Three cases of fusion imaging in endovascular treatment of occlusive peripheral artery disease

Makoto Haga, MD, PhD, Takayori Shimizu, MT, Ayako Nishiyama, MD, PhD, *and* Shunya Shindo, MD, PhD, *Tokyo, Japan*

ABSTRACT

Endovascular treatment of peripheral artery disease has dramatically improved in the past decades; however, occlusive or stenotic lesions of the femoral-popliteal artery segment remain a significant challenge for vascular specialists. Real-time guidance based on vessel visualization might be helpful for successful recanalization. Herein, we present three successful cases of fusion imaging during endovascular treatment of the femoral-popliteal artery segments. (J Vasc Surg Cases and Innovative Techniques 2019;5:427-30.)

Keywords: Peripheral artery disease; Fusion imaging; Endovascular treatment

Although endovascular treatment (ET) of peripheral artery disease has improved in the past decades, occlusive peripheral artery disease remains a significant challenge for vascular specialists. ET requires intraoperative use of ionizing radiation and iodine contrast agents for such cases. These risks increase in more complex occlusive or stenotic endovascular cases, which may result in greater exposure to radiation and require higher contrast agent doses.[1]

Fusion imaging using a dynamic overlay from preoperative contrast-enhanced computed tomography (CT) in real time on the fluoroscopy screen decreases the fluoroscopy time and contrast material volume needed during ET.[1-7] Real-time guidance based on vessel visualization may contribute to successful recanalization. Herein, we present three cases of the use of fusion imaging in ET of diseased femoral-popliteal artery segments. Informed consent was obtained from all three patients to publish this case report and the images.

IMAGING AND SETUP

Before the intervention, all the patients underwent outpatient CT angiography (CTA; Aquilion ONE TSX-305A; Canon Medical Systems, Tochigi, Japan) for diagnosis and ET planning. The CTA scans were performed in dual-energy settings, allowing a dedicated postprocessing method. Just before ET initiation, C-arm cone beam CT was performed with the rotational movement of the C-arm covering a 180-degree circular trajectory (Artis zee ceiling system; Siemens Healthcare, Erlangen, Germany). The volumetric data set of the preprocedurally acquired CTA images was transferred to a three-dimensional (3D) workstation (syngo X Workplace; Siemens Healthcare) and co-registered to the patients' preinterventional diagnostic CTA images. During ET, the fusion roadmap was presented in real time on a screen next to the conventional fluoroscope.

CASE REPORTS

Case 1. An 83-year-old man with hypertension, dyslipidemia, and smoking presented with a 2-year history of progressive lifestyle-limiting claudication. The right popliteal pulse was absent, and the ankle-brachial index (ABI) for the right leg was 0.51. CTA revealed a 17-cm-long chronic total occlusion (CTO) in the right superficial femoral artery (SFA). An intervention in the right SFA was performed through a contralateral femoral approach. Under fusion imaging guidance, a 0.014-inch guidewire with a microcatheter (Asahi Corsair Armet; Asahi Intecc Co, Ltd, Aichi, Japan) traversed the CTO of the SFA without catheter angiography (Fig 1, *A*). Subsequently, a 6- × 200-mm self-expandable nitinol stent (LifeStent; Bard Peripheral Vascular, Tempe, Ariz) was implanted in the SFA. The final catheter angiography revealed a successful recanalization of the SFA (Fig 1, *B*). The contrast agent dose and fluoroscopy time were 80 mL and 61 minutes, respectively. (The contrast agent concentration for the catheter angiography was 150 mg iodine/mL).The postoperative ABI was 0.75. At 9 months, he remained asymptomatic without restenosis on duplex ultrasound imaging.

Case 2. A 76-year-old man with hypertension, diabetes, and chronic renal failure who was undergoing hemodialysis presented with a 1-month history of rest pain and ulcer in the right toe. The right popliteal pulse was absent, and the ABI for the right leg was 0.71. Catheter angiography through the right femoral approach showed stenosis with calcification in the popliteal artery (Fig 2, *A*). Under fusion imaging guidance, a 0.014-inch guidewire easily traversed the popliteal artery without catheter angiography. Subsequently, a 4- × 120-mm drug-coated

From the Department of Cardiovascular Surgery, Tokyo Medical University Hachioji Medical Center.

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Correspondence: Makoto Haga, MD, PhD, Department of Cardiovascular Surgery, Tokyo Medical University Hachioji Medical Center, 1163 Tatemachi-chou, Hachioji-shi, Tokyo 193-0998, Japan (e-mail: makoto420@hotmail.com).

