—Case Reports—

Fracture of an Expandable Metallic Stent Placed for Biliary Obstruction due to Common Bile Duct Carcinoma

Hiroshi Yoshida[1], Yasuhiro Mamada[1], Nobuhiko Taniai[1], Yoshiaki Mizuguchi[1], Tetsuya Shimizu[1], Takayuki Aimoto[1], Yoshiharu Nakamura[1], Tsutomu Nomura[1], Shigeki Yokomuro[1], Yasuo Arima[1], Eiji Uchida[1], Hirofumi Misawa[2], Eiichi Uchida[2] and Takashi Tajiri[1]

[1]Surgery for Organ Function and Biological Regulation, Nippon Medical School Graduate School of Medicine
[2]Uchida Hospital, Tokyo

Abstract

We report our second case of fracture of a SMART self-expandable metallic stent (Cordis Endovascular, Warren, NJ) placed to treat biliary obstruction due to an unresectable common bile duct carcinoma. An 82-year-old man presented with jaundice. Computed tomography and ultrasonography on admission demonstrated a mass in the lower common bile duct. The mass was identified as a common bile duct obstruction. A SMART stent was inserted. Ten months after stent insertion, two additional SMART stents were inserted to relieve obstructive jaundice due to occlusion of the first stent. Fourteen months after insertion of the first stent, endoscopic examination revealed stenosis of the duodenum due to invasion of the common bile duct carcinoma, prompting us to perform a gastrojejunostomy 1 month later. Three months after gastrojejunostomy, the patient presented with obstructive jaundice and cholangitis. A fracture of one of the stents was then discovered on plain X-ray films and percutaneous transhepatic cholangiography. Two SMART stents were inserted simultaneously. In conclusion, we report the fracture of a SMART stent placed for common bile duct carcinoma. Fracture should be considered as a possible complication after metallic stent insertion.
(J Nippon Med Sch 2006; 73: 164–168)

Key words: expandable metallic stent, common bile duct carcinoma, obstructive jaundice, fracture

Introduction

The incidence of biliary obstruction by pancreatic cancer is increasing, and more patients are undergoing resection as both operative techniques and diagnostic imaging improve. Inoperable cases still have a poor prognosis, due, in part, to the frequent presence of obstructive jaundice. However, stenting has been demonstrated to improve patients' quality of life[1].

Several features of expandable metallic stents make them more suitable for this indication than plastic stents. In addition to having a larger diameter, they can be introduced in smaller delivery catheters and remain in position after release[2–6].

Correspondence to Hiroshi Yoshida, MD, Department of Surgery, Nippon Medical School, 1–1–5 Sendagi, Bunkyo-ku, Tokyo 113–8603, Japan
E-mail: hiroshiy@nms.ac.jp
Journal Website (http://www.nms.ac.jp/jnms/)

Fig. 1 Plain X-ray film showing the stent fracture **(arrow)**.

Fig. 2 Cholangiography demonstrating the stent fracture **(arrow)** at the papilla of Vater and obstruction due to tumor ingrowth.

Many patients with obstructive jaundice have undergone this procedure with expandable metallic stents.

We have previously reported a "one-step insertion" technique for inserting an expandable metallic stent during percutaneous transhepatic cholangiography. One-step insertion of an expandable metallic stent for biliary obstruction is a useful way to shorten hospitalization[7].

Reported complications of metallic stent placement for malignant bile duct obstruction include tumor ingrowth or overgrowth[4,8], viscus perforation[9,10], and stent migration[11]. Our group was the first to describe the fracture of a SMART stent (Cordis Endovascular, Warren, NJ), which had been inserted because of biliary obstruction[12].

The present report describes the fracture of another SMART stent, which had been inserted because of an unresectable common bile duct carcinoma. Upon discovering the fracture, we inserted additional SMART stents with our one-step insertion technique.

Fig. 3 Two 10×80-mm SMART stents were inserted simultaneously by one-step insertion, and the drainage catheters were left in place.

Case Report

An 82-year-old man presented with jaundice in May 2003. Computed tomography and ultrasonography on admission demonstrated dilation of intrahepatic bile ducts and a mass in the lower common bile duct. Endoscopic cholangiography

demonstrated an obstruction of the common bile duct, and an external biliary drainage catheter was left in place. The patient refused tumor resection but underwent placement of a SMART stent measuring 10 mm (diameter) × 80 mm (length) as soon as the cholestasis had resolved.

