Case Report

Transcatheter Arterial Embolization Using Cone-beam Computed Tomography during Angiography and Automated Vessel Detection Software for Obscure Colonic Diverticular Hemorrhage after Unsuccessful Endoscopic Clipping: A Report of Two Cases

1) *Department of Radiology, Aichi Prefectural Welfare Federation of Agricultural Cooperatives Kainan Hospital, Japan*
2) *Department of Radiology, Aichi Medical University, Japan*
3) *Department of Gastroenterology, Aichi Prefectural Welfare Federation of Agricultural Cooperatives Kainan Hospital, Japan*
4) *Department of Emergency/Intensive Care, Nagoya Medical Center, Japan*
5) *Department of Radiological Technology, Aichi Prefectural Welfare Federation of Agricultural Cooperatives Kainan Hospital, Japan*

Seiji Kamei[1)], Takahiro Yamamoto[1)], Hiroaki Okada[2)], Yuki Kinbara[4)], Kyohei Takahata[1)], Yoshimi Horikawa[1)], Kuniya Yamada[3)], Yukiya Kitajima[5)], Tesuya Hattori[5)], Kojiro Suzuki[2)]

Abstract

We report the usefulness of cone-beam computed tomography angiography (CBCTA) and automated vessel detection (AVD) software in transcatheter arterial embolization in two cases of obscure ascending colonic diverticular hemorrhage after unsuccessful endoscopic clipping. Arteriography of the superior mesenteric artery demonstrated no active bleeding. Considering the positional relationship of the clips, we could narrow the responsible vessel down to two candidates but could not definitively identify the responsible vessel. We performed CBCTA at the marginal artery of the right colic artery, and the responsible branch was identified using AVD. The responsible vessel could be embolized, and hemostasis was achieved with no ischemic complications. CBCTA and AVD software for colonic diverticular hemorrhage after endoscopic clipping were useful for identifying the responsible vessel and in performing selective embolization.

Key words: embolization, colonic diverticular hemorrhage, cone-beam CT angiography, endoscopic clipping

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Introduction

Endoscopic clipping is a safe and widely used method for treating colonic diverticular hemorrhage. When a clip is placed directly on the bleeding vessel (direct method), complete hemostasis is achieved in a high proportion of cases [1]. However, direct clipping is not always achieved; for example, it is difficult to establish a visual field and blind clipping is forced due to massive bleeding. In such cases, the diverticular opening is closed with clips using the zipper method (indirect method), which reduces the proportion of cases in which complete hemostasis is achieved [1].

Transcatheter arterial embolization (TAE) is useful when hemostasis cannot be achieved endoscopically; however, selective embolization of the responsible vessel is impossible

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Correspondence Author: Seiji Kamei. E-mail: kainan.kamei@gmail.com