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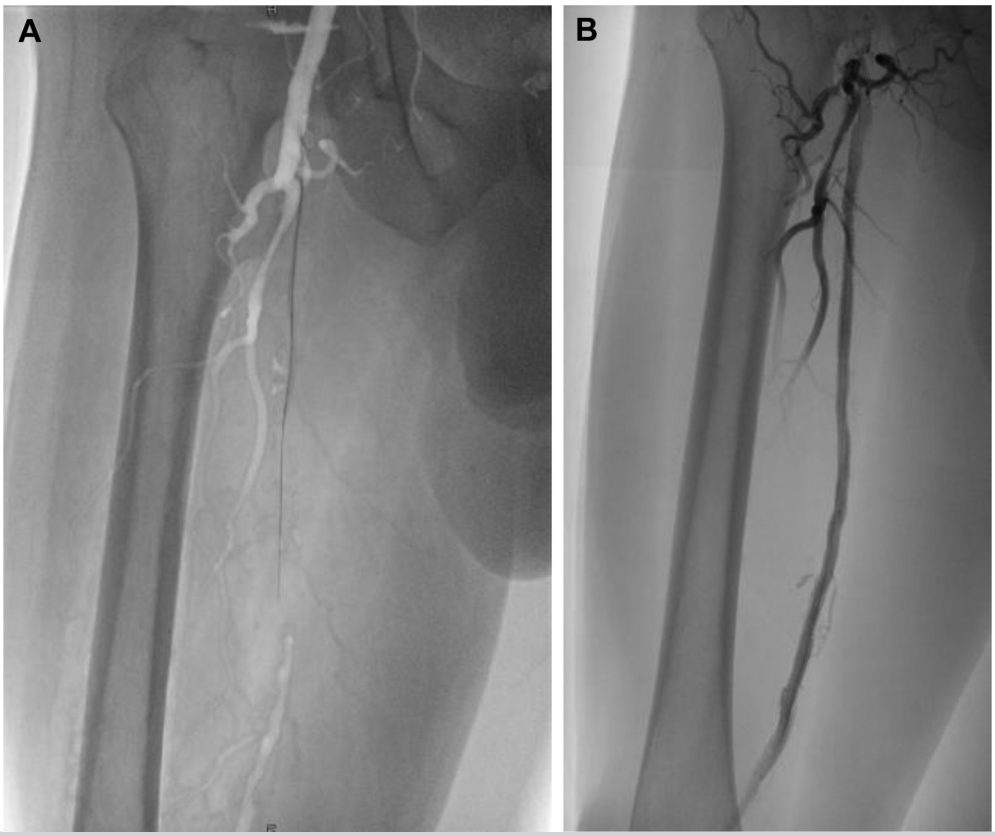

Fig 1. A, A 0.014-inch guidewire traversed the chronic total occlusion (CTO) of the superficial femoral artery (SFA) under fusion imaging guidance. **B,** Final angiography showed successful recanalization of the SFA.

