

Stent placement for benign portal vein stenosis following pancreaticoduodenectomy in a hybrid operating room

Yutaka Sawai¹, Takashi Kokudo¹, Yoshihiro Sakamoto¹, Hidemasa Takao², Yusuke Kazami¹, Yujiro Nishioka¹, Nobuhisa Akamatsu¹, Junichi Arita¹, Junichi Kaneko¹, Kiyoshi Hasegawa^{1,*}

¹ Hepato-Biliary-Pancreatic Surgery Division, Artificial Organ and Transplantation Division, Department of Surgery, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan;

² Department of Radiology, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan.

Summary

Benign portal vein stenosis is a rare complication following pancreaticoduodenectomy. Because a direct surgical approach to the portal vein is difficult due to severe adhesions following pancreaticoduodenectomy, portal vein stent placement is considered a good treatment option. Herein, we report 3 cases of severe portal vein stenosis following pancreaticoduodenectomy that were treated with portal venous stent placement in a hybrid operating room, combining a conventional operating room with an angiography suite. High-resolution images on digital subtraction angiography provide better contrast and support accurate stent placement compared to using a mobile C-arm.

Keywords: Digital subtraction angiography, portal hypertension, hepato-biliary-pancreatic surgery

1. Introduction

Benign portal vein (PV) stenosis is a rare complication following hepato-biliary-pancreatic surgery, such as hepatectomy and pancreaticoduodenectomy (PD) (1,2). The most frequent cause of stenosis is postoperative inflammation, which leads to portal hypertension and subsequent gastrointestinal hemorrhage from varices (3). Because a direct surgical approach to the PV is difficult due to adhesions following hepato-biliary-pancreatic surgery, PV stent placement is considered a good treatment option for benign PV stenosis (4).

Here, we report 3 cases of severe PV stenosis following PD treated with portal venous stent placement in a hybrid operating room (OR), which combines a conventional OR with a digital subtraction angiography (DSA) unit (5).

We place this study into appropriate perspective with the most recent clinical practice guidelines.

2. Patients and Methods

2.1. Patients

From August 2016 to July 2017, 62 patients underwent PD, including five hepatopancreatic duodenectomies (HPDs), at the University of Tokyo Hospital. Two patients developed acute PV stenosis with symptoms (patients 1 and 3). Patient 2 was referred from another hospital for surgical resection of remnant pancreatic cancer following PD. In total, 3 patients underwent PV stent placement for severe PV stenosis following PD in a hybrid OR in our hospital from April 2017 to October 2017. Portal vein stent placement was considered when a patient developed symptoms due to portal vein stenosis. However, in patient 2, portal vein stent placement was indicated to avoid complication, such as ascites, related to portal vein stenosis after distal pancreatectomy. Table 1 shows the patient characteristics prior to stent placement. After the surgery, all three patients developed benign PV stenosis at 2, 52, and 3 months. Patient 1 developed melena 6 months after PD, and PV stenosis was identified on computed tomography (CT) scan (Figure 1). In patient 2,

Released online in J-STAGE as advance publication December 28, 2018.

*Address correspondence to:

Dr. Kiyoshi Hasegawa, Hepato-Biliary-Pancreatic Surgery Division, Artificial Organ and Transplantation Division, Department of Surgery, Graduate School of Medicine, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-8655, Japan.

E-mail: kihase-tky@umin.ac.jp

Table 1. Preoperative Patient Characteristics

| Patient Characteristics | Patient 1 | Patient 2 | Patient 3 |
|----------------------------------|-----------|-----------|-----------|
| Age, years | 68 | 68 | 75 |
| Sex (Male/Female) | Male | Female | Female |
| Primary lesion | CC | PC | CC |
| Pathological TNM staging* | T3aN1M0 | T3N0M0 | T3bN1M0 |
| ASA score | 2 | 2 | 2 |
| BMI, kg/m ² | 30.0 | 19.2 | 19.4 |
| Albumin, g/dL | 3.5 | 3.4 | 2.7 |
| Total bilirubin, mg/dL | 0.7 | 0.9 | 0.6 |
| AST, U/L | 19 | 50 | 60 |
| ALT, U/L | 14 | 16 | 30 |
| PT-INR | 1.04 | 0.92 | 1.11 |
| Comorbidities | | | |
| Hypertension | yes | yes | no |
| Diabetes mellitus | yes | yes | no |
| Tobacco use (ever) | no | yes | no |
| Alcohol use (ever) | no | yes | no |
| PD | | | |
| Operative time, min | 597 | 494 | 689 |
| Estimated blood loss, mL | 840 | 884 | 1680 |
| Portal vein resection | no | no | yes |
| Additional right hemihepatectomy | no | no | yes |
| RBC transfusion required | no | yes | yes |
| Characteristics after PD | | | |
| Major abdominal complications** | | | |
| POPF | yes** | no | no |
| Cholangitis | no | yes | no |