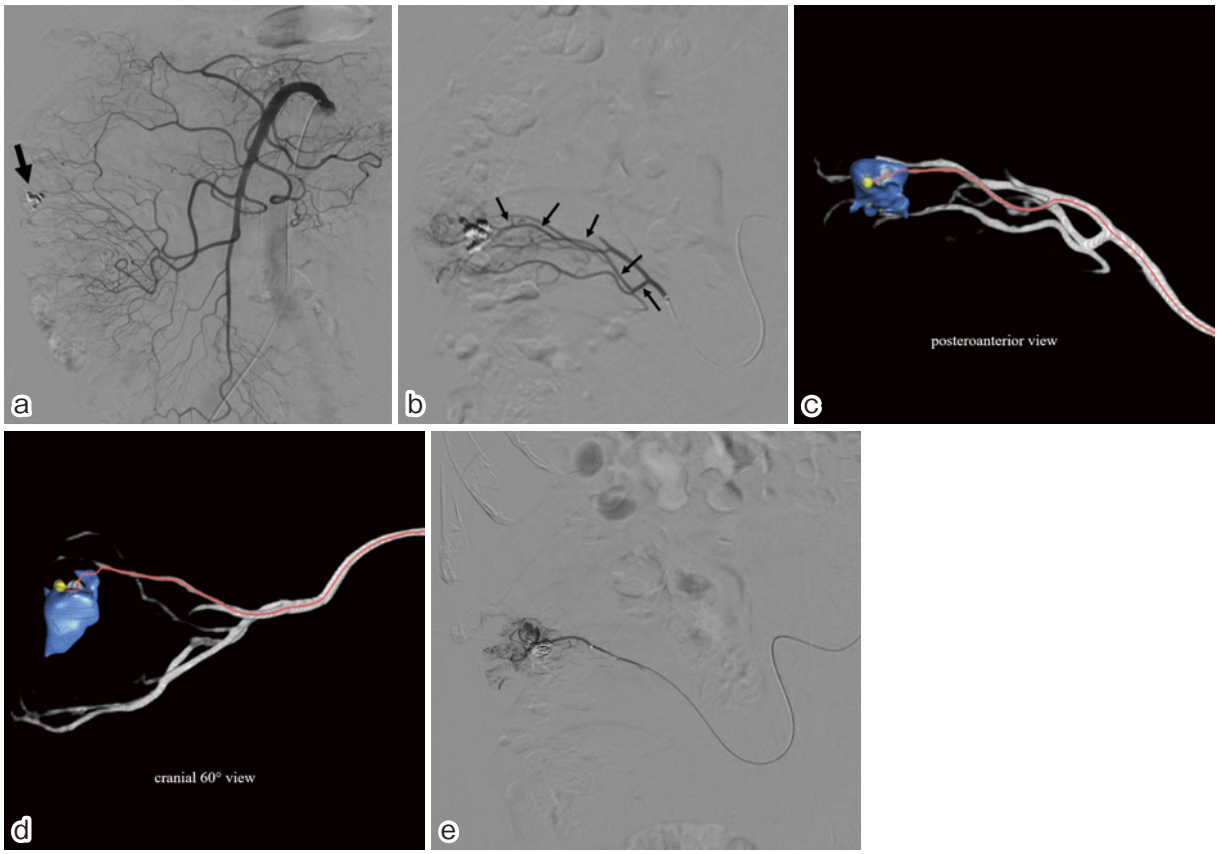

Fig. 1. A male patient in his 70s with bleeding from an ascending colonic diverticulum.
a: Superior mesenteric arteriography demonstrates no active bleeding from the clipping site (arrow).
b: Arteriography of the marginal artery via the right colic artery demonstrates no active bleeding. The proximal branch appears to be the responsible vessel (arrows).
c: Automated vessel detection (AVD) software indicates the distal branch as the responsible vessel.
d: AVD software indicates that the distal branch reaches the anterior wall close to the clips. The proximal branch reaches the posterior wall.
e: Extravasation of contrast medium was detected following selective arteriography of the branch indicated by the AVD software.

when the site of bleeding cannot be identified on angiography [2].

Here, we report two cases of selective embolization in which cone-beam computed tomography (CBCT) during angiography (CBCTA) was used to clarify the vessel responsible for colonic diverticular bleeding after unsuccessful endoscopic clipping.

Case reports

These case reports were approved by our institutional review board, and the requirement to obtain informed consent was waived.

Case 1

A male patient in his 70s underwent endoscopic clipping using the indirect method for a hemorrhage arising from an ascending colonic diverticulum, and hemostasis was achieved. However, six hours later, he again complained of melena and was referred to our department for TAE. His blood pressure was 125/67 mmHg, and his heart rate was 80 bpm. His hemoglobin level, platelet count, and prothrombin time were 9.4 g/dL, 15.7 $\times$ 10^4/μL, and 91.2%, respectively.

