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Case report

Successful left hepatic trisectionectomy after portal vein embolization for colon cancer liver metastasis in a patient with right-sided ligamentum teres: a case report

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Abstract

Right-sided ligamentum teres (RSLT) is a rare congenital anomaly in which the fetal umbilical vein is connected to the right paramedian trunk of the portal vein. An 80-year-old woman underwent curative sigmoidectomy for sigmoid cancer 3 years prior to presentation. After 1 year, small solitary liver metastasis was noted in segment 4. Because the patient experienced recurrence of the same lesion after chemotherapy and radiofrequency ablation, she was referred to our hospital. CT revealed an anomaly of the liver with RSLT, classified as an independent posterior branch type. The tumor in the left paramedian section was located in the right umbilical portion (RUP), and BDDT was advanced to the common bile duct. Because the estimated future remnant liver volume was 35.2%, transileocecal portal vein embolization (PVE) for the portal branches from the RUP increased it to 43.5% in three weeks. Left trisectionectomy with extrahepatic bile duct resection and hepaticojejunostomy were performed. The patient was discharged on postoperative day 75. We successfully performed a left trisectionectomy after PVE in a patient with RSLT. Understanding the vascular and biliary anomalies of patients with RSLT is essential. When the future remnant liver is small, PVE can be considered for safe hepatectomy.

Keywords: Bile duct tumor thrombus, colorectal liver metastasis, hepatectomy, portal vein embolization,
right-sided ligamentum teres

Introduction

Right-sided ligamentum teres (RSLT) is a rare congenital anomaly in which the fetal umbilical vein is connected to the right paramedian trunk of the portal vein with a reported frequency of 0.2 to 1.2% [1-3]. This anomaly should be carefully understood and managed because several surgical problems can occur because of the complex portal vein and biliary anatomies during major hepatectomy. Although there are several previous reports of major hepatectomy in patients with RSLT, cases of portal vein embolization (PVE) before hepatectomy to prevent postoperative liver failure have rarely been reported. The feasibility and safety of PVE before major hepatectomy in patients with RSLT are unclear. Herein, we present an RSLT case of left trisectionectomy for colon cancer liver metastasis with a common bile duct tumor thrombus (BDTT) after PVE.

Case Report

An 80-year-old woman had undergone curative sigmoidectomy for sigmoid cancer 3 years prior (pT3/N0/M0/Stage IIA). One year later, a 1.2-cm solitary liver metastatic tumor was noted in segment 4. Because it completely responded to a 3-month course of FOLFOX and panitumumab, the chemotherapy was finished. A 2.0-cm recurrence of the same lesion was detected 6 months after the end of chemotherapy, for which she underwent radiofrequency ablation (RFA). Thereafter, biloma and biliary stenosis of the left

hepatic duct developed for which an endoscopic retrograde biliary drainage stent was placed. Bile duct injury during RFA was the suspected cause of the biliary complications. Recurrence of the same lesion was noted 7 months later. The patient rejected the offer of chemotherapy because of its strong side effects. Therefore, she was referred to our hospital for surgery.

A physical examination revealed no specific symptoms. Laboratory investigations revealed a normal white blood cell count (7200/ μ L), slightly elevated C-reactive protein level (0.34 mg/dL), and normal levels of aspartate aminotransferase, alanine aminotransferase, and bilirubin. Regarding liver reserve, indocyanine green (ICG) 15 min retention rate, Child-Pugh score, and albumin-bilirubin (ALBI) score were 5.0%, 5 (grade A), and -2.82 (grade 1), respectively. Gamma-glutamyl transpeptidase and alkaline phosphatase levels were elevated to 130 U/L and 257 U/L, respectively. The levels of carcinoembryonic antigen and carbohydrate antigen 19-9 were elevated to 7.0 ng/mL and 291 U/mL, respectively. Abdominal CT showed an anomaly of the liver with RSLT, classified as an independent right lateral type of the portal vein and biliary tree [4,5]. The tumor in the left paramedian section was located in the right umbilical portion (RUP), and BDTT was advanced to the common bile duct (CBD) (Figure 1A, 1B). The BDTT might have also been caused by the bile duct injury during RFA. Endoscopic retrograde cholangiopancreatography showed that the BDTT had advanced to the confluence of the cystic duct (Figure 1C). FDG PET/CT showed FDG accumulation in the tumor and BDTT without any lymph node or other organ metastasis. Left trisectionectomy was scheduled for curative resection. However, volumetry using a 3D workstation

