Table 2 Sensitivity and positive predictive value for the detection of liver metastases on contrast-enhanced CT and gadoxetic acid-enhanced MR imaging by off-site readers

	CECT alone	CECT and EOB-MRI	*p* value
	Sensitivity (%)		
Reader 1	77.6 (66/85)	91.8 (78/85)	0.008
Reader 2	76.5 (65/85)	87.1 (74/85)	0.014
Reader 3	83.5 (71/85)	94.1 (80/85)	0.035
Mean	79.2 (202/255)	91.0 (232/255)	0.026
	Positive Predictive Value (%)		
Reader 1	90.4 (66/73)	95.1 (78/82)	0.108
Reader 2	92.9 (65/70)	96.1 (74/77)	0.626
Reader 3	94.7 (71/75)	96.3 (80/83)	0.288
Mean	92.7 (202/218)	95.8 (232/242)	0.423

Note: Data in parentheses are numbers used to calculate sensitivity and positive predictive value.

CECT contrast-enhanced CT

EOB-MRI gadoxetic acid-enhanced enhanced MR images

The κ values for the three readers were 0.62 for CE-CT alone and 0.70 for the combination of CE-CT and EOB-MRI. These results indicated good interobserver agreement with regard to the presence of liver metastases.

Table 3 Az values for the detection of hepatic metastases on contrast-enhanced CT and Gd-EOB-DTPA enhanced MR imaging by off-site readers

	CECT alone	CECT and EOB-MRI	*P* value*
Reader 1	0.843	0.916	0.03
Reader 2	0.832	0.902	0.042
Reader 3	0.879	0.948	0.024
Mean	0.853	0.929	0.034

CECT contrast-enhanced CT

EOB-MRI gadoxetic acid-enhanced enhanced MR images

Change in therapeutic strategy of on-site data (Fig. 2)

The following surgical procedures were performed: right lobectomy in two patients, right lobectomy and metastatectomy in three, right anterior segmentectomy in five, right anterior segmentectomy and metastatectomy in two, right posterior segmentectomy in three, right posterior segmentectomy and metastatectomy in one, left lobectomy in one, left lobectomy and metastatectomy in three, left lateral segmentectomy in four, and left lateral segmentectomy and metastatectomy in one patient.

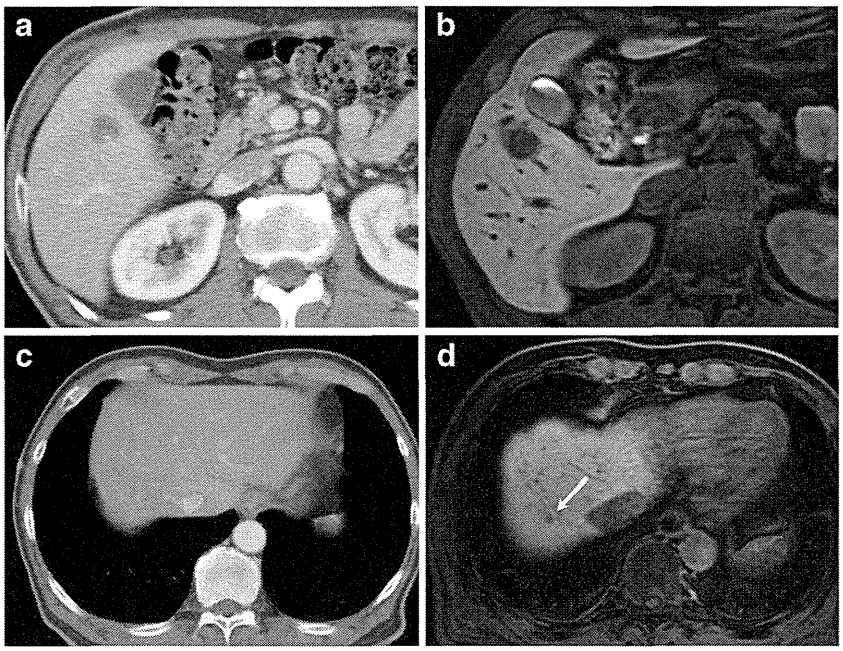

Fig. 1 Surgically-proved liver metastases from colon cancer in a 67-year-old man. A 16 mm diameter liver metastasis could be detected in segment 5 on both portal phase of CE-CT images (**a**) and hepatocyte-phase of gadoxetic acid-enhanced T1-weighted GRE images (**b**). On hepatocyte-phase (**d**) of gadoxetic acid-enhanced T1-weighted GRE images, additional sub-centimetre metastasis was identified in segment 7 (white arrow), although the lesion was not detected on portal phase of CE-CT images (**c**). Before the EOB-MRI examination, the planned surgical procedure was right anterior partial segmentectomy. After the EOB-MRI examination, the planned therapeutic strategy was changed to right anterior partial segmentectomy and metastatectomy

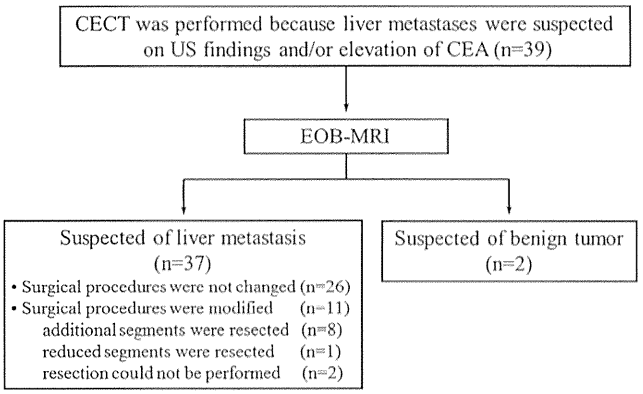

Fig. 2 Flow diagram shows changing diagnosis and therapy of a patient who was suspected of having liver metastasis from colorectal cancer, and underwent both CE-CT and EOB-MRI