*According to the American Joint Committee on Cancer Classification (8). **International Study Group of Postoperative Pancreatic Fistula Grade B (9). TNM, tumor, lymph node, metastasis; ASA, American Society of Anesthesiologists; AST, aspartate transaminase; ALT, alanine transaminase; PT-INR, prothrombin time-international normalized ratio; CC, cholangiocarcinoma; PC, pancreatic cancer; POPF, postoperative pancreatic fistula; RBC, red blood cells.

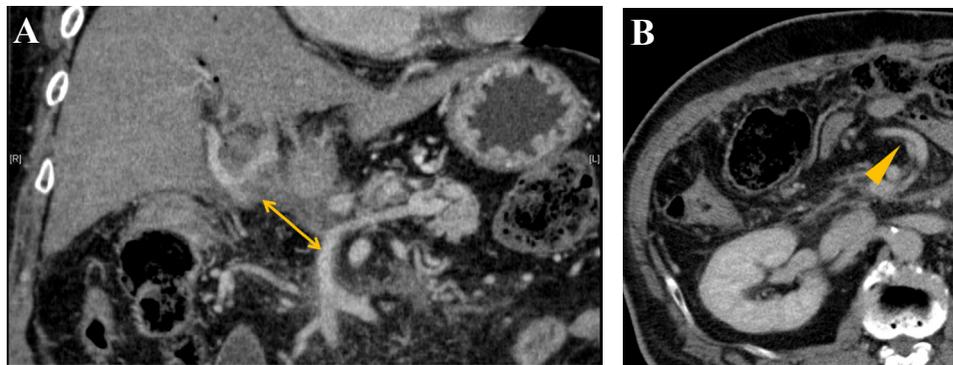


Figure 1. Preoperative findings. (A) Coronal image on contrast-enhanced CT showing extrahepatic portal vein stenosis (arrow). (B) Axial image on contrast-enhanced CT showing the dilated collateral vessel from the first jejunal vein (arrow head).

preoperative CT scan revealed severe PV stenosis with surrounding soft tissue density area. No malignant cells were found in the soft tissue on repeated endoscopic ultrasound-guided fine needle aspiration (EUS-FNA); thus the PV stenosis might be because of postoperative cholangitis associated with severe stenosis resulting from choledocojejunostomy. Stent placement was performed to relieve stenosis 17 months after PD. Patient 3 developed a liver abscess 2 months after HPD with CT scan revealing PV stenosis. The study was approved by the institutional ethics committee (approval number: CL2017037).

2.2. Surgical technique

For our three patients, we used an open trans-ileoceleal approach to the portal venous system in a hybrid OR because safe puncture using a percutaneous approach was difficult. In patients 1 and 2, the portal vein diameter of the umbilical portion was small (5 mm) and portal vein flow was difficult to detect. In patient 3, although the portal vein diameter was relatively thick (9 mm), liver abscess existed at the puncture tract.

During transileocolic PV stent placement, a midline incision was made on the lower abdomen. A vascular

