery (arrowheads). The proximal and distal ends of the occluded branch are seen (arrows). The lower pole of the right kidney is supplied by a second renal artery. **C** Post-PTA selective arteriogram demonstrates reopening of the occluded branch (less than 20% residual stenosis) (arrow).

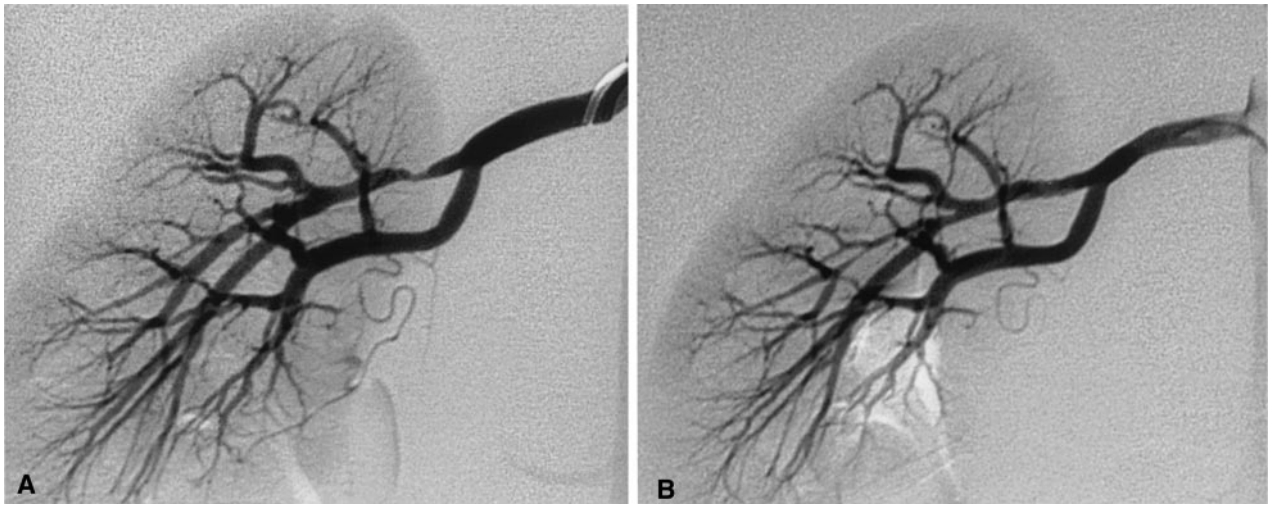

Fig. 2. Recurrent stenosis and PTA approximately 2.5 months after the first intervention. **A** There is significant stenosis seen at the location of the previously dilated occlusion (60–70%). **B** Essentially normal caliber postero-superior branch following high-pressure balloon angioplasty.

During the following months the patient's blood pressure gradually rose again despite increased antihypertensive medication (labetelol and nifedipine), and she was referred to our department for a second time, approximately 2.5 months after the initial intervention. The patient's blood pressure at that time was 130/85 mmHg. Following induction of general anesthesia, 5 Fr arterial and 4 Fr venous introducer sheaths were placed in the right common femoral artery and vein. Blood samples for renin assay were again obtained from the inferior vena cava, above and below the renal veins, as well as from both renal veins, and revealed normal plasma renin activity in all of the collected samples (right renal vein 4.4 ng/ml/hr and left renal vein 2.5 ng/ml/hr). Angiography showed significant restenosis at the site which was previously balloon-dilated. The branches to the upper pole, which previously received the collaterals and appeared somewhat tortuous on the prior angiogram, appeared normal at this time. Using a technique similar to the one described above, including i.v. heparin (100 U/kg bolus) a 5 Fr dilatation catheter with a 3.0-mm × 1.5-cm high-pressure balloon (Diamond; Boston Scientific) was advanced across the stenosis. The balloon was inflated twice to 20 atm for approximately 3 min each time. No residual stenosis on the post-procedure angiogram or significant pressure gradient across the lesion was noted following PTA. The patient was again anticoagulated with i.v. heparin (20 units/kg/hr overnight) and aspirin after the procedure. Her blood pressure readings following PTA were within normal range. She was discharged the following day with prescribed anticoagulation and antihypertensive medication, and was scheduled for a routine follow-up. The patient's blood pressure responded well to PTA. Antihypertensive medication was gradually eliminated. Presently, 3 years later, the patient is normotensive without medication.

Discussion

Renovascular etiology is found in approximately 3–10% of hypertensive children, whereas this is the case in only 1–5% of the entire hypertensive population [1–3, 5]. Most cases of pediatric renovas-

cular hypertension are diagnosed during routine check-ups or during the diagnostic workup following hypertensive encephalopathy [1, 6]. Fibromuscular dysplasia (FMD) is considered to be the most common cause of renal arterial stenoses in children, whereas atherosclerosis is the leading cause in the adult population. Although most obstructions involve the main renal arteries, segmental renal artery or renal branch artery stenosis or occlusion may be encountered, either as an isolated abnormality or associated with the main renal arterial stenosis. FMD appears to be the most common cause of these intrarenal arterial obstructions, particularly in children. Segmental renal arteries are affected in 30–56% of patients with FMD [4, 7]. Other causes of renal artery stenosis in children include neurofibromatosis, Takayasu arteritis, Williams syndrome, Ehler-Danlos syndrome, congenital aneurysms, extrinsic compression due to a tumor or a hematoma, Kawasaki syndrome, polyarteritis nodosa, radiotherapy, and nonspecific aortoarteritis [6, 8].

Arteriography remains the gold standard for the diagnosis of renovascular hypertension. Since its introduction in 1978, PTA has evolved into a successful method for correcting main renal artery stenoses [9, 10]. PTA has also become the treatment of choice for correcting isolated segmental renal artery or renal branch artery stenoses [4, 11]. Nephrectomy or partial nephrectomy for intrarenal arterial stenoses or occlusions is no longer a primary treatment option. Previously, surgical ligation of stenotic segmental renal arteries or renal branch arteries was sometimes attempted to treat renovascular hypertension [12]. Cluzel et al. [4] reported an 84% success rate of PTA for correcting renal branch artery stenoses in 20 patients with a mean age of 30.5 years. Their patients included two cases of complete or near-complete branch artery occlusion, but attempts to cross the lesions were not successful and the branches were embolized. Currently there are no data regarding the success rates or complications of PTA for correcting renal branch or segmental arteries in children. Preservation of renal tissue in these patients, particularly in children, is crucial because of the high prevalence of bilateral disease and the frequent progression of fibromuscular disease. Therefore, treatment of segmental renal artery or renal branch artery stenoses with PTA is preferable for preserving maximal renal tissue. When a stenosis or occlusion is noted involving the main renal artery or one of the branching arteries, PTA should be performed to correct potential future complications, particularly in children, even though the patient's blood pressure may be well controlled on antihypertensive medication.

When segmental renal artery stenosis that cannot be dilated or an occlusion of the renal branch artery with collateral formation is encountered, embolization of either the collateral vessels feeding the ischemic renal parenchyma or the stenotic artery is preferred over surgical intervention [13–16]. Attempted recanalization of the obstructed branch was considered appropriate in our patient because retrograde opacification of the distal portion of the occluded artery showed that the occlusion was relatively short. The small opacified stump at the origin of the occluded artery was useful in identifying the point of occlusion and is probably a prerequisite for attempting to cross an occlusion.

There are no data available for the use of metal stents in renal branch artery stenoses, although they are commonly used following PTA of main renal artery stenoses. Renal vascular stents are generally used to prevent elastic recoil of the lesion and to cover and tack down intimal flaps. A stent was not used in our patient because of the small caliber of the stenotic vessel and the young age of the patient, but it would have been considered if the stenosis had recurred.