In 13 of the 39 patients (33.3 %), the planned therapeutic strategy was changed after EOB-MRI examination at the on-site assessment. In 11 of these 13 patients, planned surgical procedures were ultimately modified on the basis of the combination of CE-CT and EOB-MRI findings. Additional segmentectomy or metastatectomy was performed in eight patients; additional lesions excluding the possibility of resection were detected and reduced segments were resected in one patient; and no surgical resection was performed due to multiple liver metastases in bilateral liver lobes and peritoneal dissemination at surgery in one each. In the remaining two of these 13 patients, each suspected liver metastasis on CE-CT was confirmed as a liver cyst by EOB-MRI findings. Watchful waiting was adopted for these patients, and the lesions demonstrated no change in size at follow-up examinations 15 and 18 months later.

In 26 of the 39 patients, the planned therapeutic strategy prior to EOB-MRI was unchanged after EOB-MRI. Of these 26 patients, although two had an additional lesion on EOB-MRI, a change in therapeutic strategy was unnecessary because the location of the missed lesions on CE-CT did not result in alteration of the surgical procedure.

Discussion

The results of this study demonstrate that the combination of CE-CT and EOB-MRI showed significantly higher detection of liver metastases than CE-CT alone. Moreover, the planned therapeutic strategy was changed in one-third of the patients after EOB-MRI examination. These findings indicate that, with the use of state-of-the-art 64-row MDCT and 3.0T MR system, EOB-MRI can provide information in addition to that provided by CE-CT for preoperative evaluation of colorectal liver metastases, frequently resulting in a change in therapeutic strategy.

Our results revealed that, for all readers, the combined reading of CE-CT and EOB-MRI yielded significantly higher detection sensitivity and resulted in better diagnostic performance for liver metastases than CE-CT alone. Moreover, the detection sensitivity of the combination of CE-CT and EOB-MRI for liver metastases in the present study was higher than that reported in several previous studies that used 1.0T–1.5T MRI [8]. The higher detection sensitivity in this study can be explained by the fact that 3.0T MRI provides a higher signal-to-noise ratio (SNR), and the increased SNR and contrast-to-noise ratio on hepatocyte-phase 3D-GRE images allowed us to obtain higher spatial resolution, such as thinner-slice images, than can be obtained at a lower field strength, resulting in improvement of the conspicuity and detectability of liver metastases [13, 14]. However, a potential drawback of EOB-MRI is the lack of an equilibrium phase in the real sense of the term, which makes it difficult to distinguish liver metastases from haemangiomas, particularly in sub-centimetre lesions that do not show peripheral globular enhancement on arterial-phase images [15, 16]. The shortcomings of EOB-MRI can be overcome by multiphase CE-CT [16], which also supports our result that PPV with the combination of CE-CT and EOB-MRI in this study was superior to that of EOB-MRI in previous reports [11–13]. However, in contrast to the findings of previous studies (Table 4), we did not clearly demonstrate the superiority of EOB-MRI at 3.0T over 1.5T or the superiority of the combination of CE-CT and EOB-MRI over EOB-MRI alone. Further studies are needed to elucidate the superiority of 3.0T EOB-MRI or the combination of CE-CT and EOB-MRI for the detection of colorectal liver metastases as compared to 1.5T EOB-MRI or EOB-MRI alone.

In our study, the planned therapeutic strategy was changed in 13 of the 39 patients (33.3 %) on the basis of the EOB-MRI examination findings, a rate that is higher than that in a previous report [8]. This discrepancy may be due to the fact that some patients in the previous study had hepatocellular carcinoma with chronic liver disease, which may have caused less hepatocyte uptake of gadoxetic acid than in the case of a non-cirrhotic liver, resulting in a lower tumour-to-liver contrast [17]. Another possible explanation is that Hammerstingl et al. [8] used 1.0T–1.5T MRI, whereas we used 3.0T MRI, and MRI with a 3.0T field provided a higher contrast-to-noise ratio than lower-field-strength MRI [14]. Furthermore, the combination of CE-CT and EOB-MRI could minimize residual liver metastases by detecting the number of lesions more precisely, and could avoid redundant surgery by differentiating liver metastases from benign lesions. These findings indicate that EOB-MRI, with a state-of-the-art 64-detector-row CE-CT and 3.0T MR system, can provide information beyond that of CE-CT for preoperative evaluation of colorectal liver metastases and can improve the accuracy of the therapeutic strategy, including preoperative planning of liver resection.

Table 4 Comparison with previous articles on CE-CE and EOB-MRI for the detection of colorectal liver metastases

Article	CT and MRI unit	CE-CT			EOB-MRI		
		Sensitivity	Specificity	PPV	Sensitivity	Specificity	PPV
Hammerstingl R, et al. [8]	CT; unknown MRI; 1.0–1.5T	77.1 %	88.5 %	None	87.4 %	90.1 %	None
Muhi A, et al. [9]	CT; 16-detector row MRI; 1.5T	63 %	None	96 %	95 %	None	98 %
Kim YK, et al. [10]	CT; 16-detector row MRI; 1.5T	75 %	96 %	None	96 %	98 %	None
Scharitzer M, et al. [11]	CT; 64-detector row MRI; 3.0T	82.8 %	96.5 %	None	91.2 %	97.1 %	None
Berger-Kulemann V, et al. [12]	CT; 64-detector row MRI; 3.0T	72.1 %	None	None	97.1 %	None	None
Sofue K, et al. [13]	CT; not examined MRI; 3.0T	None	None	None	92.0 %	None	94.2 %
Present study	CT; 64-detector row MRI; 3.0T	79.2 %	None	92.7 %	91.0 %	None	95.8 %

Note: None indicates that data were not expressed in the paper.