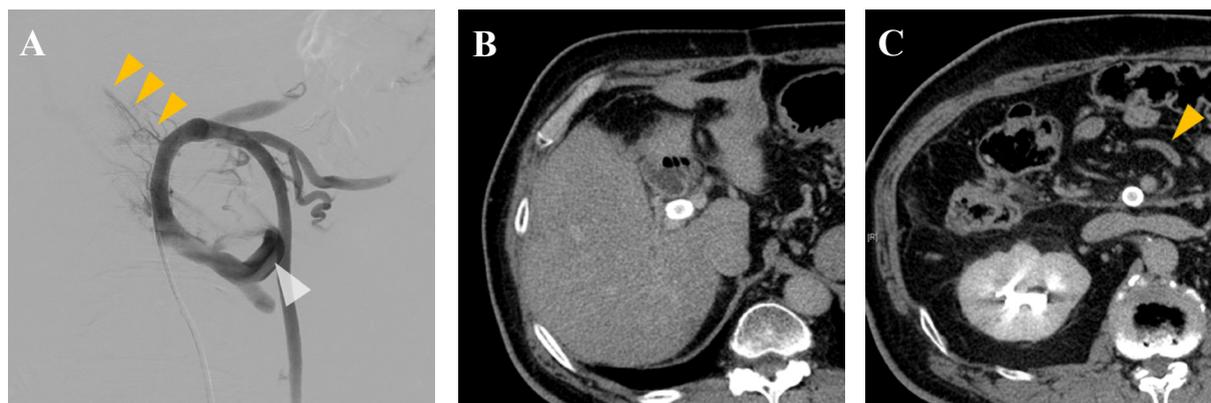


Figure 2. Intraoperative and postoperative findings. (A) Portography showing portal vein stenosis (yellow arrow head) and collateral vessels from the first jejunal vein (white arrow head). (B, C) Contrast-enhanced CT images 3 months after stent placement showing stent patency (B) and collateral vessel shrinkage (C, yellow arrow head).

Table 2. Intraoperative and Postoperative Outcomes of Stent Placement

| Variables | Patient 1 | Patient 2 | Patient 3 |
|---|-----------|-----------|-----------|
| Intraoperative outcome | | | |
| Operative time, min | 164 | 140 | 154 |
| Estimated blood loss, mL | 115 | 50 | 0 |
| Decrease in pressure gradient between the PV and SMV, cm H ₂ O | 7.5 | 18.4 | 8.5 |
| Postoperative morbidity | | | |
| Clavien-Dindo classification | 0 | 0 | 0 |
| Postoperative hospital stay, d | 11 | 7 | 9 |

*According to Dindo et al's classification (10). PV, portal vein; SMV, superior mesenteric vein.

sheath was introduced into the peripheral ileal vein following ileal mesentery dissection. The severity and length of the PV stenosis were examined by high-resolution portography using DSA (Figure 2A). A metallic stent was placed following balloon dilatation of the stenotic site, and additional balloon dilatation of the PV from inside of the stent was performed. Portal pressure gradient was measured before and after stent placement.

Anticoagulant therapy with heparin was administered for 1 week following stent placement and then switched to warfarin (5) for 6 months. Intraoperative and postoperative outcomes are shown in Table 2.

3. Results and Discussion

The portal system was clearly visualized in all three patients using DSA in a hybrid OR. The pressure gradient at the stenotic site was 10.5, 21.2, and 9.5 cmH₂O, respectively. It improved to 3.0, 2.8 and 1.0 cmH₂O after stent placement. Postoperative courses were uneventful in all patients. The postoperative hospital stay was 11, 7, and 9 days, respectively.

Contrast-enhanced CT scan was performed 1 week after the surgery confirmed PV stent patency. In patient 1, stent patency and collateral vessel shrinkage were detected on contrast-enhanced CT 3 months after stent placement (Figure 2B, C).

Patients 1 and 3 were symptom free following stent placement for 9 and 3 months, respectively, and patient 2 underwent resection of remnant pancreatic cancer 1 month after stent placement and was complication free for 7 months. The latest stent patency for each patient was confirmed on contrast-enhanced CT at 9, 1, and 5 months following stent placement, respectively.

We herein report 3 cases of stent placement for severe benign PV stenosis in a hybrid OR with high-resolution DSA. To our knowledge, this is the first study to report successful PV stent placement owing to the use of hybrid OR.

A hybrid OR combines a conventional OR with an angiography suite, providing radiologists with the same environment as an angiography room outside of the surgical unit. Compared to using a mobile C-arm, better contrast resolution on DSA facilitates optimal balloon inflation and supports accurate stent placement. In the present cases, stent placement using high-resolution DSA images in a hybrid OR contributed to successful stent placements.

In an angiography room, the percutaneous transhepatic approach is ultrasound guided and less invasive but is performed under local anesthesia, and the patient must undergo interventional treatment for 2-3 hours. Additionally, using the retrograde approach to the main PV, the guidewire is sometimes difficult

to advance beyond the stenotic site (3). On the other hand, the transileocecal approach requires laparotomy under general anesthesia, but it is possible to advance a guidewire through the thin portal branches, which are difficult to approach using percutaneous transhepatic access. Furthermore, it is easier to place a stent at the stenotic site using an antegrade approach than using a retrograde approach. A hybrid OR is superior to the angiography suite or a regular OR as the approach can be switched immediately whenever necessary. Therefore, referral to a specialized institution with a high-resolution hybrid OR may be beneficial in patients with severe PV stenosis.