Patients with renovascular hypertension are expected to show increased renin activity from the ischemic kidney and decreased activity from the normal kidney. Although some centers still rely on renal vein assays to establish the diagnosis of renovascular hypertension, most centers do samplings of the renal veins and IVC as complimentary studies to the renal arteriography and perform PTA based on the severity of angiographic stenosis. There are several factors (e.g., drug interference and high sodium level) affecting the results of renal vein renin assays that, if not properly managed, lead to erroneous results [20]. Antihypertensive medications must be withheld for at least 5 days prior to performing the renal vein sampling to eliminate false-negative results. While renin activity was elevated and lateralized appropriately during the first procedure, it was normal during the second procedure, even though the patient had significant angiographic renal artery stenosis and an excellent response to PTA. This confirms the appropriateness of using angiographic findings to determine the suitability of PTA in children.

Based on the excellent outcome in our patient, we feel that attempts to restore patency of an occluded renal branch artery are justified, especially if the occluded branch supplies a relatively large volume of renal parenchyma. Visualization of the occluded artery, proximally and distally, and short-segment involvement are probably prerequisites for attempting recanalization. Anticoagulation and antiplatelet therapy may be important, and close follow-up is advised, with re-intervention if necessary.

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Pain Palliation by Percutaneous Acetabular Osteoplasty for Metastatic Hepatocellular Carcinoma

Hirofumi Hokotate,[1,2] Yasutaka Baba,[1] Hisahiko Churei,[1] Masayuki Nakajo,[1] Kouichi Ohkubo,[2] Kenji Hamada[2]

[1]Department of Radiology, Faculty of Medicine, Kagoshima University, 8-35-1 Sakuragaoka, Kagoshima-shi 890-8520, Japan
[2]Department of Radiology, Imakiire General Hospital, 4-16 Shimotatsuo-cho, Kagoshima-shi 892-0852, Japan

Abstract

A 68-year-old man with hepatocellular carcinoma and known skeletal metastasis developed right hip pain and gait disturbance due to an osteolytic metastasis in the right acetabulum. This was treated initially with chemoembolization and radiation therapy. When these procedures proved unsuccessful percutaneous injection of acrylic bone cement into the acetabulum was undertaken. Immediately after this procedure, he obtained sufficient pain relief and improved walking ability, which continued for 3 months until he died of hepatic insufficiency.

Key words: Osteoplasty, percutaneous—Metastatic bone tumor—Hepatocellular carcinoma—Bone cement

Conventional anticancer therapy such as transcatheter arterial chemoembolization (TACE) or percutaneous ethanol injection therapy (PEIT) for unresectable hepatocellular carcinoma (HCC) has offered a relatively favorable local control of the primary tumor [1, 2]. An alternative treatment strategy is now being required for metastatic lesions [3]. There are some patients who first present signs attributable to bone metastasis [4]. For such cases, quality of life (QOL) must be taken into account when deciding the treatment method. We report a patient with HCC whose QOL was dramatically improved by percutaneous injection of acrylic bone cement into the metastatic HCC iliac bone lesion.

Case Report

A 68-year-old man with chronic hepatitis C and HCC metastatic to the thoracolumbar spine and ribs had undergone several palliative TACE, PEIT, and radiation treatments to alleviate pain over a 1-year period when he presented with pain in the right hip which was related to an osteolytic metastasis in the right acetabulum (Figs. 1, 2). TACE of the hypervascular metastasis via the right superior gluteal artery was performed 6 weeks later. Since the pain did not improve the patient was irradiated with a total dose of 45 Gy (a daily dose of 3 Gy). A second TACE was performed via the right superior gluteal artery, resulting only in focal necrosis of the metastatic lesion. The gait disturbance became worse because of iliac fracture. The patient insisted on being able to walk short distances. The lesion had no

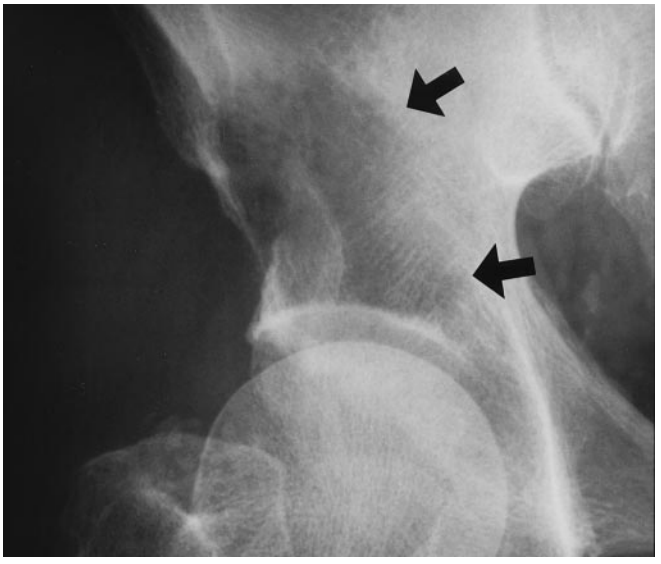

Fig. 1. Anteroposterior radiograph shows an osteolytic lesion of the right hip (arrows).

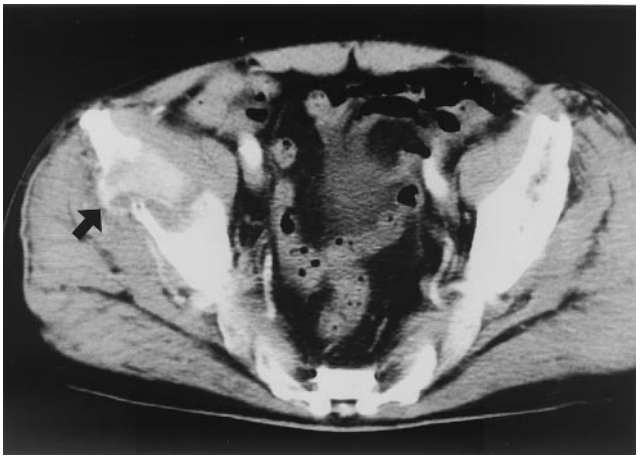

Fig. 2. Contrast-enhanced CT scan shows an osteolytic metastatic lesion from hepatocellular carcinoma at the acetabular roof of the right iliac bone (arrow).

Correspondence to: H. Hokotate, M.D.; e-mail: hirofumi@m3.kufm.kagoshima-u.ac.jp

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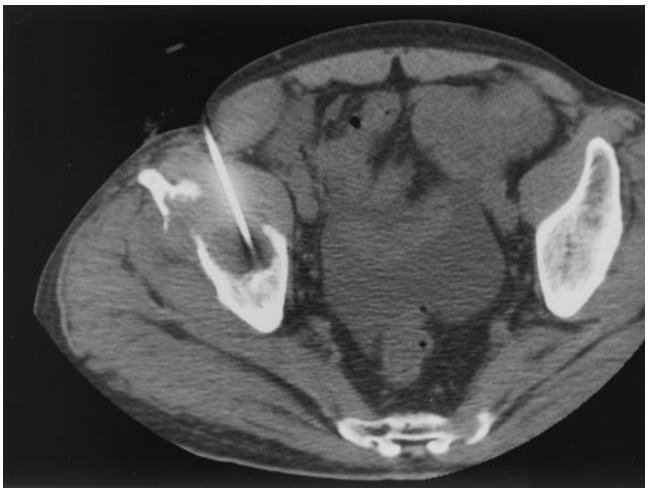

Fig. 3. CT scan shows a 13 gauge needle positioned in the center of the tumor by means of an anterior approach.

cortical destruction of the acetabular roof and no extensive soft tissue involvement. These findings met the criteria for acetabular osteoplasty with bone cement [5]. We explained the merits and the possible side effect of the procedure to the patient [6, 7]. After obtaining informed consent, we performed CT-guided percutaneous injection of acrylic bone cement (Methylmethacrylate, Zimmer, Warsaw, IN, USA; 8.3 ml with 3 g of sterile barium for visualization) into the metastatic lesion. We had mixed 15 g of poly (methyl methacrylate-co-styrene) copolymer with 10 ml of methyl methacrylate monomer to prolong the polymerization time using the manufacturer's recommendation of 2:1–1.5:1 copolymer to monomer ratio [8]. The lesion was entered via an anterior approach using a 13 gauge bone marrow puncture needle (Fig. 3). The cement injection was done under C-arm fluoroscopy in order to confirm that no leak of bone cement into the joint occurred. CT reconstruction and plain films confirmed the absence of bone cement leakage into the joint (Fig. 4). The patient walked to the toilet at midnight the day of the procedure against advice not to walk that soon. After the treatment he was satisfied with his condition. There was no subsequent fracture and no recurrence of gait disturbance until he died of hepatic insufficiency 3 months later.