In March 2004, 10 months after stent insertion, the patient again presented with jaundice. Computed tomography and ultrasonography revealed dilation of the intrahepatic bile ducts. Endoscopic cholangiography demonstrated an obstruction of the stent, and a second external biliary drainage catheter was left in place. As soon as the cholestasis had resolved, two more SMART stents were inserted, one measuring 10 mm (diameter) × 80 mm (length) and the other measuring 10 mm(diameter) × 60 mm (length). In July 2004 the patient presented with loss of appetite and vomiting. Endoscopic examination revealed stenosis of the duodenum due to invasion of the common bile duct carcinoma. Gastrojejunostomy was performed in August 2004.

In November 2004 the patient presented with jaundice and pyrexia. Computed tomography and ultrasonography revealed dilation of intrahepatic bile ducts, and a fracture of one of the stents was discovered on plain X-ray films (**Fig. 1**). Percutaneous transhepatic cholangiography demonstrated fracture of the stent at the papilla of Vater and obstruction due to tumor ingrowth (**Fig. 2**). During the procedure we placed two SMART stents measuring 10 mm (diameter) × 80 mm (length) with our one-step insertion technique[2]. The drainage catheters were left in place after surgery (**Fig. 3**) and were removed after stent patency was confirmed 3 days later.

Discussion

Long-term survival is poor in patients with malignant biliary obstruction when they cannot undergo surgical resection. The objectives of palliation with a biliary stent are to relieve symptoms related to obstructive jaundice, to prevent cholangitis, and possibly to prolong survival. Biliary insertion of a metallic stent is now the preferred treatment for jaundice caused by inoperable malignant bile duct tumors with obstruction.

Success rates up to 100% have been reported for stent insertion[13–15]. However, clinical results with metallic stents have varied. Serious complications, particularly hemobilia, have occurred in 2.3% to 20.8% of patients in previous series[13,16,17]. In much rarer cases, stent placement has also led to complications due to malpositioning of the stent, insufficient luminal diameter, and failure of stent release[13]. Most complications are related to the percutaneous transhepatic approach and not to stent implantation itself[17]. Early occlusion rates of 7% to 42% and late occlusion rates of 12% and 38% have been reported, with a mean time to stent failure of 6 to 9 months[5,6,18–20]. Viscus perforation[9,10] and stent migration[11] have also been reported after metallic stent placement for malignant bile duct obstruction. Finally, Peck et al.[21] have reported 4 fractures of modern metallic stents inserted in the biliary tree in a series of 66 patients (6.1%). These stent fractures were presumably related to metal fatigue due to repeated bending.

Ell et al.[22] have reported the fracture of a stent (Wallstent; Medinvent SA, Lausanne, Switzerland) after electrocoagulation was used to remove obstructing tumor tissue in a case of inoperable cholangiocarcinoma. They later performed *in vitro* studies to assess the potential risk of stent fracture with electrocoagulation. Even with their monopolar electrocoagulation probe set at the low intensities usually used for hemostasis, the metal filaments of the stent started to melt after only 3 to 10 seconds. Our earlier paper on the fracture of a SMART stent used for an unresectable pancreatic carcinoma[12] was, to our knowledge, the first published account of a SMART stent fracture.

There have been reports of fractures of stents placed in the bronchus[23,24], esophagus[25–28], stomach[26,29], duodenum[29,30], and large intestine[31]. The reports of fractures of bronchial stents (Gianturco stent, Cook Europe, Bjaerverskov, Denmark[24]; Z stent, Myungsung Medical, Seoul, Korea)[23] suggest that they may have resulted from repeated and prolonged shearing forces placed on the stents by coughing or forced respiratory movements. Odurny[31]

has reported fractures of colonic stents (Memotherm stent, Bard, Angiomed, Karlsruhe, Germany) 3 to 7 months after insertion. Anatomic factors unique to anastomotic colonic strictures produce constant compression; hence, the duration of stent implantation may be a major factor leading to fracture[31]. Another report describes the fracture of an esophageal nitinol stent (Ultraflex, Microvasive, Boston Scientific Corporation, Watertown, MA, USA) after laser treatment for tumor ingrowth[25].