All procedures were performed in the angiographic suite (Azurion7 M20; Philips Healthcare, Best, Netherlands) under local anesthesia. Superior mesenteric arteriography using a 4-French catheter (Medikit Co., Ltd., Miyazaki, Japan) demonstrated no active bleeding from the clipping site (**Fig. 1a**). Arteriography using a 2.2-French microcatheter (Progreat β3; Terumo Corp., Tokyo, Japan) navigated by a 0.016-inch guidewire (ASAHI Meister, Asahi Intecc, Seto, Japan) from the marginal artery via the right colic artery demonstrated no active bleeding. Considering the positional relationship with the clips, we thought that the proximal branch from the tip of the microcatheter was the responsible vessel (**Fig. 1b**). To increase our level of confidence, we decided to perform CBCTA of the marginal artery through the microcatheter. CBCTA was performed using XperCT (Philips Healthcare) and the following protocol: 312 projec-

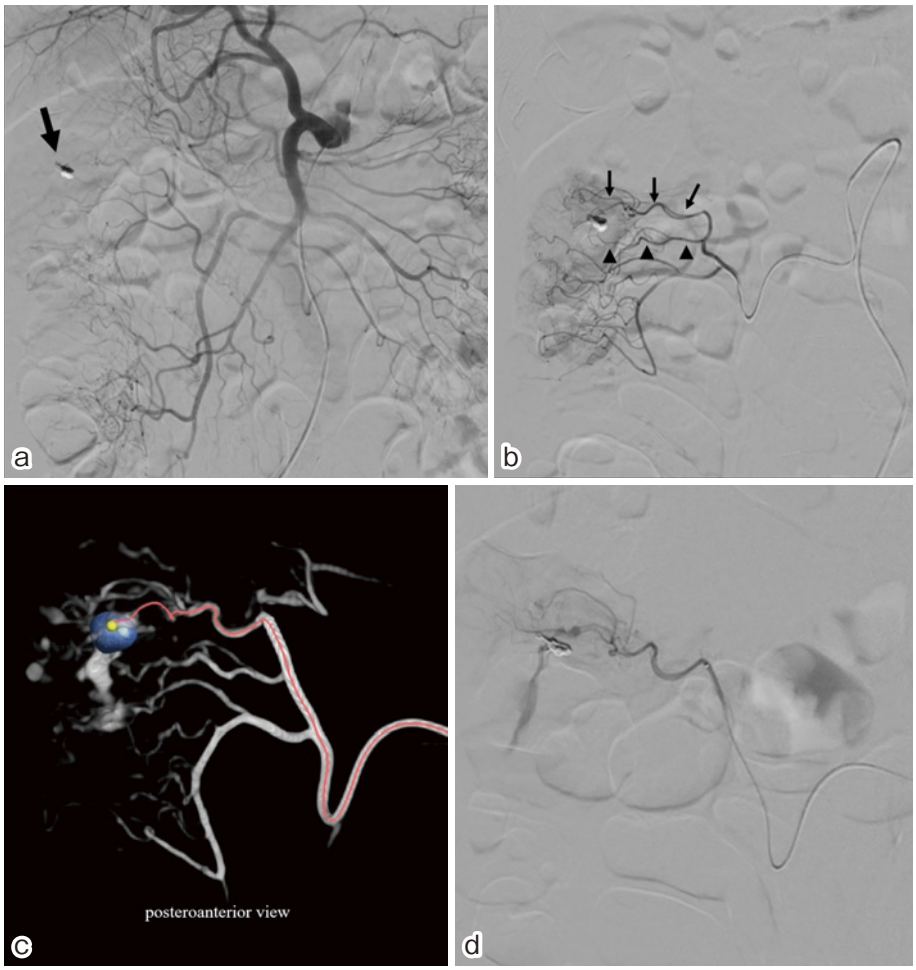

Fig. 2. A male patient in his 70s with bleeding from an ascending colonic diverticulum.
a: Superior mesenteric arteriography demonstrates no active bleeding from the clipping site (arrow).
b: Arteriography of the marginal artery via the right colic artery demonstrates no active bleeding. The responsible vessel appears to be either the proximal branch (arrowheads) or distal branch (arrows) running near the clips, with the distal branch the more likely responsible vessel.
c: AVD software indicates the distal branch as the responsible vessel.
d: Extravasation of contrast medium was detected following selective arteriography of the distal branch indicated by the AVD software.