Discussion

When an osteolytic metastasis is located in the acetabulum, the patient commonly faces difficulty in walking. In such a case, it is important to fully consider the patient's quality of life when selecting the best possible palliation. Percutaneous injection therapy with acrylic bone cement has been performed in France for metastasis from cancers of the kidney, uterine cervix and lung [5]. We previously reported successful treatment of a painful vertebral metastasis by this method [9]. Cotten et al. [5] suggests the following radiographic and CT findings as possible contraindications for percutaneous acetabular osteoplasty: articular cortical destruction of the acetabular roof of more than 5 mm in diameter and soft-tissue involvement of more than three times the area of bone destruction. Our patient had no such contraindications.

Benefits of the bone cement therapy for a metastatic bone tumor are: tumor necrosis caused by the heat generated in the polymer-

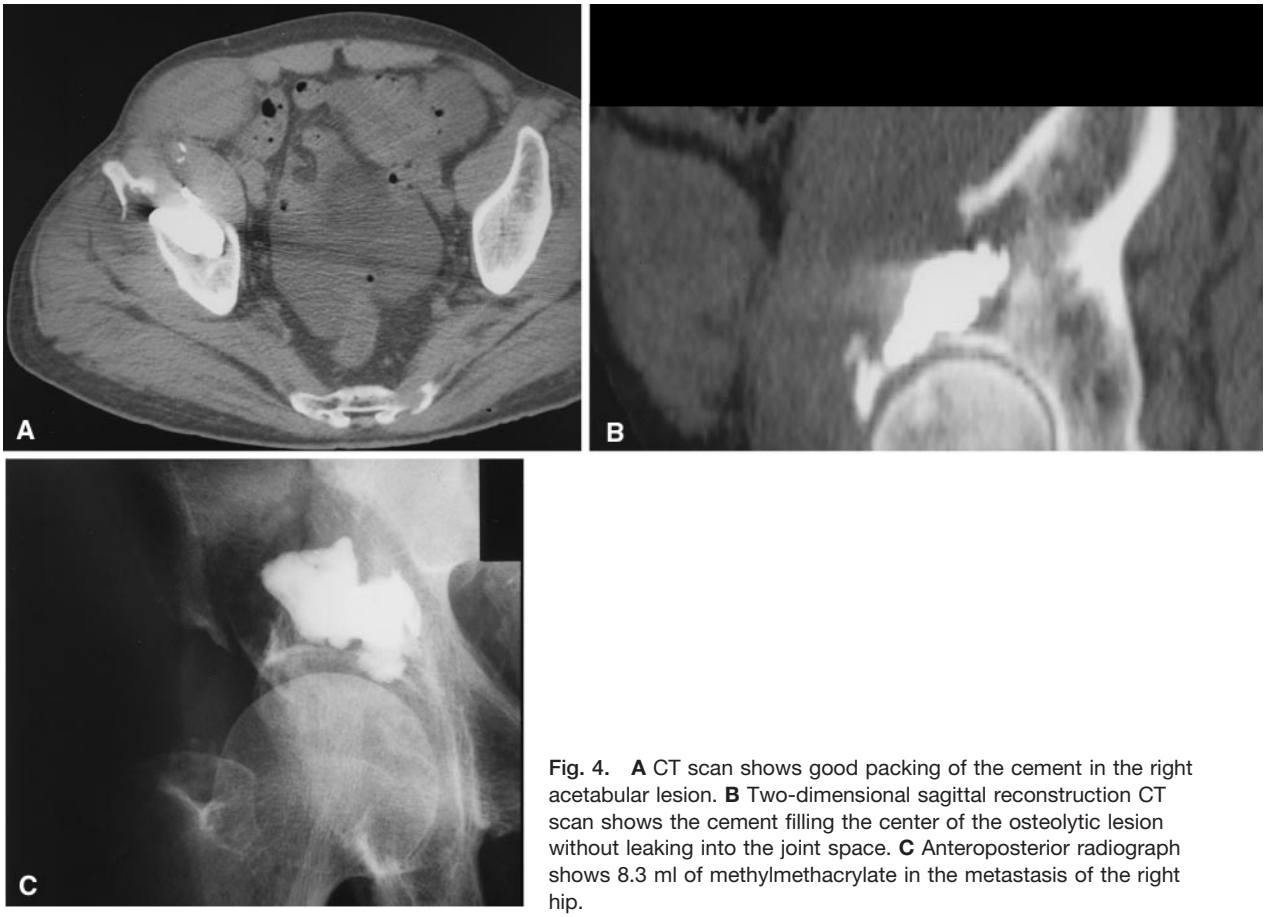

Fig. 4. **A** CT scan shows good packing of the cement in the right acetabular lesion. **B** Two-dimensional sagittal reconstruction CT scan shows the cement filling the center of the osteolytic lesion without leaking into the joint space. **C** Anteroposterior radiograph shows 8.3 ml of methylmethacrylate in the metastasis of the right hip.

ization process, stabilization of the acetabulum and pain relief due to destruction of sensory nerve terminals and chemical stimuli [10].

Prior to the procedure we had explained to the patient the side effects, such as transient and spontaneously resolving fever and worsening of hip pain [5]. We had also explained the complications, including cardiac arrest, as reported when using bone cement in orthopedic surgery [6].

Other reported severe side effects are hypotensive reaction or pulmonary embolism, called "bone cement implantation syndrome," during operative implantation of endoprostheses with bone cement, especially in older patients with cardiovascular disease [7].

Therefore when determining candidacy for this procedure, we must consider the patient's cardiopulmonary disease, poor performance status, femoral bone metastasis due to malignant tumor, advanced age, osteoporosis, steroid treatment, dehydration, hypoxemia and obesity [11, 12]. Our patient had no such factors. The pressure of the cement injection is not higher during percutaneous injection than during surgery, and the amount of the cement is small ($<$ 10 ml) [5]. Furthermore the prolonged polymerization time that we chose reduced the injection pressure and helped prevent leakage of the mixture into blood vessels and into the articular space.

Percutaneous acetabular osteoplasty with acrylic bone cement provides prompt pain relief and strength of bone as observed in vertebroplasty with bone cement. We believe that this treatment technique enhances the therapeutic effect on gait disorder even in advanced cases, resulting in an improved quality of life.

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High-Flow Arteriovenous Malformation of the Lower Extremity: Ethanolamine Oleate Sclerotherapy

Hideki Hyodoh,[1] Akifumi Fujita,[2] Kazusa Hyodoh,[1] Makoto Furuse,[2] Osamu Kamisawa,[3] Masato Hareyama[1]

[1]Department of Radiology, Sapporo Medical University, School of Medicine, S1 W16 Chuo-ku, Sapporo 060-8543, Japan
[2]Department of Radiology, Jichi Medical School, 3311-1 Yakushiji, Minamikawachi, Kawachi, Tochigi 329-0498, Japan
[3]Department of Thoracic and Cardiovascular Surgery, Jichi Medical School, 3311-1 Yakushiji, Minamikawachi, Kawachi, Tochigi 329-0498, Japan

Abstract

We report the case of a young man presenting with high-flow arteriovenous malformation (AVM), in whom percutaneous direct nidus puncture ethanolamine oleate (EO) sclerotherapy was useful in the management of the AVM. To our knowledge, this is the first report of percutaneous trans-nidus EO sclerotherapy for AVM in the extremities. Percutaneous trans-nidus sclerotherapy should be considered as an alternative choice for the management of symptomatic AVM.

