

Intravascular ultrasound complements the diagnostic capability of carbon dioxide digital subtraction angiography for patients with allergies to iodinated contrast medium.

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Abstract

Carbon dioxide digital subtraction angiography (CO₂ DSA) is a useful and safe alternative for patients with renal dysfunction or allergies to iodinated contrast medium.

However, CO₂ DSA image quality is worse than that of angiography with iodinated contrast medium, primarily because of movement during imaging and stent struts. In angioplasty of arteries of the lower extremities, CO₂ DSA cannot be used to sufficiently

evaluate target lesions and determine the most efficient intervention. However, in the current case report, we describe a patient with severe allergies to iodinated contrast medium (Stevens-Johnson syndrome), because of which we were unable to use any iodinated contrast medium when conducting angioplasty. Therefore, we used intravascular ultrasound (IVUS), which facilitated the complete observation of the target lesion after stent implantation without requiring iodinated contrast medium. In this case, IVUS was used to complement the diagnostic capabilities of CO₂ DSA.

Introduction

Angiography is an essential technique for the diagnosis and treatment for atherosclerotic disease. Patients with coronary and peripheral artery diseases have benefitted from angiography and other technical interventions for decades. However, conventional angiography and intervention require the use of iodinated contrast medium, which is known to increase the risk of renal impairment or contrast allergies in some patients, and these problems have not yet been overcome.

The first study of intra-arterial carbon dioxide digital subtraction angiography (CO₂ DSA) was reported by Hawkins in 1982 (1). Since then, studies have shown that CO₂ can be used as an alternative intravascular contrast agent for patients with renal dysfunction or contrast medium allergies; however, the quality of CO₂ DSA images is poor compared to the quality of images obtained with conventional iodinated contrast medium. Kessel et al. reported that 12% of cases required adjunctive use of conventional contrast medium or gadolinium (2). In particular, angiography and interventions for the patients with contrast medium allergies must be performed only with CO₂, since drug allergies do not occur in a dose-dependent manner, unlike the effects of contrast medium on renal impairment. However, CO₂ DSA cannot always

obtain adequate image by patients' restless. Additionally, CO₂ DSA cannot provide in-stent image because stent strut is not able to be completely subtracted. In recent angioplasty to supra-femoral artery and iliac artery, stents are often deployed. The stent position and stent expansion are important for the safety and optimal intervention. There are a few problems for revascularization to femoral artery guided only by CO₂ DSA. In the current case report, we describe the implementation of intravascular ultrasound (IVUS) to improve the quality of peripheral artery intervention by CO₂ DSA.

Case history

A 62-year-old man was admitted to our hospital for bilateral lower extremity pain and ulcers. He had previously experienced allergies to iodinated contrast material (Stevens-Johnson syndrome) during coronary angiography. He had suffered from systemic erosive dermatitis. Plain magnetic resonance angiography (MRA) and echography revealed severe stenotic lesions in the right superficial femoral artery (SFA) and chronic total occlusion in the left SFA. We performed lower extremity angiography by CO₂ DSA. He was administered no premedication for allergic reaction before

angiography. A 4-Fr catheter was inserted into the distal descending aorta (common iliac artery junction) via the left brachial artery. The catheter was inserted into the SFA ostium, after patency from the common iliac artery to the SFA ostium was confirmed, and CO₂ was injected into the SFA ostium. The patient's lower extremity was elevated for improvement of image quality, because the specific gravity of CO₂ is lower than blood. Thirty cc of CO₂ in a plastic syringe was manual injected for a few seconds. Angiography revealed that antegrade flow was observed in the right SFA lesion, while neither antegrade nor retrograde flow was observed in the left SFA lesion. These angiography results confirmed our earlier diagnosis (by MRA and echography) of severe stenosis in the right SFA lesion, and chronic total occlusion in the left SFA (Figure 1).

We decided to perform catheter intervention for the right SFA lesion. He was performed antegrade right common femoral artery puncture. A 0.018 inch guidewire was crossed over the right SFA from the right femoral artery sheath. IVUS (Atlantis Pro Peripheral 40MHz®; Boston Scientific, MA) was performed from the popliteal artery to the proximal SFA lesion after pre-dilatation, and a nitinol self-expandable stent (SMART Control®; Cordis Corporation, NJ) was implanted after pre-dilatation. Because of the patient's restlessness during CO₂ injection and stent implantation, CO₂ DSA

could not provide sufficient quality images for evaluation of peri-stent and in-stent lesions (Figure 2). After post-dilatation, we again examined the treated area by IVUS. IVUS revealed favorable stent dilatation and bonding to the vascular wall; and no major dissection in the stent edge was evident (Figure 3 and 4). We were able to determine the definitive completion of intervention through IVUS, since CO₂ DSA did not allow us to obtain satisfactory images. Eleven injections of 30 cc CO₂ were used in this intervention.