CECT contrast-enhanced CT

EOB-MRI gadoxetic acid-enhanced enhanced MR images

This study had several limitations. First, it was conducted in a highly selected population of patients with colorectal cancer scheduled for surgery, which resulted in a higher level of suspicion on image analysis among the readers. However, image evaluation was performed by on-site and off-site blinded readers who were unaware of any information regarding tumour burden. Second, the findings of true-positive lesions were not completely accurate, as the exact number of liver metastases in non-resected liver segments could not be determined and specificity could not be calculated. However, we performed intensive evaluation of the non-resected liver segments by intraoperative US, and follow-up examinations were available for all lesions in the non-resected segments to minimize the number of false-negative lesions. Third, diffusion-weighted imaging (DWI) pulse sequences and positron emission tomography (PET) were not used in the analyses. DWI and PET may have additional value for the detection of liver metastases and differentiation from cysts and haemangiomas [18–20]. DWI and PET in addition to EOB-MRI may lead to improvement in diagnostic performance for detecting small liver metastases. Fourth, the number of sub-centimetre liver metastases was small. Further studies in a larger series should be performed to evaluate the detectability of tiny liver metastases. Finally, only liver metastases were assessed in image analysis, and extrahepatic metastases were not evaluated and compared between CE-CT and EOB-MRI. Extrahepatic metastases preclude surgical resection of liver metastases and affect the prognosis and survival of patients [20]. Further validation studies are needed to clarify the role of EOB-MRI for the detection of metastases in patients with colorectal cancer.

In conclusion, our study showed that the combination of CE-CT and EOB-MRI provided significantly higher sensitivity, and thus better diagnostic performance, than CE-CT alone for the detection of colorectal liver metastases in a preoperative setting. Indeed, the initially planned surgery was altered in one-third of the patients after EOB-MRI examination. EOB-MRI combined with CE-CT contributed to improved determination of appropriate therapeutic strategies, which may lead to better prognosis and survival of patients.

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CASE REPORT

Bridging stent placement through the superior vena cava to the inferior vena cava in a patient with malignant superior vena cava syndrome and an iodinated contrast material allergy

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Abstract Positioning is critical during the placement of superior vena cava (SVC) stents in patients with malignant SVC syndrome. Although SVC stents effectively relieve various symptoms of SVC syndrome, improper stent positioning may cause life-threatening complications such as migration that result in fatal cardiac failure. Here we describe a patient with an allergy to iodinated contrast material (ICM) who presented with SVC syndrome owing to mediastinal lymph node metastases from hepatocellular carcinoma, which was successfully treated with an SVC stent. Secure stent placement was achieved by bridging the stent through the SVC to the inferior vena cava with venography using carbon dioxide instead of ICM.

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Keywords Malignant superior vena cava syndrome · Iodinated contrast material allergy · Bridging stent · Tandem · Carbon dioxide digital subtraction venography

Introduction

The use of superior vena cava (SVC) stents for patients with malignant SVC syndrome effectively relieves the various symptoms [1]. However, inaccurate stent positioning may cause life-threatening complications such as migration of the stent that result in fatal heart failure [2]. Stent positioning is critical during placement for patients with malignant SVC syndrome. Contrast venography using iodinated contrast material (ICM) is usually required for making accurate evaluations of the vascular anatomy and the obstruction site. Image quality of venography using other contrasts such as carbon dioxide is equivocal. Thus, ICM contraindications may cause SVC stent positioning difficulty. Here we present a patient with an allergy to ICM who presented with SVC syndrome who was successfully treated with an SVC stent.

Case report

A 39-year-old man presented with symptoms of SVC syndrome, a condition that is refractory to medical therapies such as chemotherapy and steroids, including dyspnea on effort and severe edema of the upper extremities and face. He had a history of anaphylactic shock after the intravenous administration of ICM. Hepatitis B surface antigen was positive, and hepatitis C antibody was negative. He drank socially. He had undergone a partial hepatectomy for hepatocellular carcinoma 18 months before