tion images; tube voltage, 120 kV; tube current, 150-300 mAs; 240° rotation of the flat panel detector around the patient; and acquisition time, 5.2 s. Scanning was initiated 7 s after the start of injection of 3 mL of contrast material (370 mg iopamidol; Iopamiron 370, Bayer, Osaka, Japan), which was manually injected over 15 seconds. CBCTA demonstrated no active bleeding but revealed the location of the clips in the anterior wall of the ascending colon. However, the proximal branch unexpectedly reached the posterior wall, and the distal tiny branch reached the anterior wall close to the clips (**Fig. 1c, d**). After visually confirming the CBCT dataset and setting the entire clipping site as the target area, we used automated vessel detection (AVD) software (EmboGuide, Philips Healthcare) to identify the responsible vessel. The AVD software also indicated the distal branch (**Fig. 1c, d**). CBCTA image analysis was performed by a board-certified interventional radiologist and radiology technologist, and it took approximately 3 min after acquisition of CBCTA images. Based on the CBCTA finding and AVD software, we decided to embolize the branch despite being unable to detect extravasation of contrast medium from this branch on selective arteriography and advanced the microcatheter. Extravasation of contrast medium was consequently visualized from the distal branch (**Fig. 1e**), which was then embolized using microcoils (one 3/2-mm Tornado Embolization Coil and two 3 × 10-mm single-curled Hilal Embolization Coils; Cook, Inc., Bloomington, IN, USA), and hemostasis was obtained. There were no further episodes of bleeding or colonic ischemia during 6 months of follow-up.

Case 2

A male patient in his 70s who had undergone endoscopic clipping using the indirect method for hemorrhage from an ascending colonic diverticulum was referred for TAE because of persistent oozing bleeding. His blood pressure was

147/63 mmHg, and his heart rate was 69 bpm. His hemoglobin level, platelet count, and prothrombin time were 10.6 g/dL, 26.5 × 10^4/μL, and 59.5%, respectively, and he was receiving antiplatelet therapy (aspirin, 100 mg/day; clopidogrel, 75 mg/day).

Imaging procedures were performed using the same systems, catheters, and protocol as in Case 1. Arteriography of the superior mesenteric artery and marginal artery via the right colic artery demonstrated no active bleeding, including from the site of clipping (**Fig. 2a, b**). Considering the positional relationship with the clips, we thought that one of the two branches running near the clips was the responsible vessel, with the distal branch being the more likely candidate (**Fig. 2b**). To increase our level of confidence, we performed CBCTA, which demonstrated no active bleeding, but revealed that the distal branch reached close to the clips. The AVD software also indicated the distal branch (**Fig. 2c**). CBCTA image analysis was performed by a board-certified interventional radiologist, a board-certified diagnostic radiologist, and a radiology technologist, and took approximately 3 min. Therefore, we decided to embolize the distal branch. A microcatheter was advanced, and selective arteriography demonstrated extravasation of contrast medium (**Fig. 2d**). The branch was embolized using microcoils (four 3/2-mm Tornado Embolization Coils), and hemostasis was achieved. There were no further episodes of bleeding or colonic ischemia during 6 months of follow-up.

Discussion

Colonoscopy is strongly recommended as the initial diagnostic and therapeutic procedure for patients who present with acute lower gastrointestinal hemorrhage [3]. Endoscopic clipping is safer and easier to perform than other endoscopic treatments, such as band ligation, detachable snare ligation therapy, injection therapy, and thermal contact band ligation [3]. When clips are placed directly on the bleeding stigma, the reported early rebleeding rate is only 5.9%; however, when direct clipping is difficult and the diverticular orifice is closed in a "zipper-like" fashion, the rebleeding rate is 35.7% [1].