Discussion

Allergies to iodinated contrast medium are rare but occasionally lethal complications. To circumvent these allergic reactions, CO₂ has been used to allow imaging in a variety of methods (3-5). Hawkins reported that using a combination of CO₂ injection and DSA could provide arteriographic images of the abdominal aorta, renal arteries and arteries of the lower extremity (1). Later, Weaver et al. demonstrated that percutaneous transluminal angioplasty (PTA) of the lower extremities could be performed by CO₂ DSA guidance (6). However, CO₂ DSA angiography was not always able to provide

adequate information for diagnosis and intervention. Leg cramps, toe pain, and tingling in the feet can cause movement and restlessness in the patient and are therefore major factors contributing to the degradation of CO₂ DSA image quality (7).

While patients with renal insufficiency are able to use low-dose iodinated contrast medium, patients with allergies to iodinated contrast medium are unable to use any conventional contrast media. In our case, the patient had previously experienced a severe hypersensitivity reaction to iodinated contrast medium, and we were unable to use iodinated contrast medium to complement other imaging technique. Because there are case reports showed that the re-challenge with causative drug carried severe complication, it is widely known that the re-challenge test for Stevens-Johnson syndrome patients is contraindication. Therefore, it has been published that the incidence of recurrent reactions appears to be extremely low. (8, 9)

The patient even complained of limb pain and tingling after CO₂ injection, leading to restlessness during the procedure, which prohibited the collection of adequate quality images. Moreover, we were unable to image treated lesion after stent implantation since CO₂ DSA cannot subtract stent strut and is not sufficient for evaluating in-stent lesions.

IVUS has been used extensively for observing target lesions and determining the completion of revascularization. However, no reports have discussed the utility of

peripheral IVUS in CO₂ DSA. In previous reports, PTA of arteries of the lower extremities could be performed via plain balloon angioplasty only. Therefore, the rate of adequate imaging by CO₂ DSA may be higher than the present study suggests. However, CO₂ DSA, unlike conventional angiography using iodinated contrast medium, cannot achieve sufficient resolution to evaluate in-stent and peri-stent lesions. Moreover, since we often deploy the stents to stenotic lesions from the common iliac artery to the SFA, where they must expand and bond to the vessel wall, and since stent edge dissections are evaluated when determining the endpoint of intervention, the utility of CO₂ DSA may be limited in these cases. The advantages of IVUS are as follows;

- (1) The therapeutic result could be assessed without CO₂ or iodinated contrast medium.
- (2) The image quality does not depend on patients' comfort and restful state, unlike CO₂ DSA.
- (3) IVUS is an established and safe technique.

In this case, we could obtain no information on the treated lesion by CO₂ DSA images alone, because the image quality is affected by the patient's restlessness and stent implantation. Only IVUS images contributed to the decision of PTA endpoint. However,

we are not suggesting that PTA should only be performed via IVUS or body surface arterial sonography in patients with allergies to iodinated contrast medium. Rather, the method used will depend on the type of diagnosis and the patient's disease state. For example, in peripheral artery disease, where vessel calcification is often observed, ultrasound cannot evaluate calcified lesions as well as CO₂ DSA. The limitations of IVUS are the difficulty of transit IVUS catheter and interpretation the IVUS images in heavy calcification cases. Moreover, because CO₂ DSA uses X-ray analysis, the orientation of vessel calcification can be observed. In contrast, in PTA performed only via ultrasound, it is difficult to estimate lesion length and to determine stent placement position. Especially, in severe diffuse calcification case, IVUS cannot provide whole vessel image. Therefore, the determination of stent size and PTA endpoint is very difficult by only IVUS navigation.

In this case, CO₂ DSA is the more appropriate imaging technique to view overall condition, while IVUS can be used to observe the details of the target lesion. Hence, the advantages of CO₂ DSA and IVUS are completely different, and in the era of the stent, CO₂ DSA and IVUS often work better when used in combination. These arguments clearly demonstrate that physicians need to have a sufficient understanding of the advantages and disadvantages of each diagnostic modality.

Conclusion

The lower extremity artery intervention by CO₂ DSA is very useful and safety alternative method for the patients with iodinated contrast medium allergies. However, the image quality of CO₂ DSA is worse than the image quality of conventional angiography using iodinated contrast medium. IVUS can obtain the image of treated lesion and determine the endpoint of intervention without iodinated contrast medium and CO₂. IVUS is a useful intraoperative imaging modality in PTA using CO₂ DSA.

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Figure legends

Figure 1. Carbon dioxide digital subtraction angiography; (a) right superficial femoral artery (SFA) lesion, (b) left SFA lesion.

Figure 2. Percutaneous transluminal angioplasty of the right superficial femoral artery (SFA): (a) Preoperative carbon dioxide digital subtraction angiography (CO₂ DSA), (b) pre-dilatation, (c) intravascular ultrasound after pre-dilatation, (d) fluoroscopy after stent placement, (e) post-dilatation to in-stent lesion, and (f) postoperative CO₂ DSA.

The patient's restlessness degraded the image quality, preventing accurate evaluation of peri-stent and in-stent lesions. Intravascular ultrasound (IVUS) was performed after pre-dilatation and after post-dilatation.

Figure 3. Intravascular ultrasound images after pre-dilatation.

