The efficacy of digital subtraction angiography using carbon dioxide gas before balloon-occluded retrograde transvenous obliteration using foam sclerosants for gastric varices

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Purpose

Prior to balloon-occluded retrograde transvenous obliteration (BRTO), balloon-occluded retrograde transvenous venography (BRTV) using liquid iodine contrast media is usually used to identify the gastric varices. On the other hands, foam sclerosants have been applied for BRTO to reduce the dose of sclerosants and related hemolysis [1]. However, physiological property of foam is completely different from liquid iodine contrast media; the latter is heavier while the foam is lighter than blood and ascends into the more ventral gastric varices. Moreover, the visualization of foam sclerosants is difficult on fluoroscopy and requires CT during BRTO [1]. Thus, we introduced digital subtraction angiography using carbon dioxide gas (CO2) to estimate the distribution of foam sclerosants before BRTO.
Methods and Materials

For five patients (Table 1 on page 4; 4 males and 1 female, 58-76 years old) with gastric varices, BRTO using foam sclerosants was attempted. Multidetector row CT or magnetic resonance (MR) imaging were performed to identify the target varicose veins or portosystemic shunt and to plan the access routes. Prior to the interventions, celiac and superior mesenteric arteriography with CT (Fig 1a on page ) and volume renderings (Fig 1b-c on page ) was performed to evaluate visceral anatomy and flow directionality, hemodynamics including the identification of the feeders and draining veins of the gastric varices. For the balloon-occluded retrograde transvenous obliteration B-RTO procedures, we followed the method of Kanagawa et al [2]. Briefly, a 5.2 or 6 French balloon catheter with an 11- or 20-mm balloon diameter (Terumo-Clinical Supply, Tokyo, Japan) was inserted from the right femoral vein to the left renal vein and wedged into the left inferior phrenic vein. After temporary balloon occlusion at gastro-renal shunt, BRTV was performed using conventional liquid iodine contrast first and then CO2 (Fig 1d-e on page ) second. These BRTV (Fig 1f-g on page ) were repeated after downgradings [3] or changing the catheter positions. Each grade on Hirota's classification; grade 1: gastric varices are well opacified without collateral veins, grade 2: gastric varices remain opacified despite small and few collateral veins, grade 3: gastric varices are opacified partially with medium to large collaterals, grade 4: gastric varices are not opacified due to many large collaterals, grade 5: left adrenal vein cannot be occluded with a balloon catheter due to a large gastro-renal shunt with rapid blood flow [4] was compared. When gastric varices were opacified on CO2-BRTV, foam sclerosants were injected (1b-g on page ). As a sclerosing agent foam polidocanol was made by the mixture of 2 ml of 3% polidocanol (Polidocasklerol, ZERIA Pharmaceutical, Tokyo, Japan) and 8 ml of air by using a pumping method with two syringes on a three-way stopcock. After obtaining opacification of the target varicose veins on CO2-BRTV, foam sclerosants were was injected into the target varices until full occupation filling of the varices by the foam was observed. During the balloon occlusion, C-arm CT (AXIOM Artis FD system and DynaCT, Siemens, Erlangen, Germany) was performed to confirm the filling of the target vessels by the sclerosants (Fig 1h on page ). After confirming variceal thrombosis the catheter was retrieved and followed by CT (Fig 1i on page ) and endoscopy.
Results

Nine BRTV were performed for five patients (Table 2 on page ). The grades on CO2-BRTV (1.7±0.9) were significantly (p<0.01, Fig. 2 on page ) smaller than the grades on iodine-BRTV (3.8±0.4). In all patients complete thrombosis of the gastric varices was obtained without any complication.
Conclusion

Discussion

Because balloon-occluded retrograde transvenous obliteration B-RTO was first introduced by Kanagawa et al. [2] to embolize gastric varices through a gastrorenal shunt, satisfactory results have been reported for patients with gastric varices and hepatic encephalopathy [2, 4]. To date, balloon-occluded retrograde transvenous obliteration B-RTO has been extensively applied in the past decade for the management of fundic gastric varices in several specialized centers. Because B-RTO is less invasive than surgical treatment, it can be performed on patients with poor hepatic function reserve or hemorrhagic diathesis [2, 10]. In addition, it can be used for emergency treatment to control bleeding from gastric varices. The efficacy of B-RTO for the treatment of gastric varices and hepatic encephalopathy has been reported in the 87% - 100% range and the relapse rate is as low as 0% - 10% [2, 10]. To select the appropriate technique for B-RTO, it is necessary to determine the volume of gastric varices and collateral veins. Hirota et al. [2] classified the degree of the gastric varices and collateral veins into five grades, according to the venographic findings obtained from B-RTV and reported that 22 of 50 (44%) patients needed second or third procedures to obliterate gastric varices completely. Nevertheless, repeated B-RTO is considered to be a burden for patients and results in longer hospitalization. In the present series, none of the patients required more than one procedure to achieve variceal thrombosis. To obliterate gastric varices completely at the first procedure, it is necessary (1) to reduce the blood flow of the feeding vein and/or (2) to obliterate the collateral veins more effectively. To achieve the former, partial splenic embolization or balloon occlusion of the splenic artery and coronary vein with a balloon catheter can be used. However, although partial splenic embolization can reduce the flow of the feeding veins, such as the short or posterior gastric vein, the procedure requires long hospitalization because of resultant high fever or abdominal pain. For the latter, collaterals can be occluded with use of metallic coils, absolute ethanol and stepwise injection of EO after selective catheterization [11]. However, the injected dose should be determined carefully because of possible severe and acute alcohol intoxication or a highly destructive effect on endothelial cells. Moreover, ethanolamine oleate EO may cause several complications such as intravascular hemolysis [5] leading to renal dysfunction [11], allergic reaction possibly leading to cardiogenic shock [7], pulmonary embolization resulting in pulmonary infarction [14] or ARDS [9] following alveolar wall edema and lung congestion, etc. Because some of these complications are correlated with the amount of infused ethanolamine oleate EO [10], total dosage should be minimized. Consequently, more effective and safe sclerosing agents or methods need to be developed.