(SYNAPSE VINCENT; Fujifilm Medical, Tokyo, Japan) showed that the estimated volume of the right posterior section of the future remnant liver was 366 mL, equivalent to 39.1% of the standard liver volume and 35.2% of total liver volume (Figure 1D). Thereafter, transileocecal portal vein embolization of the portal branches of the RUP was performed to prevent post-hepatectomy liver failure. Transileocecal portal vein embolization was chosen rather than percutaneous transhepatic embolization for two reasons. First, the patient had intrahepatic biliary dilatation in the left lobe; thus, puncture of the portal vein of the right umbilical portion (RUP) from the right anterior section was expected to make cannulating several portal branches from RUP demanding due to difficulty inverting the catheter within the same section. The portal branches into the left lateral section and the left and right paramedian sections from the RUP were embolized with absolute ethanol under balloon occlusion (Figure 2A, 2B). After 3 weeks, ICG 15 min retention rate, Child-Pugh score, and ALBI score were 4.8%, 6 (grade A), and -2.1 (grade 2b), respectively. The future remnant liver volume increased to 452 mL, the equivalent of 48.3% of the standard liver volume and 43.5% of the total liver volume (Figure 2C). ICG clearance of the remnant liver was 0.076.

Left trisectionectomy with extrahepatic bile duct resection and hepaticojejunostomy was performed 1 month after the PVE. After cholecystectomy (Figure 2D), the BDTT was extracted because dissection around the hepatoduodenal ligament was difficult due to the swollen CBD (Figure 2E). No invasion of the hepatic artery or portal vein was observed, and R0 resection was achieved (Figure 2F). The operative time was 677 min, estimated blood loss was 950 ml, and blood transfusion was required. Intra-abdominal

abscess drainage was required on postoperative day 11 and the patient was discharged on postoperative day 75. Pathological examination revealed liver metastasis consistent with colonic origin and BDTT that did not invade the epithelium of the CBD (Figure 3). Six months after hepatectomy, there was no sign of recurrence, and the tumor marker levels decreased to normal ranges.

Discussion

RSLT is a rare congenital anomaly that is occasionally encountered during hepatobiliary surgery, including cholecystectomy and hepatectomy. According to previous publications, the anatomy of the RSLT was classified into three types based on the origin of the right lateral portal pedicle: bifurcation (28.6%), trifurcation (23%), and independent right lateral (48.6%) [4]. In addition, the anatomy of the biliary tree is classified into symmetrical (56.5%), independent right lateral (28.3%), total left (13%), and total right (2.2%) types [5]. These anomalies should be carefully evaluated using preoperative imaging modalities because surgical complications can occur during hepatectomy. For example, interpreting the RUP as the left portal vein must be avoided during left hepatectomy in patients with independent right lateral portal pedicle type, because ligation of the RUP at the hepatic hilum will result in a lack of portal flow in the left two-thirds of the whole liver (4). The biliary anatomy must be preoperatively understood to avoid biliary complications, because no significant correlations were detected between the portal and biliary types [5]. In particular, in patients with either total left or total right biliary pedicle, it is unknown whether ipsilateral

major hepatectomy is possible. Fortunately, the present case had an independent right lateral type of both the portal vein and biliary tree, in which left trisectionectomy was anatomically possible.

Preoperative evaluation of the vascular anatomy, including the hepatic veins and arteries, is important to perform major hepatectomy, especially in patients with RSLT, to prevent fatal surgical complications. Needless to say, preoperative diagnosis of RSLT is required before hepatectomy. Strong deviation of the umbilical portion towards the right, a lack of liver parenchyma between the gallbladder and umbilical portion, or a deeply fissured groove for the ligamentum venosum near the bifurcation of the portal vein may suggest the presence of RSLT [4]. In addition, preoperative 3D simulation analysis is important and useful not only for understanding the spatial relationship of the vascular structures to determine the transection planes but also for predicting the future remnant liver volume. It is reported that the volume of the posterior section was significantly larger in patients with an RSRL of the independent right lateral portal pedicle type (43.9%) than in patients with normal portal vein anatomy (31.0%) [6]. However, a left trisectionectomy is a demanding and risky procedure. In the present case, we considered PVE necessary for the left trisectionectomy to prevent post-hepatectomy liver failure because the patient was older and had undergone chemotherapy. Although the patient's liver function was within the normal range according to the ICG test results, Child-Pugh grade, and ALBI score, the future remnant liver was relatively small. In our institute, major hepatectomy with biliary reconstruction is allowed in cases of remnant liver that is >40% of the standard liver volume and the total liver volume. In addition, ICG clearance of the remnant liver should

exceed 0.05. Owing to PVE, adequate compensatory hypertrophy of the future remnant liver volume was achieved at 43.5% at a safety margin of more than 40%.