Benign PV stenosis is a rare complication following hepatobiliary-pancreatic surgery (1,2), and is possibly caused by postoperative inflammation, such as pancreatic fistula. In the present cases, the origin of benign PV stenosis was probably due to inflammation after the surgery. Malignancy was ruled out using contrast-enhanced CT, positron emission tomography CT (PET-CT), and biopsy. Patients often develop symptoms of portal hypertension, such as gastrointestinal hemorrhage, ascites, and thrombocytopenia, when PV stenosis is > 80% (6). In our study, stenosis was > 90% in each case, and two of three patients suffered from complications.

Kato *et al.* (3) performed stent placement in 29 patients using a percutaneous transhepatic approach in 22 patients and using laparotomy via the transileocolic vein in seven patients. In total, 7 patients had stent occlusion: three had acute thrombosis, one had thrombosis at 80 days after stenting, and three had tumor growth. The patency rate was 76%, and the mean stent patency period was 17.3 ± 21.4 months. They also found that presence of a collateral vein is a significant variable related to the development of stent occlusion. Scant evidence supports using anticoagulant therapy following stent placement (7). In the present cases, warfarin was administered for 6 months after the surgery.

As a major limitation of this study, we did not compare this new approach to previous technique. Future study is necessary to clearly demonstrate the usefulness of a hybrid operating room for this relatively rare situation.

In conclusion, benign PV stenosis is a good

indication for PV stent placement. A hybrid OR with high-resolution DSA contributed to the success of PV stent placement.

References

1. Monge JJ, Judd ES, Gage RP. Radical pancreatoduodenectomy: A 22-year experience with the complications, mortality rate, and survival rate. *Ann Surg.* 1964; 160:711-722.
2. Watanobe I, Ito Y, Akimoto E, Sekine Y, Haruyama Y, Amemiya K, Miyano S, Kosaka T, Machida M, Kitabatake T, Kojima K. Postoperative portal vein thrombosis and gastric hemorrhage associated with late-onset hemorrhage from the common hepatic artery after pancreaticoduodenectomy. *Korean J Hepatobiliary Pancreat Surg.* 2016; 20:44-47.
3. Kato A, Shimizu H, Ohtsuka M, Yoshitomi H, Furukawa K, Miyazaki M. Portal vein stent placement for the treatment of postoperative portal vein stenosis: Long-term success and factor associated with stent failure. *BMC Surg.* 2017; 17:1-6.
4. Jeon UB, Kim CW, Kim TU, Choo KS, Jang JY, Nam KJ, Chu CW, Ryu JH. Therapeutic efficacy and stent patency of transhepatic portal vein stenting after surgery. *World J Gastroenterol.* 2016; 22:9822-9828.
5. Yamakado K, Nakatsuka A, Tanaka N, Fujii A, Isaji S, Kawarada Y, Takeda K. Portal venous stent placement in patients with pancreatic and biliary neoplasms invading portal veins and causing portal hypertension: Initial experience. *Radiology.* 2001; 220:150-156.
6. Shan H, Xiao XS, Huang MS, Ouyang Q, Jiang ZB. Portal venous stent placement for treatment of portal hypertension caused by benign main portal vein stenosis. *World J Gastroenterol.* 2005; 11:3315-3318.
7. Funaki B, Rosenblum JD, Leef J a, Zaleski GX, Farrell T, Lorenz J, Brady L. Percutaneous treatment of portal venous stenosis in children and adolescents with segmental hepatic transplants: Long-term results. *Radiology.* 2000; 215:147-151.
8. American Joint Committee on Cancer. *AJCC Cancer Staging Manual*, 8th Edition. 2016.
9. Bassi C, Marchegiani G, Dervenis C, *et al.* The 2016 update of the International Study Group (ISGPS) definition and grading of postoperative pancreatic fistula: 11 years after. *Surg.* 2017; 161:584-591.
10. Dindo D, Demartines N, Clavien P-A. Classification of Surgical Complications. *Ann Surg.* 2004; 240:205-213.

(Received December 12, 2018; Revised December 18, 2018; Accepted December 24, 2018)