Correspondence to: H. Hyodoh, M.D.; e-mail: hyodoh@sapmed.ac.jp
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Key words: Arteriovenous malformation, extremities—Interventional procedures—Sclerotherapy—Alcohol—Vein, therapeutic blockade

Solitary arteriovenous malformation (AVM) is a benign vascular anomaly that tends to recur after inappropriate treatment. Many reports have described treatment of AVM by surgical removal, transarterial embolotherapy [1], ethanol ablation [2], liquid glue [3–5], and combinations of these techniques.

We report a case of symptomatic high-flow AVM in which percutaneous direct trans-nidus ethanolamine oleate (EO) sclero-

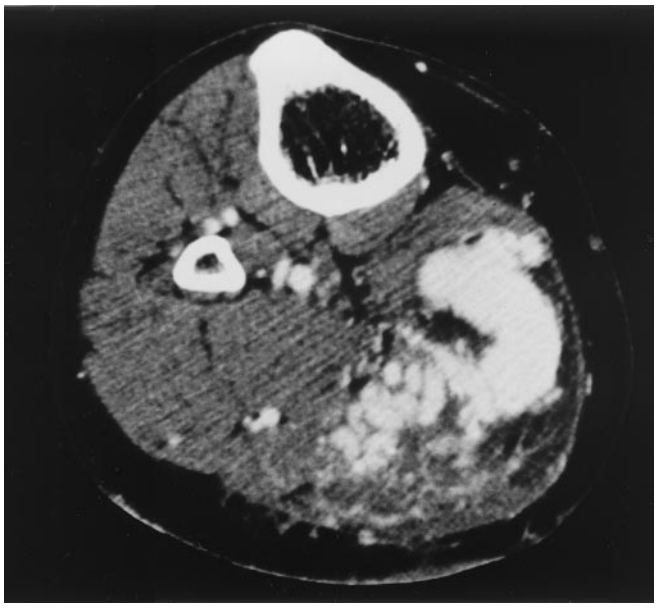

Fig. 1. Pre-therapeutic enhanced CT. Many tortuous vessels were revealed in the gastrocunemius muscle. Early venous filling was observed in the enlarged popliteal vein.

therapy was useful for relieving the symptoms. To our knowledge, this is the first report of the use of percutaneous trans-nidus EO sclerotherapy in high-flow AVM.

Case Report

A 22-year-old man who had previously undergone partial removal of an AVM exhibited recurrent tight pain and swelling in the right leg. After the operation, his clinical symptoms were temporarily relieved, but the AVM regrew rapidly within 8 months and he was admitted for AVM embolization and sclerotherapy. He had no vascular risk factors.

An enhanced CT scan revealed an enhanced vascular cavity in the right gastrocunemius muscle with multiple curvilinear vessels at the periphery. The venous canal was also dilated at the early arterial phase (Fig. 1). Arteriography showed multiple feeding arteries around the level of the popliteal artery and early venous filling to the popliteal vein, and a recurrent high-flow AVM was confirmed (Fig. 2).

Since transarterial embolization is difficult and not completely effective unless embolic material can fill the AVM nidus completely when multivascular supply is observed, the drainage venous flow was controlled and transvenous and percutaneous trans-nidus EO sclerotherapy was used to relieve the AVM and prevent recurrence.

A 16 Fr sheath was inserted into the right femoral vein retrogradely and an occlusion balloon catheter (33 mm diameter) was placed into the popliteal vein, which collected the venous drainage. Balloon-occluded retrograde transcatheter venography provided partial retrograde nidus and deep venous filling. Up to 20 ml 5% EO mixed with Iopamiron (Schering, Berlin, Germany) injected through a 3 Fr microcatheter under fluoroscopic control and additional absolute ethanol (5 ml) were administered. After the sclerosant material was injected, the patient was observed for more than 30 min and transvenous sucking was used to prevent pulmonary embolization. After this procedure the nidus was partially thrombosed but was seen on CT examination at 2 weeks. Therefore, additional sclerotherapy was performed to achieve complete nidus thrombosis.

At the second session, using the same balloon occlusion technique as described above, a 21 G puncture needle was inserted into the nidus and contrast was injected to confirm nidus puncture. Under percutaneous venography, the nidus and feeding arteries were seen to have filled retrogradely. A maximum dose of EO (5%, 20 ml) and additional absolute ethanol (5 ml) were administered under intermittent fluoroscopy (Fig. 3). After the procedure, the injected EO was sucked out through the balloon catheter. During these procedures, epidural or spinal anesthesia was used for pain relief. During and after these procedures, haptoglobin was infused at 4000 U/day to prevent intravascular hemolysis.

After the procedures, leg swelling was observed for 2 weeks, and oral pain killers and a support bandage were used for pain and swelling control. At 2-month follow-up, enhanced CT revealed complete nidus occlusion and reduced leg swelling. However, deep vein thrombosis (DVT) was noted below the popliteal vein. In the 2 years of follow-up, there has been no recurrence (Fig. 4).

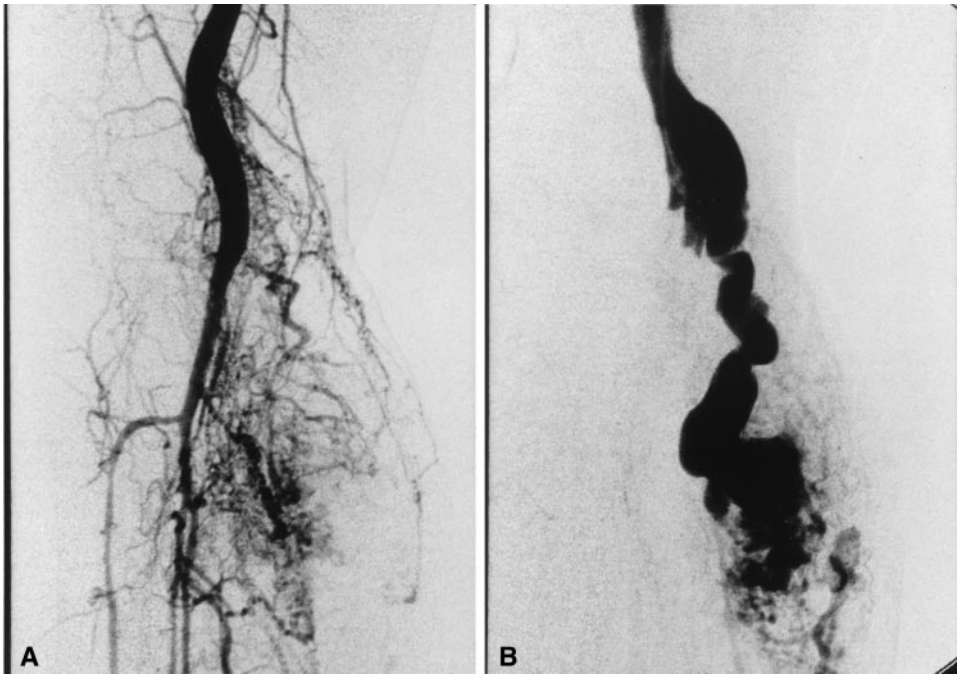

Fig. 2. **A** Selective right superficial femoral arteriogram reveals many feeding arteries, tortuous nidus, and early enlarged venous filling. **B** Within 4 sec the drainage vein was revealed; therefore this AVM was classified as a high-flow type.