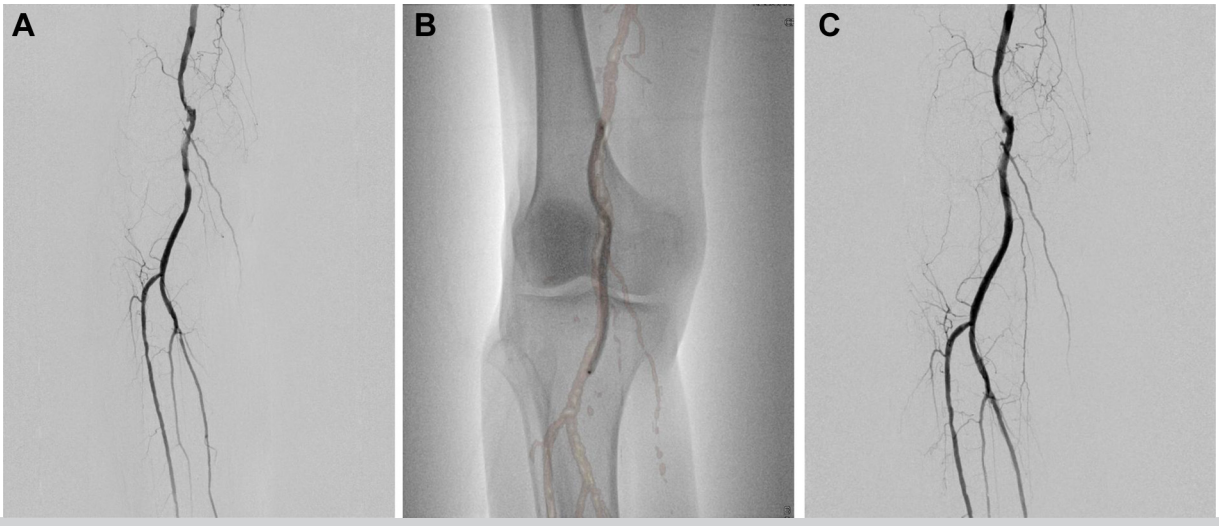

Fig 2. A, Angiography showed stenosis with calcification in the popliteal artery. **B,** A 4- × 120-mm drug-coated balloon was expanded in the popliteal artery under fusion imaging guidance. **C,** Final angiography showed successful recanalization of the popliteal artery.

balloon (IN.PACT Admiral; Medtronic, Santa Rosa, Calif) was expanded in the popliteal artery (Fig 2, *B*). The final catheter angiography revealed a successful recanalization of the popliteal artery (Fig 2, *C*). The contrast agent dose and fluoroscopy time were 60 mL and 19 minutes, respectively. The postoperative ABI was 0.88. He remained asymptomatic without restenosis on duplex ultrasound imaging at the 6-month follow-up.

Case 3. A 79-year-old man with a history of hypertension, diabetes, and chronic renal failure who was undergoing hemodialysis presented with a 2-week history of rest pain in the left

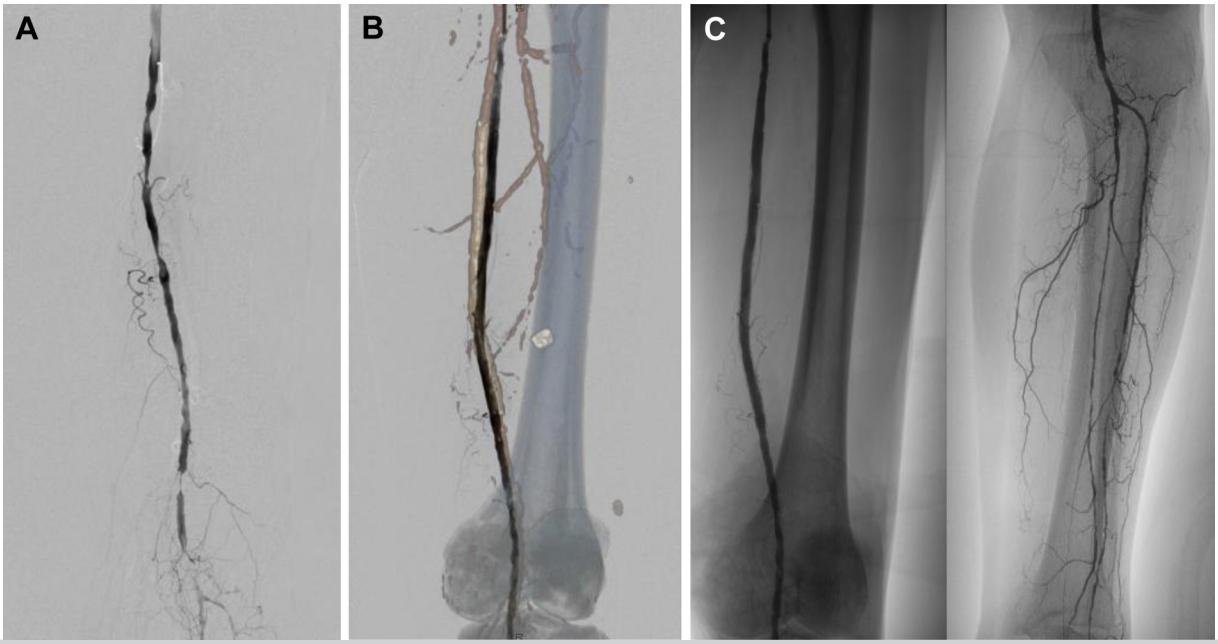

Fig 3. A, Angiography showed stenosis in the superficial femoral artery (SFA) stent and chronic total occlusion (CTO) in the popliteal artery. **B,** Angiography and fusion imaging guidance showed SFA and popliteal artery. **C,** Final angiography showed successful recanalization of the SFA stent and the popliteal artery. Anterior tibial and peroneal artery showed good runoff.