TAE has been shown to be effective for colonic diverticular hemorrhage [2, 4] and is considered for patients who have ongoing bleeding or rebleeding after endoscopic therapy [3, 4]. There is a higher risk of ischemic complications in lower gastrointestinal bleeding than in upper gastrointestinal bleeding. Embolization of up to three vasa recta must be conducted, and of only the responsible vasa recta if possible because the smaller the number of embolizing vasa recta, the lower the risk of ischemia [4]. However, the vasa recta are often poorly separated due to anterior-posterior overlap on conventional angiography, as they arise from the marginal artery and pass beneath the serosa of the anterior or posterior wall in the distributing submucosal vascular plexus [5]. It is therefore essential to identify the bleeding site; however, colonic diverticular bleeding can be intermittent, and extravasation of contrast medium is often not detected on conventional angiography. To overcome this issue, several methods for detecting active bleeding have been reported. In provocative angiography, thrombolytics, vasodilators, or anticoagulants are administered intra-arterially to elicit active bleeding from a source that has recently ceased bleeding [6]. According to a previous report, the rate of identification was 50% (6 of 12 cases) [6]. Another method is CO_2 angiography, which exploits the combined properties of CO_2 (low viscosity, compressibility, and immiscibility) for better detection of the source of bleeding [7]. The rate of CO_2 angiography identifying gastrointestinal bleeding has been reported to be 44%, compared with 14% for conventional angiography [7]. In a CBCT study of emergency cases, including gastrointestinal hemorrhage, the bleeding site was detected in 20/20 (100%) using CBCT, whereas the bleeding site was occult in 4/20 (20%) on conventional angiography. Furthermore, the AVD software (EmboGuide) enabled the responsible vessel to be identified, which was difficult using conventional angiography, in 18/20 (90%) [8]. Notably, more than half of patients were hemodynamically unstable and CBCT was performed under shallow breathing [8]. This might suggest that CBCTA is less susceptible to patient motion than conventional angiography. In addition, there have been some case reports of empiric embolization for lower gastrointestinal bleeding based on CT angiography [9] or using endoscopic clips as markers [10]; however, embolization was not performed selectively at the vasa recta. Therefore, we believe it is reasonable to perform CBCTA for selective embolization because the rate of identifying active bleeding and responsible vessel using conventional angiography, provocative angiography, or CO_2 angiography is not sufficiently high.

In the present cases, active bleeding was not detected in the marginal artery using conventional angiography or CBCTA. On conventional angiography, the clips served as markers, but were of limited use for identifying the positional relationship between the clip and vessels, particularly with regard to the anterior and posterior walls. On CBCTA, the positional relationship was much clearer, without the severe metallic artifacts caused by clips; accordingly, we could rule out unrelated vessels and identify the responsible vessel with a higher degree of confidence. If we had not used CBCTA and no obvious active bleeding was detected on selective angiography, we might have abandoned the embolization, embolized unrelated vessels, or failed to embolize the responsible vessel.

There are some limitations to the present report. First, we report only two cases, and it is unclear whether the benefits of CBCTA outweigh the risks of increased radiation exposure. Second, radiology technologists and interventional radiologists should be trained to perform CBCTA image analysis. Third, the optimal setting for the target area when using AVD software is unclear; further research is needed because the position of the bleeding site and clipping site differed slightly. Fourth, the present patients could hold their

breath well during CBCT. In addition, hemorrhage occurred from the ascending colon where intestinal peristalsis was slow. The CBCT technique described here might be more difficult in patients who have difficulty performing even shallow breathing, and in cases of bleeding from the small intestine, transverse colon, or sigmoid colon, where intestinal peristalsis is more rapid.

In summary, CBCTA and AVD software were useful for selective embolization of the responsible vasa recta in colonic diverticular hemorrhage after endoscopic clipping. Precise embolization might be possible even if no active bleeding is detected.

Conflict of interest: The authors declare that they have no conflicts of interest to report.

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