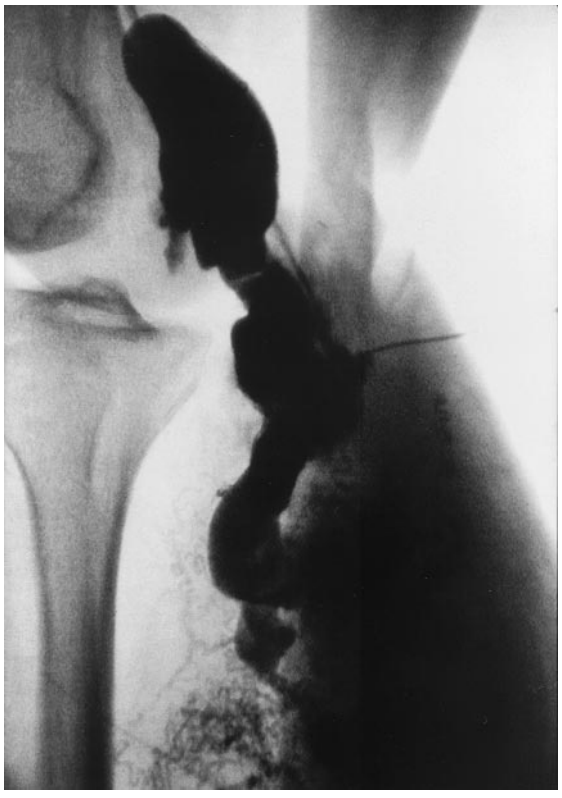

Fig. 3. Direct nidus-punctured EO sclerotherapy was performed with transvenous drainage venous balloon occlusion. The feeding arteries were revealed retrogradely using EO mixed with non-ionic contrast.

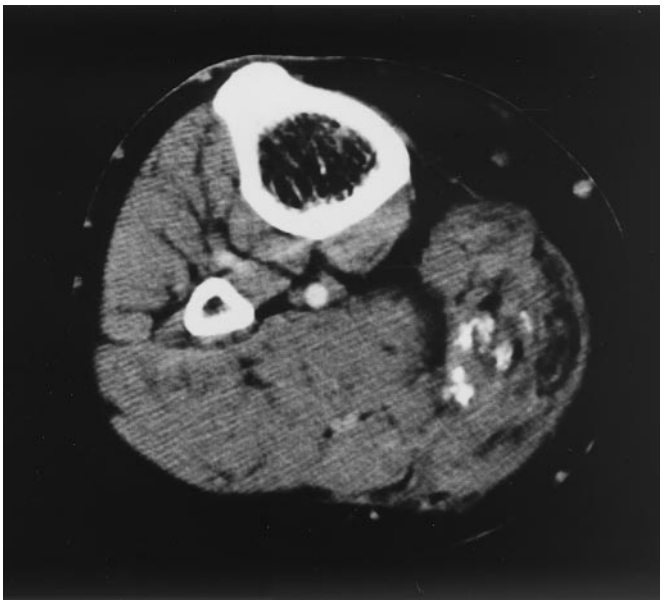

Fig. 4. Enhanced CT after 6 months. There was no recurrence and no residual AVM. The popliteal artery was preserved. No muscle atrophy was observed.

Discussion

Vascular anomalies, such as hemangioma, varices, and AVM, may affect extremities and there have been many reports on the different procedures used to treat them [1–5]. Yakes et al. [2] reported that ethanol embolotherapy for symptomatic vascular malformations yielded good results when the nidus or area adjacent to the nidus was treated. In our case, we occluded the nidus itself using EO sclerosant with good results and no recurrence to date.

The transvenous approach cannot fill the nidus completely because the tortuous venous system impeds the microcatheter's entrance into the nidus and the embolic material cannot fully enter the nidus even using a 3 Fr microcatheter. Percutaneous trans-nidus puncture was useful for complete nidus opacification and also for filling the feeding arteries under the occlusion balloon catheter. The viscosity of the embolic material may help to occlude the drainage side and the tortuous venous system also helps to press the embolic material into the feeding arteries retrogradely. Therefore, it was possible to enhance the whole nidus and the feeding arteries in the second session.

We used EO for nidus sclerotherapy and this material is known to affect the vascular intimae and induce cell lyses, fibrin deposition, platelet aggregation, and thrombotic occlusion and organization. EO has been used as embolic (sclerotic) material to treat esophageal/gastric varices under endoscopy [6] or through transvenous catheter sclerotherapy [7] and balloon occluded retrograde transvenous obliteration (B-RTO) [8]. The use of haptoglobin [9] and albumin adjustment [6] prevents the EO hemolytic side effect of renal damage.

Compared to ethanol, EO has a lower effect on the deep vascular layer and has no penetrative effect, and even the nerve system that runs along the vascular system continues to function. In particular, in the extremities, the vascular and neural systems run side-by-side, and EO sclerotherapy may have a wider safety margin compared to ethanol sclerotherapy.

Embolization using liquid glue [n-butyl-cyanoacrylate (NBCA)] has also been used to treat AVMs [5]; the NBCA spreads according to its polymerization time and the vascular flow, and several injections were needed to achieve complete nidus embolization. In our case, since multiple arteries were feeding the nidus we felt that NBCA would not be as effective as EO sclerotherapy in achieving complete nidus sclerotherapy.

Jackson et al. [10] reported AMV classification according to angiographic film imaging, and described high-flow AVM when both arteries and veins were imaged on the same angiographic film. In our case, since the contrast ran through the nidus to the drainage vein within 4 sec we diagnosed high-flow AVM. Other flow-imaging studies, such as color Doppler ultrasound, dynamic magnetic resonance (MR) imaging, and PC MR angiography, may also be useful for AVM classification. Further study is needed to establish which modality is the most useful for the classification.

Flow-control technique is necessary for sclerotherapy. In our case, we used an occlusion balloon catheter because it can be used for balloon-occluded retrograde transcatheter venography. We also suggest that blood pressure cuffs and tourniquets are good methods to maintain blood flow stasis, especially in the extremities. A good combination of intra- and extravascular flow control can help to achieve flow stasis during sclerotherapy and to reduce the sclerosant dose and procedure time.

Unfortunately, in our patient DVT occurred after the series of treatments; we speculated this was due to sclerosant leakage to the deep venous system at the first session and lower-leg swelling after the whole session. However, even with DVT, the patient was able to play sports, an improvement in his quality of life compared with his pre-procedure status.

In conclusion, although AVM is histologically benign it can recur and it is important to treat the lesion completely to prevent recurrence. Percutaneous trans-nidus EO sclerotherapy is a useful treatment of AVM in extremities.

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Percutaneous Excision of a Facet Joint Cyst Under CT Guidance

Phillip Gishen, Fiona N.A.C. Miller

Department of Radiology, King's College Hospital, Denmark Hill, London SE5, UK

Abstract

We report a patient with a cyst of the posterior inter-articular joint that was decompressed using a bone biopsy Temno needle.

Key words: Facet joint cyst—Spinal synovial cyst—Spinal epidural cyst—Posterior articular cyst—Bone biopsy—Nerve root compression

Cysts of the posterior inter-articular joints are a rare cause of nerve root compression. They are a complication of facet joint osteoarthritis. Plain films show degenerative disease of the facet joints, but cannot demonstrate the cysts. Computed tomography (CT) and magnetic resonance imaging (MRI) may show a cyst, but MRI is the modern investigation of choice [1, 2]. At present surgical removal appears to be the preferred treatment [3–5], with cyst aspiration and injection of local anesthetic and corticosteroid affording only temporary relief [6–8]. Percutaneous introduction of a bone biopsy Temno needle through the lamina to decompress the cyst was successful for one patient. There was no recurrence of the cyst at 1 year follow-up.

Case Report

A 65-year-old woman with osteoarthritis of the hips and lumbar facet joints developed left-sided sciatica following a left total hip replacement and an unsuccessful gluteus medius repair. MRI of the lumbar spine revealed a left-sided L5/S1 facet joint cyst (Fig. 1). The L5/S1 facet joint was injected with lignocaine and triamcinolone and an attempt was made to aspirate the cyst through the joint. This was unsuccessful. A bone biopsy Temno needle (4.5-mm diameter × 11-cm length) was inserted into the facet joint of L5/S1 to remove bone from either side of the joint. The intention was to make a passageway to drain the cyst. Histopathologic examination of the removed specimen showed lamellar cortical bone and part of a cyst containing synovium and amorphous eosinophilic material. No symptomatic relief occurred.