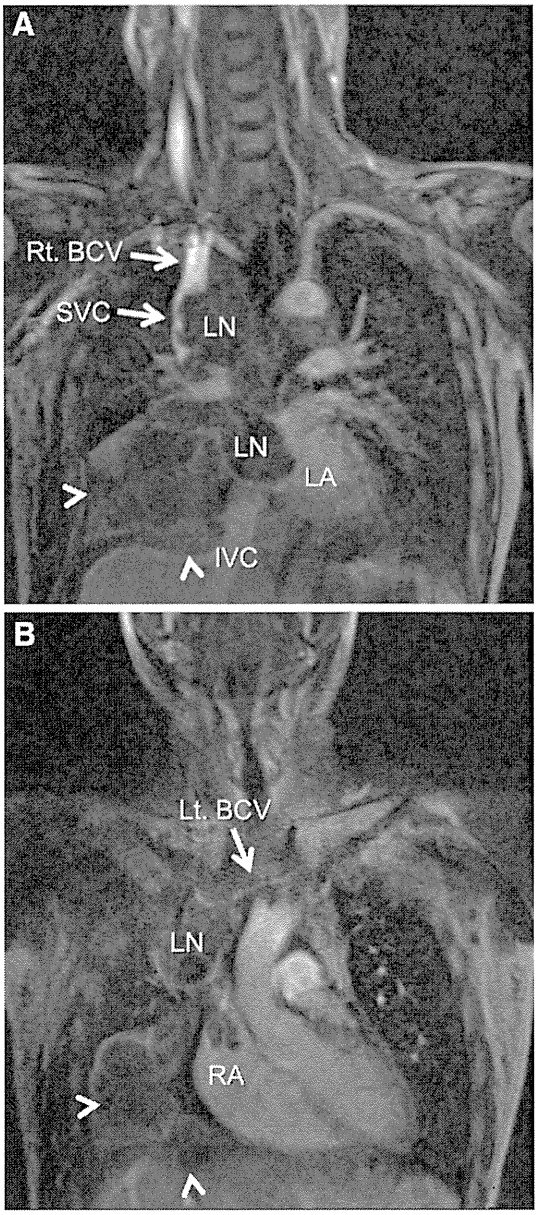

Fig. 1 Gadopentetate dimeglumine-enhanced fat-saturated T1-weighted image. **a** The superior vena cava (SVC) and the orifice of the right brachiocephalic vein (Rt. BCV) are stenosed by invasion of mediastinal lymph node (LN) metastases (*arrow*). The left atrium (LA) is also invaded by LN metastases. Right subphrenic recurrence with pleural invasion and pleural dissemination are also seen (*arrow head*). IVC indicates inferior vena cava. **b** Left brachiocephalic vein (Lt. BCV, *arrow*) is stenosed by invasion of mediastinal LN metastases. The right atrium (RA) is also invaded

and partial a pneumonectomy for lung metastasis 12 months before. He had irradiation therapy for mediastinal lymph node metastases resulting in SVC syndrome 1 month ago. His symptoms were temporarily relieved; however, SVC syndrome rapidly worsened over the last 5 days. He was admitted to our hospital immediately, and

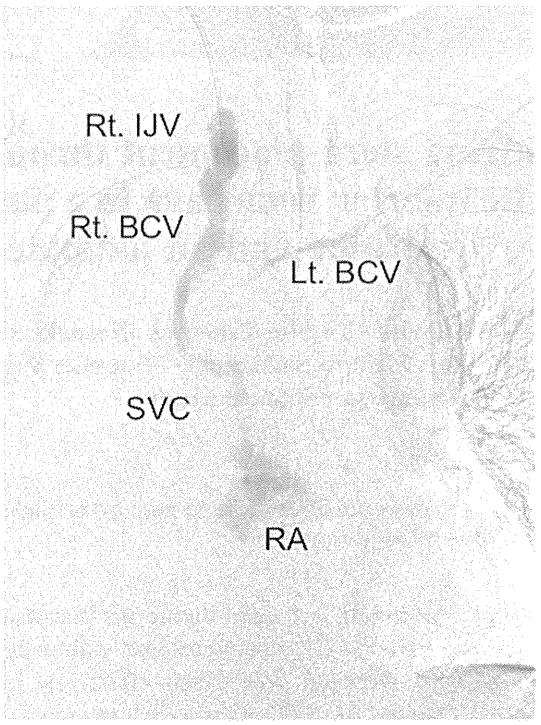

Fig. 2 Digital subtraction venography using carbon dioxide (CO_2-venography) before stent placement. CO_2-venography from the right internal jugular vein (Rt. IJV) showing a vague outline of the superior vena cava (SVC) and tumoral invasion, and an insufficient outline of the right atrium (RA). CO_2 flowed back to left brachiocephalic vein (Lt. BCV). Rt. BCV indicates right brachiocephalic vein

an SVC stent insertion was scheduled to relieve the SVC syndrome symptoms.

Dynamic magnetic resonance imaging (MRI) was performed using gadopentetate dimeglumine (Magnevist; Bayer Health Care, Osaka, Japan). MRI revealed that the mediastinal lymph node metastases had invaded the SVC, both brachiocephalic veins (BCV), and the right atrium (RA) (Fig. 1). Stenosis existed over the entire SVC and the orifices of both BCVs. The diameters of the right BCV and the inferior vena cava (IVC) were 19 and 32 mm in their normal portion, respectively.

Written informed consent for the procedure was obtained from the patient. Stent placement in the SVC was performed under local anesthesia. An 5F sheath (Super Sheath; Medikit, Tokyo, Japan) was inserted into the right internal jugular vein (IJV), and a 12F sheath (Cook-Z Stent Vena Caval and Venous Design Radiopaque Band Introducer Set; William Cook, Bjaeverskov, Denmark) was inserted into the right common femoral vein [3]. Digital subtraction venography using carbon dioxide (CO_2-venography) from the right IJV with hand injection of approximately 20 ml CO_2 showed a vague outline of the SVC as well as stenosis due to the tumor invasion (Fig. 2). CO_2-venography from IVC showed the outline of the IVC