Figure 4. Intravascular ultrasound images after post-dilatation: (a) an in-stent image with severe calcification, (b) an in-stent image with mild calcification. (this image revealed that the stent was fully expanded), and (c) stent proximal edge. White arrow:

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stent strut at stent edge.

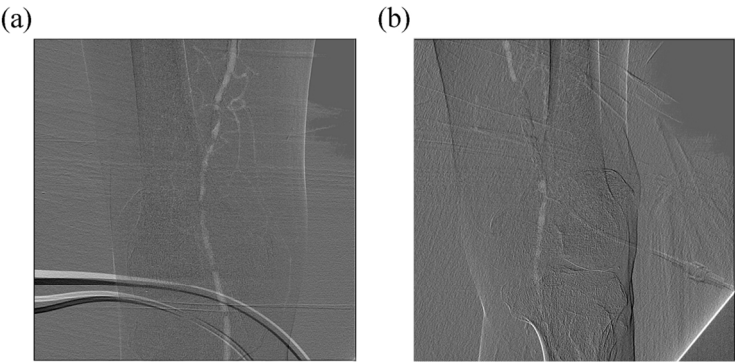


Figure 1

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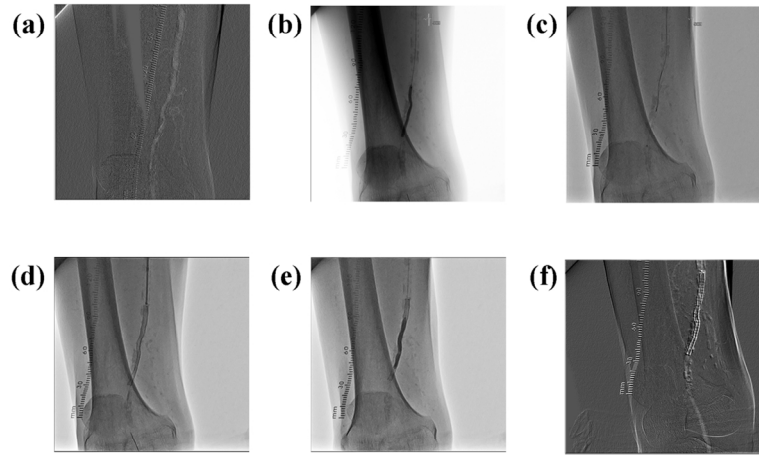


Figure 2

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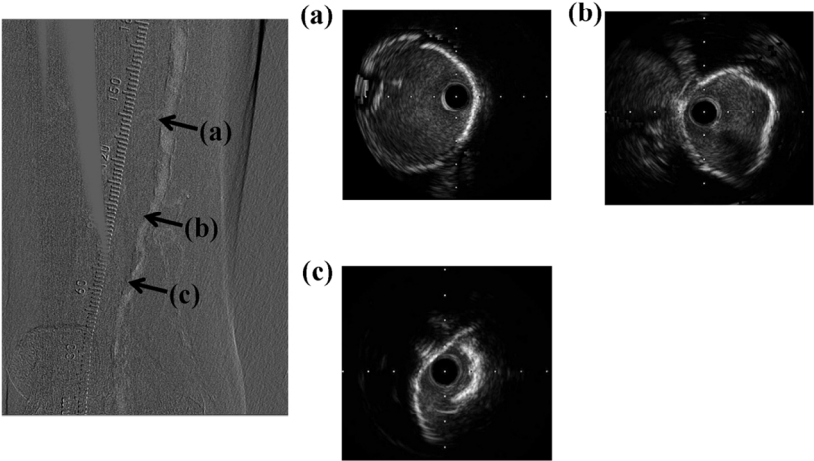


Figure 3

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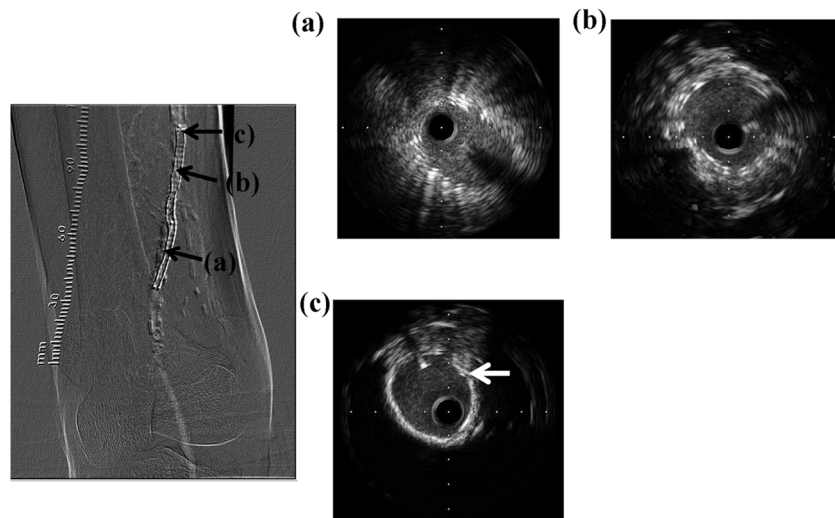


Figure 4

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