Stent fractures have also resulted from treatments for tumor ingrowth such as balloon expansion[27] and laser therapy[25]. Fractures in cases without such treatments may result from metal fatigue[28] or the tearing of the polyurethane stent cover[29]. Because our patient received no other treatment, we presume that the fracture was related to metal fatigue from repeated bending in the duodenum.

The SMART stent is composed of nitinol, a nickel-titanium alloy. The unique micromesh geometric design of this laser-cut stent confers superior radial force, excellent flexibility, and minimal foreshortening. This report is the second to describe the fracture of a SMART self-expandable stent.

The fracture was mostly likely caused by ongoing stress at the site of maximum leverage. To explain their experiences with fractured Memotherm stents, Peck et al.[21] have speculated that Memotherm stents might be stiffer than other bile duct stents and, therefore, fracture more easily by bending. The stent in our patient shifted to the left and anteriorly due to tumor growth and prolonged mechanical stress.

Duda et al.[32] compared the Memotherm stent, the SMART stent, and the Wallstent expandable metallic stents by direct testing. Radial force, a property which imparts resistance against modification by external force, was 0.39 N/cm in the Wallstent, 1.27 N/cm in the Memotherm stent, and 1.65 N/cm in the SMART stent in their experiments. This high resistance force is presumably related to hardness and may lead to weakness during bending. We inserted two SMART stents again with the one-step insertion technique[2] into the fractured stent, and the cholestasis resolved immediately.

Additional experiments in a biliary system will be required, however, as the experiments by Duda et al.[32] only evaluated the radial force of the expandable metallic stents imposed by the arterial constriction. Subsequent case studies will also be needed to determine whether the design, manufacture, and use of nitinol are at fault in these types of fractures.

In conclusion, we have reported the fracture of a SMART self-expandable metallic stent inserted in a patient with common bile duct carcinoma. This is our second report on the fracture of a SMART stent. Fractures should be considered as a possible complication after metallic stents are inserted.

References

1. Wagner HJ, Knyrim K, Vakil N, Klose KJ: Plastic endoprostheses versus metal stents in the palliative treatment of malignant hilar biliary obstruction. A prospective and randomised trial. Endoscopy 1993; 25: 213–218.
2. Yoshida H, Mamada Y, Taniai N, et al.: One-step palliative treatment method for obstructive jaundice caused by unresectable malignancies by percutaneous transhepatic insertion of an expandable metallic stent. World J Gastroenterol 2006; 12: 2423–2426.
3. Rossi P, Bezzi M, Rossi M, et al.: Metallic stents in malignant biliary obstruction: results of a multicenter European study of 240 patients. JVIR 1994; 5: 279–285.
4. Stoker J, Lameris JS: Complications of percutaneously inserted biliary Wallstents. J Vasc Interv Radiol 1993; 4: 767–772.
5. Knyrim K, Wagner HJ, Pausch J, Vakil N: A prospective randomised controlled trial of metal stents for malignant obstruction of the common bile duct. Endoscopy 1993; 25: 207–212.
6. Lee MJ, Dawson SL, Mueller PR, Krebs TL, Saini S, Hahn PF: Palliation of malignant bile duct obstruction with metallic biliary endoprostheses: technique, results, and complications. JVIR 1992; 3: 665–671.
7. Yoshida H, Tajiri T, Mamada Y, et al.: One-step insertion of an expandable metallic stent for unresectable common bile duct carcinoma. J Nippon Med Sch 2003; 70: 179–182.
8. Becker CD, Glatti A, Maibach R, Baer HU: Percutaneous palliation of malignant obstructive jaundice with the Wallstent endoprosthesis: Follow-up and reintervention in patients with hilar and non-hilar obstruction. J Vasc Interv Radiol 1993; 4: 597–604.
9. Schaafsma RJ, Spoelstra P, Pakan J, Huibregtse K: Sigmoid perforation: A rare complication of a migrated biliary endoprosthesis. Endoscopy 1996; 28: 469–470.