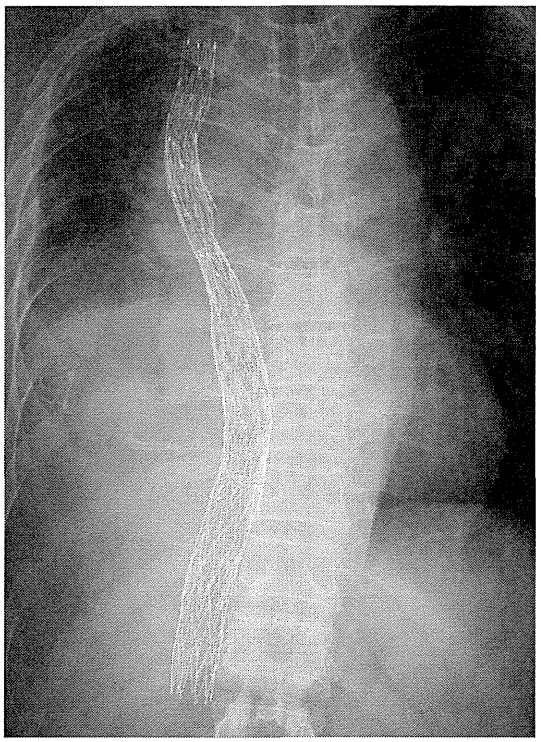

Fig. 3 Bridging stent. Five 20-mm-diameter, 80-mm-long self-expandable metallic stents, and one 20-mm-diameter, 60-mm-long self-expandable metallic stent deployed in tandem with enough overlap from the right brachiocephalic vein to the inferior vena cava using a guide wire that was inserted from the right common femoral vein to the right internal jugular vein with use of a pull-through technique

and an insufficient outline of the RA (not shown). A 4F catheter (Fansac II; Terumo-Clinical Supply, Gifu, Japan) was inserted into the IVC from the right IJV. The catheter was captured by a 12–20-mm snare (EnSnare; Merit Medical, South Jordan, UT, USA) in the IVC and was pulled out via a 12F sheath. A 0.035-inch guide wire (Amplatz Extra Stiff Wire Guide; William Cook, Bjaeverskov, Denmark) was inserted from the right common femoral vein to the right IJV; so-called pull-through was achieved [4].

After injection of 3,000 U of heparin, five 20-mm-diameter, 80-mm-long self-expandable metallic stents (Spiral Z stent; Medicos Hirata, Osaka, Japan) and one 20-mm-diameter, 60-mm-long self-expandable metallic stent were deployed in tandem from the right BCV to the IVC (Fig. 3) in the same manner as Nagata et al. [3]. We also checked the positional relationship between vertebra and venous structures on MRI, CO_2-venography and fluoroscopy. Postprocedural CO_2-venography confirmed excellent blood flow from the right BCV and IVC to the RA through the stents (Fig. 4). The pressure gradient between the SVC and the RA decreased from 42 to 5 cm of water. Symptoms of SVC syndrome improved quickly after stent placement. Anticoagulation therapy (10,000 IU/day of heparin) was continued for 1 day after the procedure and then discontinued. The patient was discharged 2 days after the procedure, and ultimately died of his primary disease 30 days later without recurrence of the SVC syndrome.

Discussion

Stent migration is a rare but potentially lethal complication of SVC stent placement [2]. The reported frequency of stent migration is 0.7–2.0 % [1, 5]. These data were collected in the setting of ICM use. When the use of ICM is contraindicated, visualization of the detailed anatomy may be difficult, and the risk of stent migration may increase even if CO_2-venography was used.

Placement of multiple stents in tandem through the SVC to the IVC could be safe and clinically useful, even in patients with ICM contraindications. Taylor et al. [2] introduced this method, named as bridging stent, to rescue stent migration from the IVC to the RA. Our report was the first to describe the successful placement of an SVC stent without the use of ICM venography. Sato et al. [6] deployed stents in the same manner for the treatment of IVC syndrome with RA involvement. SVC or IVC syndrome with RA involvement could also be successfully treated using a bridging stent.

Gadolinium contrast material may be useful to reveal stenosis. However, venography of a large vein such as the vena cava would need a large amount of contrast medium. Several bottles of gadolinium contrast material would be needed because content of commercialized gadolinium contrast material does not exceed 20 ml in Japan. Renal dysfunction may lead to the nephrogenic systemic fibrosis [7]. In our case, a bridging stent could be safely deployed with an effective combination of CO_2-venography, enhanced MRI, and positional relationship between vertebra and venous structures on fluoroscopy.

There could be some disadvantages of a bridging stent. A bridging stent could be expensive because of multiple stents. Risk of vascular injury might increase as numbers of stent delivery increase. Unknown adverse effects could exist.

Another method to reveal stenosis might be balloon dilation prior to stent placement [8]. To delineate the detailed anatomy, dilation using a sufficiently large balloon is required, but this might result in rupture of SVC [9]. Balloon rupture, which rarely occurs, might cause anaphylactic shock owing to ICM in the balloon in a patient with an ICM allergy when diluted ICM is used for inflating the balloon [10].