Patients with RSLT who underwent major hepatectomy for malignancies are summarized in Table 1 [6-13]. PubMed was searched for studies published through July 2022 using the following terms: (right-sided ligamentum teres [Title] OR right-sided round ligament [Title] OR left-sided gallbladder [Title] OR right umbilical portion [Title]) AND (hepatectomy [All fields] OR liver [All fields]). As a result, 55 articles were obtained. Among them, only case reports of major hepatectomy for malignancies were included. One additional manually identified article that seemed relevant to the subject matter was also included. In this series, no specific correlation between portal and biliary configuration types was identified, although some biliary configurations were not assessed. Nine of the 11 patients underwent extrahepatic bile duct resection and biliary reconstruction; 5 had perihilar cholangiocarcinoma, 3 had colorectal liver metastasis, and 1 had gallbladder cancer. For biliary reconstruction, preoperative evaluation of the biliary anatomy is required to predict the position of the bile duct orifices exposed on the cut surface. To the best of our knowledge, only two reported patients with RSLT underwent PVE before hepatectomy. In the present case, many portal branches into the left trisections from the RUP were embolized separately because the caudate branches into the Spiegel lobe were preserved in case of overflow or migration of embolic materials into the right lateral portal veins. Currently, the efficacy and suitability of this technique for portal vein obstruction in the caudate lobe have not been described for the prevention of liver failure after planned

major hepatectomy [14]. In addition, interventional radiologic procedures in patients with RSLT have not been well discussed. Further accumulation of cases is required to evaluate the feasibility and safety of PVE in patients with RSLT.

From a different viewpoint, in the present case, an advanced BDTT, which is rarely seen in colorectal liver metastasis, was observed on computed tomography and endoscopic retrograde cholangiopancreatography. In previous reports, macroscopic bile duct invasion of colorectal liver metastases, which occurs in 12% of cases, may reflect an indolent biological behavior, warrant an aggressive surgical approach, and confer a better prognosis [15,16]. In this case, although BDTT might have been caused by tumor cell seeding due to RFA-induced bile duct injury, R0 resection could have provided a better prognosis. Because the next strong regimen was intolerable to the patient due to her experience with previous chemotherapy, we tried to apply an aggressive surgical approach with all due preparation.

In conclusion, we successfully performed a left trisectionectomy after PVE in a patient with RSLT. Understanding vascular and biliary anomalies is essential when major hepatectomy is indicated in patients with RSLT. When the future remnant liver volume is small, PVE may provide safe and curative treatment.

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Author Contributions

Takeshi Urade collected clinical information and drafted the manuscript. Eisuke Ueshima helped draft the manuscript. Takeshi Urade, Masahiro Kido, Kuramitsu Kaori, Shohei Komatsu, Takuya Mizumoto, Eisuke Ueshima, and Koji Sasaki are directly involved in this case. Hiroaki Yanagimoto and Hirochika Toyama provided valuable feedback. Takumi Fukumoto critically revised the manuscript accordingly. All authors have read and approved the final manuscript.

Declarations

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Conflict of interest The authors declare that they have no competing interests.

Human/animal rights Not applicable.

Informed consent Written informed consent was obtained from the patient for publication of the case report.

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Figure legends

Figure 1

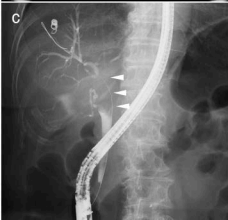
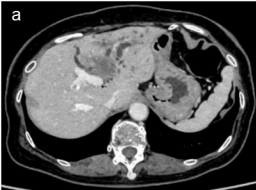
Preoperative images. a, Abdominal CT: tumor attached to the right umbilical portion with a bile duct tumor thrombus (BDTT) and intrahepatic biliary dilatation. b, BDTT advanced into the common hepatic duct (yellow arrowheads). c, Endoscopic retrograde cholangiopancreatography showing an advanced BDTT in the common bile duct (CBD) (white arrowheads). d, Preoperative simulation image showing a 35.2% (brown region) estimated future remnant liver volume.