10. Marsman JW, Hoedemaker HP: Necrotizing fasciitis: Fatal complication of migrated biliary stent. Australas Radiol 1996; 40: 80–83.
11. Pescatore P, Meier-Willersen HJ, Manegold BC: A severe complication of the new self-expanding spiral nitinol biliary stent. Endoscopy 1997; 29: 412–415.
12. Yoshida H, Tajiri T, Mamada Y, et al.: Fracture of an expandable metallic stent placed for biliary obstruction. Gastrointestinal Endosc 2004; 60: 655–658.
13. Wagner HJ, Knyrim K: Relief of malignant obstructive jaundice by endoscopic or percutaneous insertion of metal stents. Bildgebung 1993; 60: 76–82.
14. Lee BH, Choe DH, Lee JH, Kim KH, Chin SY: Metallic stents in malignant biliary obstruction: prospective long-term clinical results. AJR 1997; 168: 741–745.
15. Boguth L, Tatalovic S, Antonucci F, Heer M, Sulser H, Zollikofer CL: Malignant biliary obstruction: clinical and histopathologic correlation after treatment with self-expanding metal prostheses. Radiology 1994; 192: 669–674.
16. Salomonowitz EK, Adam A, Antonucci F, Stuckmann G, Zollikofer CL: Malignant biliary obstruction: treatment with self-expandable stainless steel endoprosthesis. Cardiovasc Intervent Radiol 1992; 15: 351–355.
17. Lammer J, Klein GE, Kleinert R, Hausegger K, Einspieler R: Obstructive jaundice: Use of expandable metal endoprosthesis for biliary drainage. Radiology 1990; 177: 789–792.
18. O'Brien S, Hatfield ARW, Craig PI, Williams SP: A three year follow-up of self expanding metal stents in the endoscopic palliation of long-term survivors with malignant biliary obstruction. Gut 1995; 36: 618–621.
19. Davids PHP, Groen AK, Rauws EA, Tytgat GNJ, Huibregtse K: Randomised trial of self-expanding metal stents versus polyethylene stents for distal malignant biliary obstruction. Lancet 1992; 340: 1488–1492.
20. Stoker J, Lameris JS, van Blankenstein M: Percutaneous metallic self-expandable endoprostheses in malignant hilar biliary obstruction. Gastrointest Endosc 1993; 39: 43–49.
21. Peck R, Wattam J: Fracture of memotherm metallic stents in the biliary tract. Cardiovasc Intervent Radiol 2000; 23: 55–69.
22. Ell C, Fleig WE, Hochberger J: Broken biliary metal stent after repeated electrocoagulation for tumor ingrowth. Gatrointest Endosc 1992; 38: 197–198.
23. Lee KW, Im JG, Han JK, Kim TK, Park JH, Yeon KM: Tuberculous stenosis of the left main bronchus: results of treatment with balloons and metallic stents. J Vasc Interv Radiol 1999; 10: 352–358.
24. Rousseau H, Dahan M, Lauque D, et al.: Self-expandable prostheses in the tracheobronchial tree. Radiology 1993; 188: 199–203.
25. Schoefl R, Winkelbauer F, Haefner M, Poetzi R, Gangl A, Lammer J: Two cases of fractured esophageal nitinol stents. Endoscopy 1996; 28: 518–520.
26. Wengrower D, Fiorini A, Valero J, et al.: EsophaCoil: long-term results in 81 patients. Gastrointest Endosc 1998; 48: 376–382.
27. Winkelbauer FW, Schofl R, Niederle B, Wildling R, Thurnher S, Lammer J: Palliative treatment of obstructing esophageal cancer with nitinol stents: value, safety, and long-term results. Am J Roentgenol 1996; 166: 79–84.
28. Cwikiel W, Tranberg KG, Cwikiel M, Lillo-Gil R: Malignant dysphagia: palliation with esophageal stents—long-term results in 100 patients. Radiology 1998; 207: 513–518.
29. Park KB, Do YS, Kang WK, et al.: Malignant obstruction of gastric outlet and duodenum: palliation with flexible covered metallic stents. Radiology 2001; 219: 679–683.
30. Maetani I, Shimura J, Ukita T, Inoue H, Igarashi Y, Sakai Y: Successful repair of a damaged duodenal stent by cutting stent wires and placement of a second stent. Endoscopy 2002; 34: 86–88.
31. Odurny A: Colonic anastomotic stenoses and Memotherm stent fracture: a report of three cases. Cardiovasc Intervent Radiol 2001; 24: 336–339.
32. Duda SH, Wiskirchen J, Tepe G, et al.: Physical properties of endovascular stents: an experimental comparison. J Vasc Interv Radiol 2000; 11: 645–654.

(Received, February 14, 2006)
(Accepted, March 28, 2006)