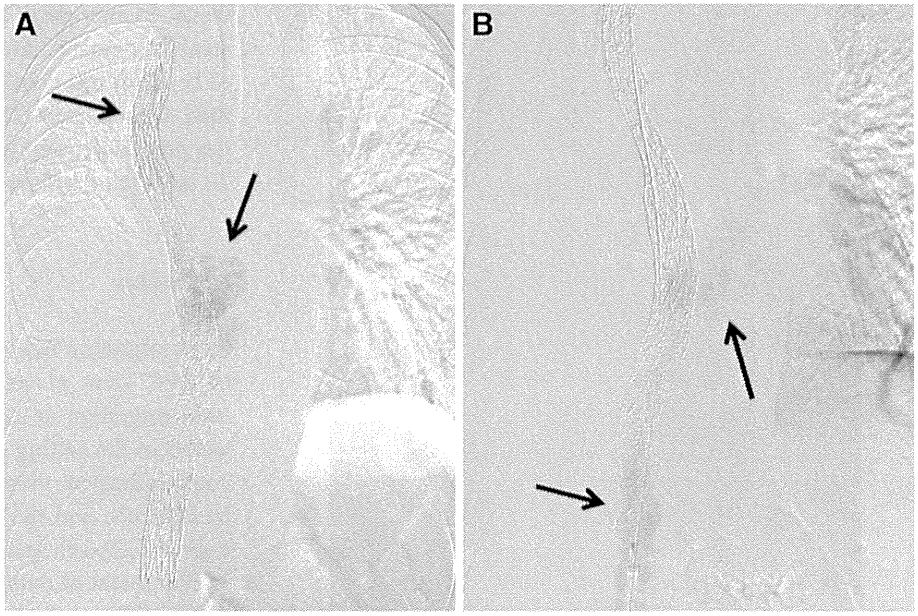

Fig. 4 Digital subtraction venography using carbon dioxide (CO_2-venography) after stent placement. CO_2-venography from the internal jugular vein (**a**) and the inferior vena cava (**b**) shows good flow into the right atrium through the mesh of stents. *Arrows* indicate CO_2

In conclusion, here we successfully treated a case of malignant SVC syndrome using an SVC stent in a patient with an ICM allergy. Secure stent placement was achieved using the bridging stent technique through the SVC to the IVC without the use of ICM venography.

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Conflict of interest We have nothing to disclose.

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CIRSE

LETTER TO THE EDITOR

Reply to Letter re: Anticoagulant Therapy in Oncologic Patients Undergoing Venous Stenting for Superior Vena Cava Syndrome and Other Interventional Procedures

Keitaro Sofue · Yoshito Takeuchi · Yasuaki Arai · Kazuro Sugimura

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To the Editor,

We thank Iaccarino et al. for their interest in our case report [1], which mentioned recanalization and restenting for acute occlusion of superior vena cava (SVC). Anticoagulation therapy with heparin was administered for 7 days, followed by warfarin sodium after discharge from the hospital.

The association of vascular thrombosis in patients underlying malignancy has been known since Trousseau reported it in 1865 [2]. One published study with a large population demonstrated that oncologic patients have a sevenfold increased risk of developing venous thrombosis compared with those without cancer [3]. During the last few decades, this has become of increasing interest: the number of cancer patients with advanced-stage disease, high tumor volume, and lengthy hospitalization has recently increased as a result of recent therapeutic developments. Several factors, including altered immune response, production of abnormal proteins, and cancer cells, affect the prothrombotic or hypercoagulative state, and these conditions further increase after endovascular procedures.

The necessity of long-term anticoagulant therapy remains unclear, and hemorrhagic complications are an unresolvable dilemma [4, 5], although we also think that antithrombotic therapy was not useful to prevent venous thromboembolism, as described in the letter. However, long-term anticoagulation therapy with warfarin sodium was applied in our case because restenting for acute thrombotic occlusion of SVC was necessary on the fifth day after the initial stent placement.

The American Society of Clinical Oncology (ASCO) guidelines reported an evidence-based clinical practice on prophylaxis and treatment of venous thromboembolism in patients with cancer [6]. ASCO recommends the utilization of low-molecular-weight heparin (LMWH) because LMWH has several advantages over unfractionated heparin and warfarin sodium, including dose-dependent plasma levels, long action, and lower bleeding risk [7]. Undoubtedly LMWH is the best option for the prevention of venous thrombosis after the endovascular procedure. However, we did not use LMWH after the treatment of the SVC stent because in our country, LMWH was available only for prophylaxis of deep venous thrombosis after orthopedic surgery of a lower limb, after abdominal surgery, during hemodialysis, or for the treatment of disseminated intravascular coagulation. Moreover, LMWH costs more than unfractionated heparin and warfarin sodium, and as outpatients, patients have to visit a hospital to receive subcutaneous treatment once or twice a day.

Although the provision of LMWH after treatment of the SVC stent is desirable for its convenience and lower hemorrhagic risk, we could not use it because it was not approved for this use and because it is costly. Further studies might to be conducted to evaluate the utility of

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LMWH for the prevention of venous thromboembolism and its safety in oncologic patients undergoing interventional procedures.

Conflict of interest The authors declare that they have no conflict of interest.

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CASE REPORT

Infusion of 50 % glucose solution to occlude an intrahepatic portosystemic venous shunt before percutaneous transhepatic portal embolization: report of a case

Keitaro Sofue · Yoshito Takeuchi · Kentaro Shibamoto · Koji Sugimoto · Kazuro Sugimura · Yasuaki Arai

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Abstract A 68-year-old man with cholangiocarcinoma underwent percutaneous transhepatic portal embolization to expand the indication for hepatic resection. Selective right posterior portography revealed an intrahepatic portosystemic venous shunt (IPSVS) connecting the segment VII branch to the right hepatic venous branch. An infusion of 50 % glucose solution was given to occlude the shunt. This is novel management for IPSVSs when they are numerous, small, or torturous, and makes the subsequent procedures simpler, shorter, and less expensive.