foot. The patient had a 6- × 150-mm self-expanding stent (Innova; Boston Scientific, Marlborough, Mass) implanted in the SFA 6 months earlier. The ABI for the left leg was 0.47. Catheter angiography through the femoral approach showed stenosis in the SFA stent and CTO in the popliteal artery (Fig 3, *A*). Under fusion imaging guidance, a 0.014-inch guidewire traversed the stenosis in the SFA stent and CTO in the popliteal artery without catheter angiography. Subsequently, 4- × 100-mm and 6- × 120-mm drug-coated balloons (IN.PACT Admiral; Medtronic) were expanded in the popliteal artery and SFA stent, respectively. The final angiography revealed successful recanalization of the SFA stent and popliteal artery (Fig 3, *B* and *C*). The contrast agent dose and fluoroscopy time were 60 mL and 28 minutes, respectively. The postoperative ABI was 0.77. He remained asymptomatic without restenosis on duplex ultrasound imaging at the 6-month follow-up.

DISCUSSION

This study demonstrated the feasibility of fusion imaging using a dynamic overlay from the preoperative contrast-enhanced CT scan in real time on the fluoroscopy screen during ET for peripheral artery segments. Fusion imaging is a new alternative to conventional angiography roadmapping in ET. We present three cases of successful recanalization in the femoral-popliteal arterial segments using this technology.

The 3D roadmap in real time helped the guidewire to traverse the CTO in the femoral-popliteal artery. The 3D roadmap facilitated the identification of the bifurcation of the superficial and deep femoral arteries and other peripheral artery branches without effort. Catheter angiography, which confirmed the calcified and stenotic popliteal artery, was performed mainly for postintervention comparison but was not used for device guidance. The mean procedural iodinated contrast agent dose and fluoroscopy time of the three cases were 60 mL and 28 minutes, respectively. The contrast agent dose and fluoroscopy time in patients undergoing similar ET procedures without using fusion imaging guidance are reported as 127 to 246 mL and 16 to 21 minutes, respectively.[8-10] Our three cases were all occlusive femoral-popliteal lesions, which might have influenced the amount of fluoroscopy time. However, our data show that fusion imaging guidance might reduce the required contrast material volume during ET.

The preparation for fusion imaging guidance is brief. If the patient has undergone CT scans before ET, 3D imaging can be performed using a relatively simple method with an already-existing C-arm cone beam CT device. Rotational movement of the C-arm to acquire 3D images takes approximately 5 minutes.[5,6] All these procedures are performed during preparation, and the device is operator friendly. The cost of a fusion imaging machine equipped with C-arm cone beam CT, fluoroscopy, and workstation is approximately $700,000. Fusion imaging guidance can be used not only for peripheral artery lesions but also for aortic, cardiology diagnostic, and therapeutic interventions. Without this advanced technology, many of these patients may have been otherwise referred to more expensive and invasive surgical treatments.

By relying on fusion imaging guidance, acquiring accurate knowledge and considerable experience of the limitations and inaccuracies of this technology is important. Inaccuracies of the overlay roadmap were observed with respiration-related vessel displacement and after the introduction of stents and balloon devices, whereas the fusion image remained in its original position. Figs 2, *B* and 3, *B* show the error of the SFA and popliteal artery origin overlay image. The error between the overlay roadmap and the artery was one-half to one vessel. This error was negligible because it was not a grave concern during cannulation of the guidewire into the artery. However, the technology still poses a risk of error, and pseudolesions should always be considered in using fusion imaging. Fukuda et al[11] reported that in a fusion imaging accuracy analysis during endovascular repair, the mean error of the renal artery origin overlay image was 2 ± 2.5 mm (range, 0-7 mm). Areas that are prone to these phenomena are the distal segments below the knee vessels that move because of the discrepancy between the relative positions of the leg intraoperatively and preoperatively, which can be related to the patient's position. To prevent fusion imaging error, we used a leg holder to maintain the leg position, measuring the distance between the heels as 10 cm during CTA and ET. This procedure improved the accuracy of the overlay 3D roadmap. Further analyses of related overlay errors in the peripheral artery lesion are necessary to provide quantifiable predictions of the overlay accuracy and expected extent of possible displacements.

CONCLUSIONS

Herein, we demonstrate fusion imaging using a dynamic overlay from the preoperative contrast-enhanced CT scan in real time on the fluoroscopy screen during ET for peripheral artery segments. The technology has potential for reducing the contrast material volume required during ET. Further trials are necessary to corroborate these findings.

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