Foam sclerotherapy has a long track record of success and safety for any kind of lower extremity varicose veins for more than 50 years [11-13]. As compared to the older, non-foamed, liquid sclerotherapy, foam offers the advantage of decreasing the injected
dose as only the surface of the bubbles carries the active drug. This dose decrease has been associated with increased safety thanks to the lower dose of sclerosing agent that may spill into the central veins and systemic circulation [14][9]. Using foam, we could reduce the amount of the sclerosants given to less than a third of the volume of contrast media used in balloon-occluded retrograde transvenous venography in the previous report [1]B-RTV. Moreover, when performing balloon-occluded retrograde transvenous obliteration B-RTO, foam sclerosants tend to ascend immediately into the non-dependent target gastric varices, which are located more ventral than the gastro-renal shunt, as opposed to heavy liquid sclerosants which remain in dependent location (i.e., dorsal in a supine patient). This may occasionally be very helpful in difficult balloon-occluded retrograde transvenous obliteration B-RTO cases where vessels are too tortuous and the target gastric varices cannot be quite reached by the catheter: the foam can ascend from the more dorsal gastro-renal shunt into more ventral gastric varices and remain trapped in them as an ‘air-pocket’, eventually leading to their thrombosis. For sclerosing agents, we used polidocanol and air at a 1:4 ratio; as the latter mixture is widely used for treatment of lower extremity varicose veins thanks to its lesser allergenic potential compared to ethanolamine oleate EO and because its injection is painless [11-13]. In addition, replacement of blood by foamed polidocanol may minimize hemolysis, a classical complication of ethanolamine oleate EO. Because intravenous administration of haptoglobin (a preventive measure against ethanolamine oleate EO-induced hemolysis routinely adopted by Japanese authors) is not FDA-approved, the choice of polidocanol appears more appropriate in the USA. The drawback of using polidocanol highly diluted in air (and not mixed with iodinated contrast) is its poor visibility under fluoroscopy. Although C-arm CT was deemed to provide sufficient visualization of air distribution demonstrated in our previous study [1], it may take a few seconds for scanning and a few minutes for reconstruction. Thus, we introduced CO2-DSA during BRTO.

Carbon dioxide coupled with digital subtraction fluoroscopy has a long track record of success and safety for any kind of vessels except for cerebral and coronary arteries since 1971 [14][6-8]. As compared to liquid iodine contrasts, carbon dioxide gas has several advantages; 1) no hypersensitivity reactions, 2) no known toxicity, permitting multiple large volume injections, 3) very low viscosity (about 1/400th that of ionic contrast), enabling injections of large volumes via very small catheters, 4) minimal patient discomfort. In addition to these advantages, the buoyancy of carbon dioxide gas has been an extremely important factor in achieving consistent and uniform vessel filling. If the area of interest is higher than the injection site, good perfusion of carbon dioxide gas is noted.

In this study, the grades on CO2-BRTV were significantly smaller than the grades on iodine-BRTV; that means carbon dioxide gas distributes into gastric varices better than iodine contrast. This may be very helpful in difficult BRTO B-RTO cases with more than grade 3 in Hirota’s classification where the target gastric varices cannot be seen and may disturb to advance the catheter. Considering the buoyancy of carbon dioxide gas, the catheter tip should be put in the most dorsal portion of the gastro-renal shunt or the target gastric varices should be positioned in the most ventral portion by changing the
patient's habitus. Low viscosity of carbon dioxide gas may be another factor for better
delineation of the target gastric varices than more viscous iodine contrast by traversing
over the very tortuous shunts and reaching the target gastric varices.

Because this study include too small number of patients, the efficacy of CO2-BRTV
should be investigated in more various anatomy and patients' habitus in addition to the
distribution differences between carbon dioxide gas and foam sclerosants.

Conclusion CO2-BRTV can demonstrate gastric varices more easily than iodine contrast
and may provide a good simulation of BRTO using foam sclerosant.
References


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