Keywords Percutaneous transhepatic portal embolization · Intrahepatic portovenous shunt · Glucose solution

Introduction

Percutaneous transhepatic portal embolization (PTPE) is performed to expand the indications for major hepatic resection. Various embolic agents are used to achieve this and include gelatin sponge, fibrin glue, polyvinyl alcohol particles, cyanoacrylate and ethiodized oil, and absolute ethanol [1, 2].

Intrahepatic portosystemic venous shunts (IPSVS) can be congenital or may develop secondary to portal hypertension or trauma [3, 4]. For patients with an IPSVS, the therapeutic effect of PTPE is insufficient because of overflow of the embolic agent into the systemic circulation, potentially resulting in non-targeted embolization of the pulmonary artery. In this situation, blood flow through the portosystemic shunt must be stopped. An IPSVS is usually embolized with microcoils or particles [3, 5]; however, this can be difficult when there are numerous shunts or the shunt is small or torturous.

We report a case of PTPE coexisting with an IPSVS which was successfully occluded with an infusion of 50 % glucose solution.

Case report

A 68-year-old man with cholangiocarcinoma underwent preoperative PVE to induce selective hypertrophy and expand the indication for extended right hepatic resection. Contrast-enhanced computed tomography of the abdomen did not reveal an anomalous portovenous shunt. The right anterior branch of portal vein was punctured percutaneously with a 21-gauze needle (Top, Tokyo, Japan) under ultrasonographic guidance. A 5-French (F) sheath (Introducer set; Medikit, Tokyo, Japan) was advanced into the portal vein using the Seldinger technique under fluoroscopic guidance. A reverse-curved 5-F balloon catheter with a tip hole (Selecon balloon catheter; Terumo-Clinical Supply, Gifu, Japan) was also inserted into the posterior branch of the portal vein.

Selective right posterior portography was done with balloon occlusion, revealing an IPSVS connecting the segment VII branch to the right hepatic venous branch (Fig. 1). We decided to embolize the portovenous shunt to prevent overflow of the embolic agent into the systemic

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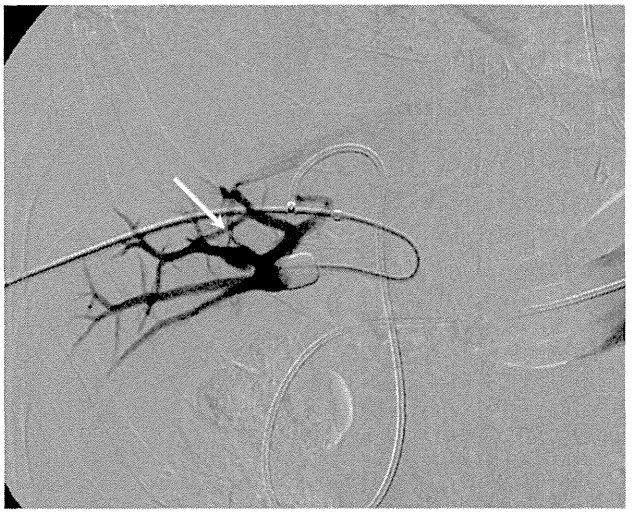

Fig. 1 Selective right posterior portogram with balloon occlusion revealed an intrahepatic portovenous shunt connecting the segment VII branches to the right hepatic venous branch (*arrow*)

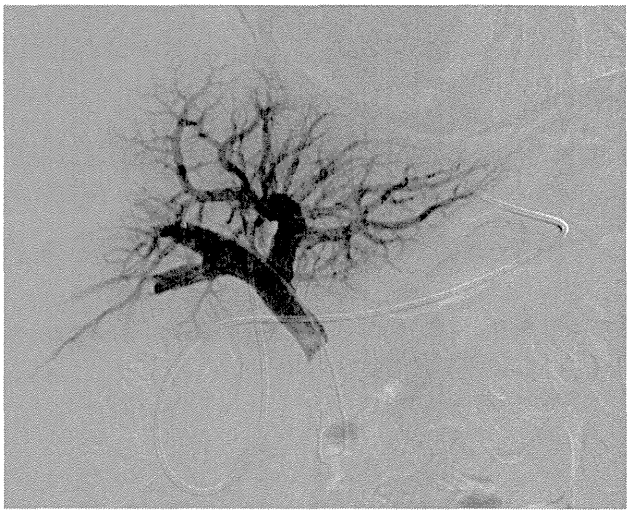

Fig. 3 Direct portogram obtained after embolization of right portal vein revealed no residual flow in the right portal venous branch or intrahepatic portovenous shunt

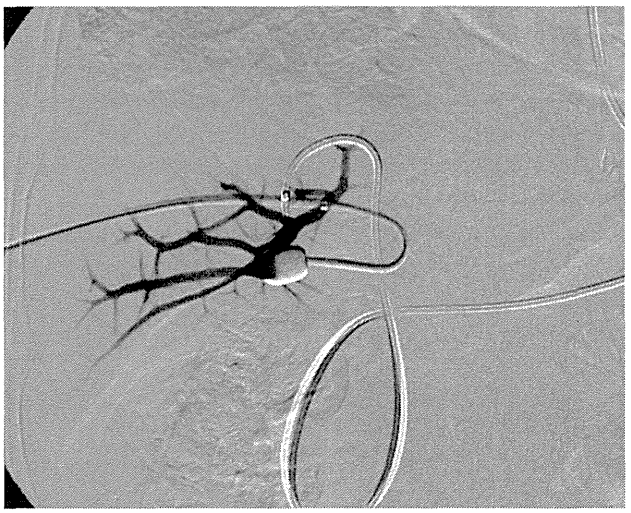

Fig. 2 Right posterior portogram with balloon occlusion after the infusion of 10 ml of 50 % glucose solution confirmed disappearance of the intrahepatic portovenous shunt