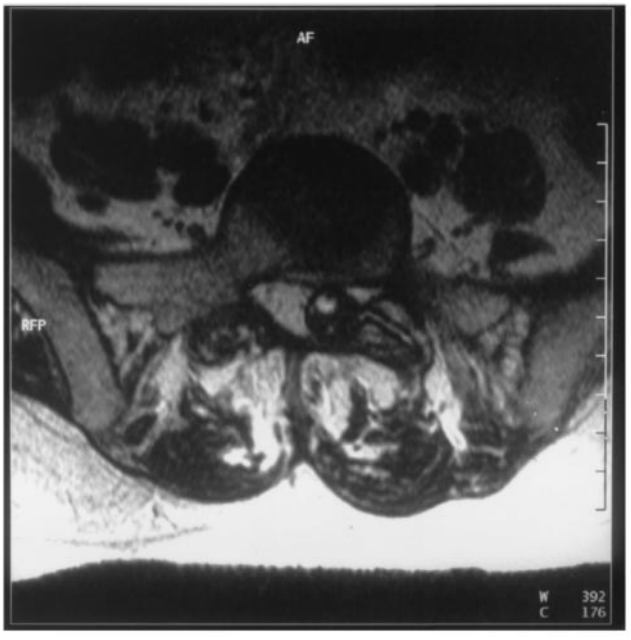

Fig. 1. T2-weighted axial MR image at the level of the L5/S1 intervertebral disc showing a left-sided facet joint cyst.

An epidural injection of lignocaine and triamcinolone 3 weeks later produced complete pain relief for 9 days, but after less than 1 month the pain

Correspondence to: P. Gishen, M.D.

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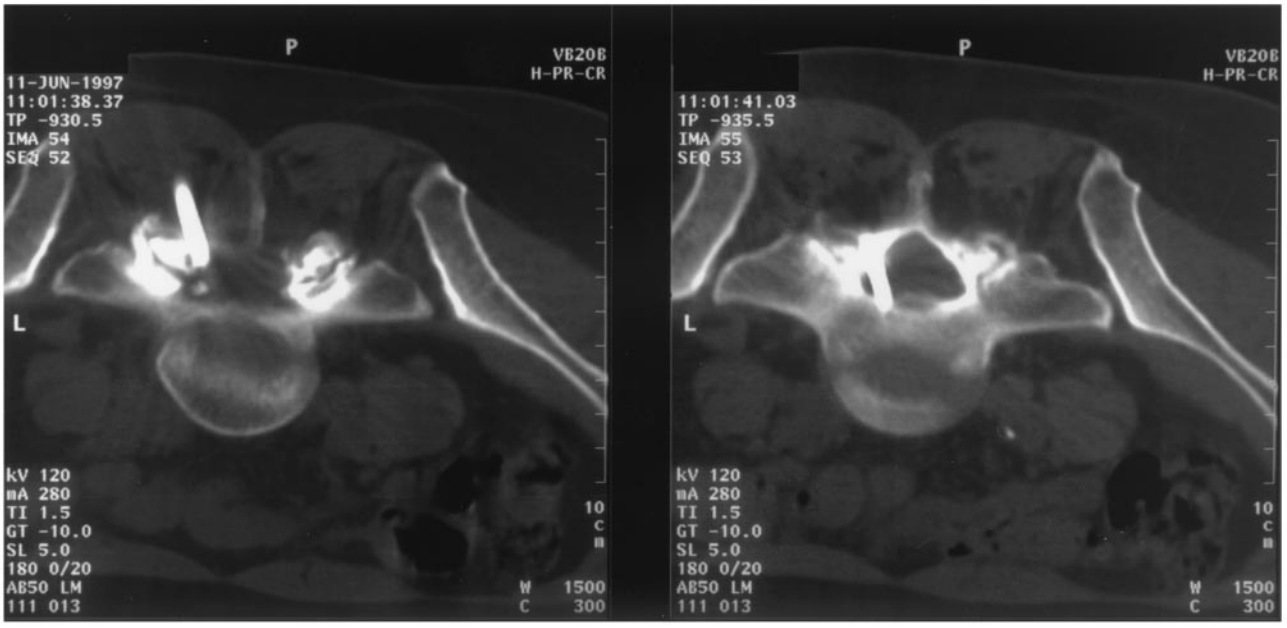

Fig. 2. CT images of the bone biopsy Temno needle approaching the cyst via the lamina.

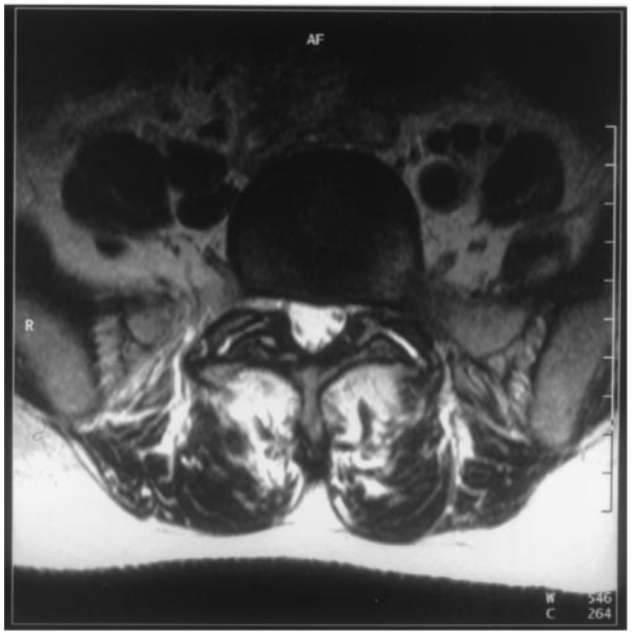

Fig. 3. T2-weighted axial MR image at the level of L5/S1 1 year after excision shows no recurrence of the cyst.

recurred to 80% of its previous level. At this stage a further left L5/S1 facet joint injection of lignocaine and triamcinolone produced no effect. A repeat MRI examination showed the cyst to still be present.

Finally, under CT guidance, the cyst was approached through the lamina using a bone biopsy Temno needle (Temno, Bauer Medical International, Santa Domingo, Dominican Republic) (Fig. 2) and aspiration was performed. This resulted in disappearance of the cyst and long-term disappearance of symptoms. MRI scan at 1 year shows no recurrence of the cyst (Fig. 3).

Discussion

Facet joint cysts are a very rare cause of sciatica. The largest series is reported in a German study by Antoniadis et al. [6]. They report a review of 19,107 spinal operations to relieve nerve root compression. Of these only 24 were caused by facet joint cysts. They assert that the treatment of choice is surgical removal of the cysts. They report spontaneous remission and short-term improvement with CT-guided aspiration and corticosteroid injection.

An earlier study by Chevalier et al. [7] describes a series of six cases treated with CT-guided aspiration and corticosteroid injection. These authors do not comment on recurrence rates. A further review of 19 patients with intraspinal cysts by Hsu et al. [8] had similar findings, with epidural and facet joint injections providing only temporary relief, and surgical decompression producing fair to good outcomes.

Our experience was that local anesthetic and corticosteroid facet joint and epidural injections provided very temporary relief. Attempted percutaneous removal and widening of the facet joint failed to produce drainage of the cyst. The cyst was decorticated and dispersed by passing a bone biopsy Temno needle through the lamina and the cyst under CT guidance.

There is a (theoretical) risk of nerve root injury associated with our technique, though it is difficult to estimate the actual risk. Occasional reports of nerve root damage are found in vertebral bone biopsies [9]. We have not identified any reports in the literature of nerve root injury from facet joint cyst aspiration, but our technique used a larger needle than would be used for cyst aspiration.

The risks of our procedure must be weighed against the risk of nerve root injury, and other risks, from surgical treatment. The risk of nerve root injury is quoted as under 1% in wide laminectomy and facet removal [10].

We chose to perform our procedure under CT guidance to allow accurate placement of the Temno biopsy needle to avoid nerve root injury.

This method offers a new minimally invasive technique for the treatment of synovial facet joint cysts, and merits further evaluation with regards to efficacy, and the risk of nerve root injury.