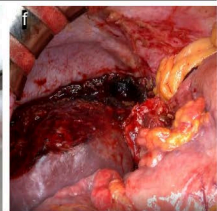
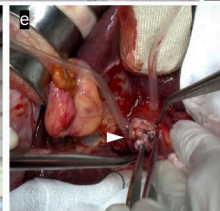
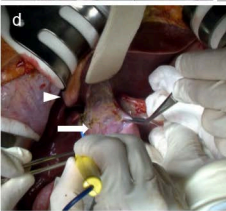
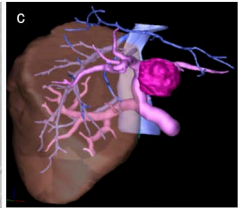
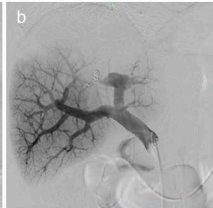
Figure 2

Operative findings. a, Before trans-ileocecal portal vein embolization (PVE). b, From the right umbilical portion, the portal branches into segments 2, 3, 4, 5, and 8 were embolized. c, Preoperative simulation image showing a 43.5% (brown region) estimated future remnant liver volume after PVE. d, Ligamentum teres (white arrowhead) is positioned at the right side of the gallbladder (white arrow). e, BDTT (white arrowhead) removed from common bile duct to enable dissection around the hepatoduodenal ligament. f, View after left trisectionectomy with extrahepatic bile duct resection.

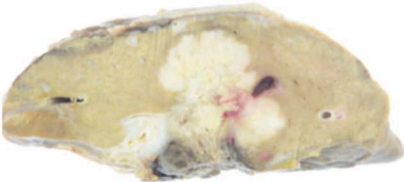
Figure 3

The resected specimen. a, Gross findings of the liver metastatic tumor at the hepatic hilum with macroscopic vascular invasion. b, Microscopic image: tumor thrombosis (upper) in the common bile duct (lower) with strong degeneration and no infiltration of the epithelium (black arrow).





a



b

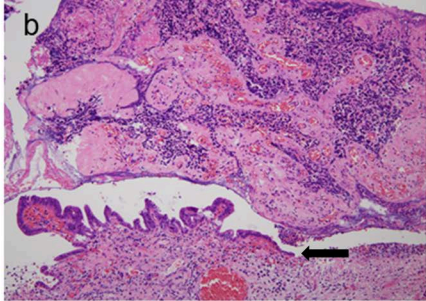


Table 1. The reported cases with right-sided ligamentum teres who underwent major hepatectomy for malignancies

Case no.	Author	Year	Sex/Age	Diseases	Surgical procedure	Portal vein configuration type	Biliary configuration type	PVE	Complication
1	Uesaka ⁷	1995	M/53	CRLM	Right hepatectomy	Independent right lateral	Unclassified	-	NA
2	Kaneoka ⁸	2000	M/53	PHC	Left hepatectomy [†]	Independent right lateral	Symmetrical	-	-
3	Kaneoka ⁸	2000	M/61	PHC	Left hepatectomy [†]	Independent right lateral	Symmetrical	-	-
4	Hsu ⁹	2007	F/50	HCC	Extended right hepatectomy	Independent right lateral	NA	-	NA
5	Abe ¹⁰	2012	F/70	CRLM	Right hepatectomy [†]	Bifurcation	Symmetrical	-	-
6	Ome ¹¹	2016	F/70	PHC	Left trisectionectomy [†]	Trifurcation	NA	-	-
7	Hai ¹²	2017	M/78	PHC	Extended left hepatectomy [†]	Independent right lateral	Independent right lateral	-	Bile leakage
8	Goto ¹³	2018	M/70s	Gallbladder cancer	Right hepatectomy [†]	Unclassified	Independent right lateral	-	-
9	Ishida ⁶	2020	F/54	CRLM	Right hepatectomy [†]	Bifurcation	NA	-	NA
10	Ishida ⁶	2020	M/70	PHC	Left trisectionectomy [†]	Independent right lateral	Total left	+	-
11	Our case	2022	F/80	CRLM	Left trisectionectomy [†]	Independent right lateral	Independent right lateral	+	Intra-abdominal abscess

F female, *HCC* hepatocellular carcinoma, *PHC* perihilar cholangiocarcinoma, *PVE* portal vein embolization, *CRLM* colorectal liver metastasis, *M* male, *NA* not available.

Portal and biliary configurations were classified according to the classifications by Shindoh (4) and Nishitai (5).

[†]Combined extrahepatic bile duct resection and biliary reconstruction with hepatectomy.