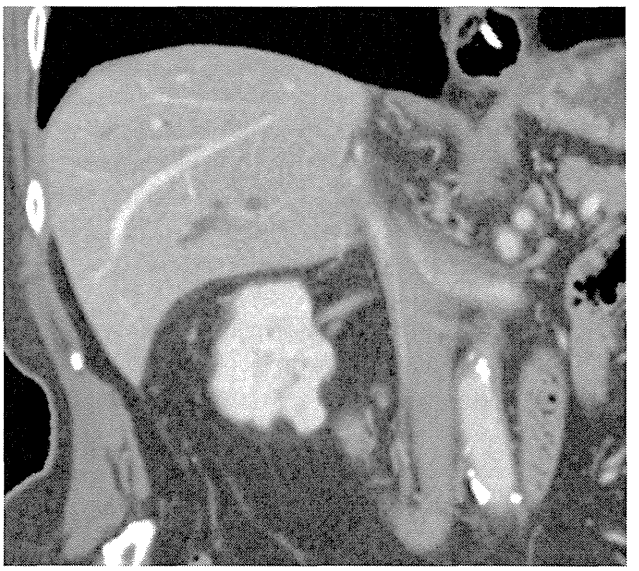

Fig. 4 Coronal image of contrast-enhanced computed tomography obtained 20 days after portal vein embolization shows sufficiently thrombosed right portal branches without right hepatic vein embolization

circulation and to occupy the right posterior branch of the portal vein with embolic agent exclusively.

First, we infused 10 ml of 50 % glucose solution from the catheter, keeping the balloon inflated. Repeated selective right posterior portography showed disappearance of the portovenous shunt (Fig. 2). We injected 5 ml of absolute ethanol to embolize the right posterior branch of the portal vein, and 6 ml of absolute ethanol with balloon occlusion to embolize the right anterior branch of the portal vein. Finally, post-embolization portography confirmed complete occlusion of the right portal branches (Fig. 3).

He was followed-up for 20 days after the procedure using computed tomography, and the left lobe of the liver became hypertrophic with a hypertrophy rate of 151.7 % without recanalization of right portal vein, right hepatic vein embolization, and unexpected pulmonary embolization (Fig. 4). He underwent extended right hepatectomy 24 days after the procedure, and his postoperative course was uneventful.

Discussion

Percutaneous transhepatic portal embolization (PTPE) is widely accepted as an effective method for inducing

atrophy of the embolized lobe to be resected and compensatory hypertrophy of the contralateral lobe [1, 2]. The technical considerations for PTPE are that the portal vein is securely occluded, stagnating the embolic agents such as liquid or microparticles, without recanalization and non-target embolization [1, 6].

An IPSVS is a rare vascular anomaly which communicates persistently between the portal vein and the hepatic vein [3]. Two theories have been proposed to explain the cause of IPSVSs: congenital origin, suggesting a persistent embryonic venous anastomosis; and acquired origin, suggesting the formation of a shunt following portal hypertension or trauma [3, 4]. Typical contrast-enhanced CT findings of IPSVS are a dilated portal branch directly communicating with the hepatic vein through a dilated venous aneurysm [7]. Treatment of IPSVSs should be considered for patients with symptoms of hepatic encephalopathy. However, the IPSVS must be occluded before the PTPE, because it may cause insufficient occlusion of the portal vein and unexpected embolization of the pulmonary artery due to overflow of the embolic agent through the shunt. The embolic agents used for IPSVS should be selected according to the shunt size and morphology. Coils, gelatin sponge, n-butyl cyanoacrylate, and an amplatzer vascular plug have all been used [3, 5, 8].

We decided to use 50 % glucose solution to occlude the small shunt in our patient. Previous reports proposed the embolic mechanism of 50 % glucose for patients with esophageal or gastric varices treated endoscopically, as the endothelial cells of the vessel are injured by its high osmolarity, blood flow stagnates, and thrombus formation [9, 10]. Several investigators have also reported the utility of hypertonic solution injected into the vessels directly during balloon-occluded retrograde transvenous obliteration and sclerotherapy of the varicose leg veins [11, 12]. The advantages of 50 % glucose are that it is easy to inject repeatedly without significant risk and it is less expensive than other embolic materials. We aimed to decrease the blood flow of the IPSVS, thereby allowing the injected absolute ethanol to occupy the portal vein sufficiently. This experiment was similar to that of the 50 % glucose solution infusion to occlude collateral vessels before the injection of ethanolamine oleate to treat gastric varices [11]. The shortcoming of 50 % glucose solution infusion would be that a large IPSVS is not occluded and remains after the injection, and embolization using coils or an amplatzer vascular plug may be required. An additional disadvantage is that injecting a large amount of the agent may induce hyperglycemia. Further experience or studies are warranted to clarify the embolic efficacy of 50 % glucose infusion for IPSVS, because this study is only case report and not fully supported theoretically.

In summary, we reported a case of percutaneous transhepatic portal embolization coexisting with an IPSVS, which was successfully occluded with an infusion of 50 % glucose solution. This is novel management for IPSVSs that are numerous, small, or torturous, and makes the accompanying procedures simpler, shorter, and less expensive, reducing the need for coils or an amplatzer vascular plug.

Conflict of interest Keitaro Sofue and his co-authors have no conflict of interest.

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