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Hemopericardium After Superior Vena Cava Stenting for Malignant SVC Obstruction: The Importance of Contrast-Enhanced CT in the Assessment of Postprocedural Collapse

Jonathan Brant,[1] Charles Peebles,[1] Paul Kalra,[2] Allan Odurny[1]

[1]Department of Radiology, Southampton General Hospital, Tremona Road, Southampton SO16 6YD, UK
[2]Department of Cardiology, Southampton General Hospital, Tremona Road, Southampton SO16 6YD, UK

Abstract

We report the complication of hemopericardium following superior vena cava (SVC) stenting with an uncovered Wallstent in a patient with malignant SVC obstruction. The patient collapsed acutely 15 min following stent placement with hypoxemia and hypotension. A CT scan demonstrated a hemopericardium which was successfully treated with a pericardial drain. The possible complications of SVC stenting, including hemopericardium, pulmonary embolism, mediastinal hematoma, and pulmonary edema from increased venous return resulting from improved hemodynamics, ensure a wide differential diagnosis in the postprocedural collapsed patient and this case emphasizes the important role of contrast-enhanced CT in the peri-resuscitation assessment of these patients.

Key words: Superior vena cava obstruction—Stent—Complications

Superior vena cava (SVC) stenting, with either the Wallstent, Gianturco stent, or Palmaz stent, is now a well-recognized and well-tolerated intervention for SVC obstruction (SVCO) of both benign and malignant etiologies. In malignant SVCO, arising in 3%–5% of cases of lung carcinoma [1], it is used alongside chemotherapy and radiotherapy, giving almost immediate relief of symptoms in the overwhelming majority of patients [1–9]. It is particularly indicated where the symptoms of SVCO are poorly tolerated, and is proposed by some authors to be the treatment of first choice [1, 3, 6, 9].

Complications are generally infrequent [1–6], with quoted incidences of between 3.2% and 7.8% [6] for minor and major complications respectively. Restenosis and thrombosis [1, 3, 5] with or without tumor recurrence is well described. Other complications include stent displacement and infection [4] and the complications of concurrent anticoagulation and thrombolysis. There is a surprisingly low reported incidence of pulmonary embolism given the nature of the procedure [7]. Mediastinal hematoma has been infrequently described. Another potential complication is pulmonary edema following increased venous return as a consequence of the improved hemodynamics. Although the possibility of hemopericardium following SVC stenting has been well described in the literature, actual case reports are rare, and recent literature reviews appear to confirm that it is a rare occurrence [7].

We report here a case of hemopericardium following the insertion of an uncovered Wallstent.

Case Report

A 71-year-old man presented with symptoms of SVCO including headaches and facial edema. A diagnosis of inoperable bronchial adenocarcinoma of the right upper lobe with mediastinal involvement, on a background of asbestos pleural disease, had been made 15 months previously. He had completed a course of 20 Gy palliative radiotherapy in five fractions to the mediastinum and right hilum and was taking dexamethasone. A CT scan showed mediastinal and pericardial invasion with tumor and compression of the SVC.

A superior vena cavagram was performed via bilateral cubital vein punctures which showed virtual occlusion of the proximal left innominate vein with extensive mediastinal collaterals and a stenosis in the distal right innominate vein involving the origins of the internal jugular and subclavian veins. A further severe stenosis was present in the SVC, just above the right atrium (Fig. 1). A right femoral vein puncture was performed and a guidewire was passed uneventfully through the SVC stenosis into the internal jugular vein. Balloon dilatation of the right innominate and SVC stenoses were performed with a 12-mm-diameter balloon. Uncovered Wallstents (16 mm × 50 mm and 16 mm × 70 mm; Boston Scientific/Schneider,

Correspondence to: Dr. J. Brant; e-mail: jbrant@doctors.org.uk

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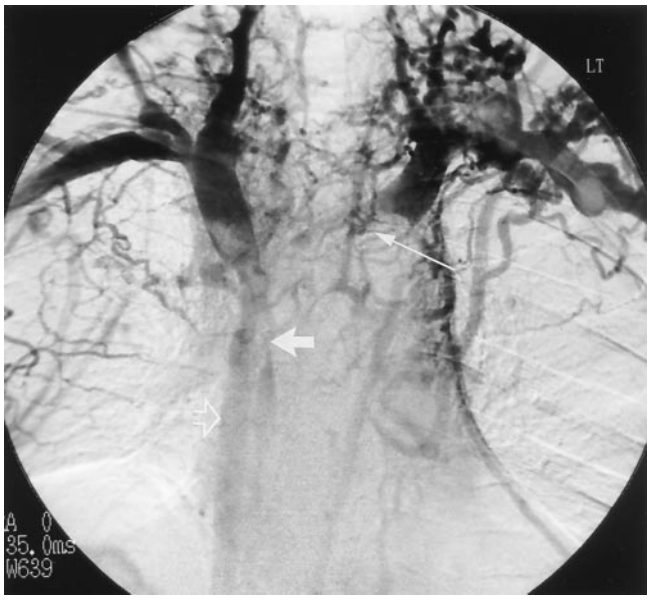

Fig. 1. Superior vena cavagram demonstrating left innominate vein occlusion (small arrow) and SVC stenosis (large arrow). The right internal jugular vein has not opacified due to a proximal stenosis. Note the reversed flow in the azygos vein (open arrow).

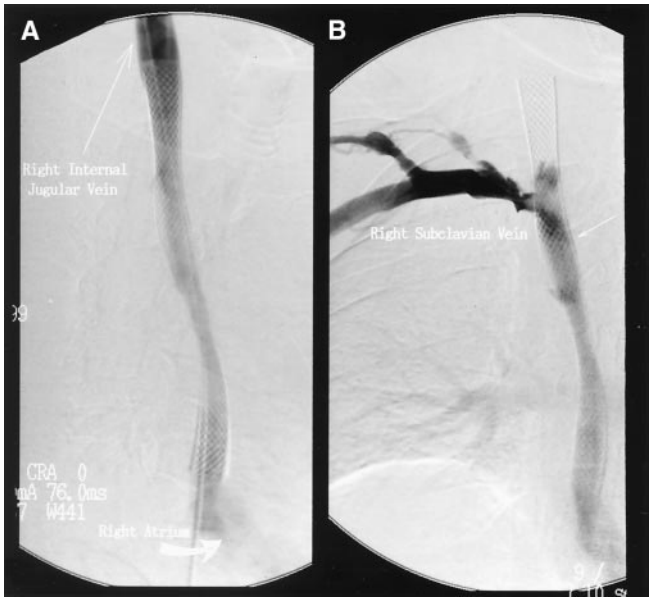

Fig. 2. **A** Postprocedural venography showing free flow from the right internal jugular vein (straight arrow) through stents to the right atrium (curved arrow). No extravasation into the pericardial sac is seen. **B** Arm venography showing flow through the right subclavian vein stenosis into the stents (arrow).

Bülach, Switzerland) were deployed across the innominate and SVC stenoses respectively. These were positioned satisfactorily and subsequently dilated with a 14-mm balloon. Postprocedural venography (Fig. 2) demonstrated excellent flow from the internal jugular vein to the right atrium and despite the subclavian stenosis there was good drainage of contrast from the right arm through the stent, with almost immediate improvement in the patient's facial coloration. The left innominate vein was not stented due to probable thrombus in the vessel and the finding of well-developed collaterals. The patient was anticoagulated during the procedure with 5000 units of heparin but did not receive thrombolytic therapy.

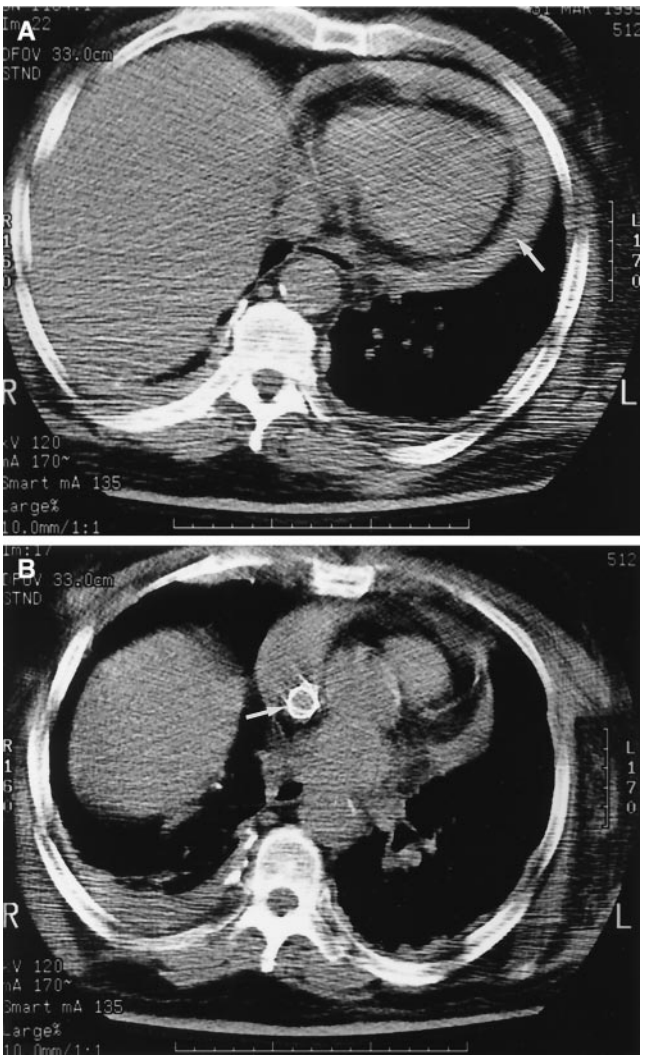

Fig. 3. **A** Unenhanced CT scan showing an extensive pericardial fluid collection (arrow). **B** The inferior extent of the SVC stent is shown (arrow).

Within 15 min of the procedure, the patient became hypotensive with a blood pressure of 90/60 mmHg, tachycardic (120 beats/min), complained of dyspnea, and became sweaty and peripherally shut down. Pulmonary examination was unremarkable. He was resuscitated with oxygen and plasma-expanders and in view of the wide differential diagnosis a CT scan with contrast was performed (Figs. 3, 4). This showed a hemopericardium with no evidence of major segmental pulmonary embolism or mediastinal hematoma.

A pericardial drain was inserted which led to the resolution of the tamponade. The patient had excellent relief from his symptoms of SVCO and was discharged 5 days later. He subsequently died 7 weeks later of pneumonia related to his bronchial carcinoma.

Discussion

SVC stenting is increasingly proposed to be the treatment of choice in malignant SVCO [1, 3, 6, 9]. The stents currently used are the Gianturco Z-stent, the Palmaz stent, and the Wallstent, with the largest body of experience with the Gianturco stent. More recent articles [8, 9], however, recommend Wallstents because of their flexibility and intrinsic radial expansive force. The major cause of complications following stenting is related to the use of fibrinolytics and anticoagulation [3, 8, 9]. It is clear that earlier referral

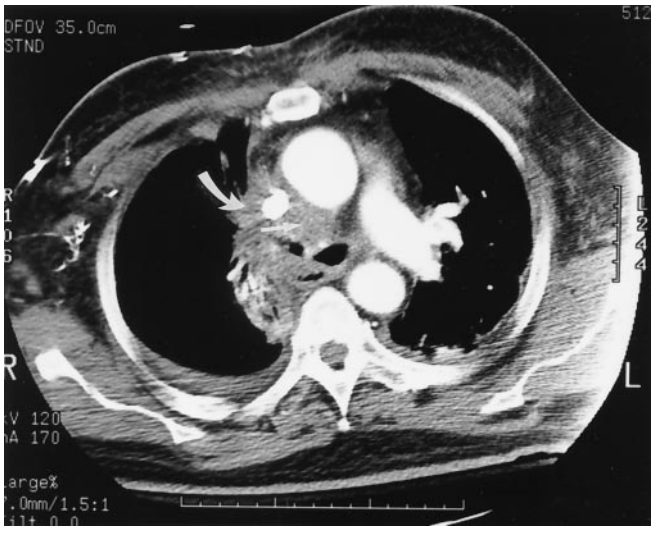

Fig. 4. Contrast-enhanced CT scan showing the patent stented SVC surrounded in its lateral extent by tumor (curved arrow). Both main pulmonary arteries are patent with no evidence of emboli. Positioned posteriorly between the SVC and the ascending aorta is the blood-filled superior pericardial recess of the pericardium (straight arrow). Paramediastinal radiation fibrosis in the medial aspect of the right lung is seen.

reduces the incidence of thrombosis and the need for pre-stent thrombolysis. Many groups, however, still advocate anticoagulation [1–4, 6, 8, 9], although no consensus on anticoagulation strategy is suggested by a recent literature review [7]. Our patient received 5000 units of heparin, which must be considered a factor in the resultant hemopericardium.

One case of pericarditis complicated by the use of fibrinolytics has been described [9], and there has been a report of rupture through the wall of the SVC in the same paper. Contrast has been seen in the pericardium [1] in another report, as a consequence of passage of the guidewire through the myocardium. No pericardial perforation with the guidewire occurred in this case. There has been one recent report of hemopericardium and cardiac tamponade [10] during attempted SVC stenting. This was in a case with complete obstruction of the SVC; passage of the guidewire was technically difficult and there was some uncertainty as to the position of the guidewire prior to dilatation. This case did not proceed to stenting whereas in our reported case guidewire passage and stent placement proceeded uneventfully.

Possible predisposing factors in our case include the history of previous radiotherapy received by this patient that could theoretically have made the tissues of the SVC friable and more liable to rupture. A study has not yet been done to look at the incidence of complications in patients with and without previous exposure to radiotherapy.

Further possible influencing factors include the extent of tumor involvement of the SVC, as currently classified by Stanford types 1 to 4. This case was Stanford type 3, with near complete obstruction of the SVC with reversal of blood flow in the azygos vein. It is thought that tumor invasion of the caval walls leads to a loss of elasticity. Furui et al. [4] have suggested that SVC stenting is less successful with greater degrees of caval encasement. However, Thony et al. [9] suggested that neither the size of tumor nor the length of caval occlusion influenced the success of stenting. Neither study indicated any increase in bleeding complications with larger tumors. Caval angioplasty could in theory lead to an increased incidence of rupture with mediastinal hematoma or hemopericardium, but is advocated prior to stent placement by a number of authors [1, 2, 4] and equally advocated by other groups following Wallstent insertion [8, 9]. Other authors suggest that prior balloon angioplasty encourages thrombus migration [3], but no studies have yet looked at the incidence of complications with angioplasty. There is currently no evidence to suggest that angioplasty leads to an increased risk of caval rupture, as we experienced. In this case we placed the lower Wallstent so that its inferior limit almost extended into the right atrium. The superior pericardial recess extends to the axial level of the carina. It seems that the lateral aspect of the SVC was protected by fibrous tissue secondary to previous radiotherapy and therefore the bleed occurred through the medial aspect of the SVC into the pericardial recess (Fig. 4).

In conclusion, although SVC stenting is a well-tolerated and successful treatment in the management of SVCO of benign or malignant etiologies, there are a number of potential major complications that can lead to postprocedural collapse. We report a case of hemopericardium following straightforward Wallstent insertion. The differential diagnosis in periprocedural collapse is wide and includes mediastinal hemorrhage, hemopericardium and cardiac tamponade, pulmonary embolism, and cardiac failure from increased venous return as a consequence of the improved hemodynamics. Hemopericardium can be identified on transthoracic ultrasound, which is a readily available and low-cost investigation, which, when it is positive for hemopericardium, will allow the early institution of appropriate therapy in the form of a pericardial drain. However, the remaining and perhaps contributing differential diagnoses, including mediastinal hematoma and pulmonary embolism, as well as possibly pulmonary edema from increased venous return, require conflicting treatments. The ability of thoracic CT and CT pulmonary angiography to quickly distinguish the important differential diagnoses in this situation is well demonstrated in this case.

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