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Case Report

Endovascular therapy for subclavian artery restenosis due to stent strut protrusion with high-resolution angioscopy and three-dimensional optical frequency domain imaging

Kuniyasu Ikeoka (MD PhD)[a], Keita Okayama (MD PhD)[b], Tetsuya Watanabe (MD PhD)[a], Shinsuke Nanto (MD PhD FJCC)[c], Yasushi Sakata (MD PhD FJCC)[b], Shiro Hoshida (MD PhD FJCC)[a,*]

[a] Department of Cardiovascular Medicine, Yao Municipal Hospital, Yao, Osaka, Japan
[b] Department of Cardiovascular Medicine, Osaka University Graduate School of Medicine, Suita, Osaka, Japan
[c] Department of Cardiovascular Medicine, Nishinomiya Municipal Central Hospital, Nishinomiya, Hyogo, Japan

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ABSTRACT

A 47-year-old female patient was admitted with a complaint of severe chest pain on effort. She had a history of effort angina treated using coronary artery bypass with left internal thoracic arterial bypass to the left ascending coronary artery. She also had left subclavian and vertebral arterial stenoses, which were treated with balloon-expandable stents. Exercise stress myocardial perfusion imaging revealed anterior to apex left ventricular myocardial ischemia. Cardiac ischemia due to left subclavian stenosis was diagnosed. We treated the left subclavian arterial stenosis with endovascular therapy. We observed that the vertebral Palmaz stent protruded from the ostium and the jailed subclavian artery on high-resolution angioscopy (Zemporshe with a 0.48-megapixel equivalent resolution; Taisho Biomed Instruments, Osaka, Japan) and optical frequency domain imaging (OFDI). A guide wire was successfully crossed through the Palmaz stent strut, which was confirmed using three-dimensional OFDI. The stent strut was dilated using balloon angioplasty. New imaging technologies are promising tools for improving the efficacy and safety of craniocervical intervention.

<**Learning objective:** New imaging technologies including high-resolution angioscopy and 3D-optical frequency domain imaging have become available for endovascular therapy of peripheral artery disease. They could be used to observe stent strut deformation with high imaging quality and demonstrated successful guidewire passage through the stent strut. High-resolution angioscopic system yields images with higher quality and larger angular field than any other previous angioscopy systems.>

Introduction

Coronary subclavian steal syndrome (CSSS) involves deterioration of flow in the internal mammary artery used as a conduit for coronary artery bypass. It is diagnosed in patients with changes in pulse and arterial pressure in the upper limbs with angina pectoris after coronary artery bypass. Endovascular therapy has been established as a treatment option for CSSS [1].

Angioscopy has a high detection rate of thrombus, stent malapposition, and neointimal coverage [2]. In coronary artery intervention, optical frequency domain imaging (OFDI) provides excellent-resolution images of intraluminal structures, allowing the evaluation of three-dimensional (3D) images for stent configuration [3]. We here describe the novel use of high-resolution angioscopy and 3D-OFDI for subclavian artery restenosis due to vertebral Palmaz stent protrusion.

Case report

A 47-year-old female patient was admitted with a complaint of life-limiting chest pain with effort. She was undergoing dialysis because of glomerulonephritis. She had a history of effort angina

* Corresponding author at: Department of Cardiovascular Medicine, Yao Municipal Hospital, 1-3-1 Ryuge-cho, Yao, Osaka 581-0069, Japan.
E-mail address: shiro.hoshida@hosp-yao.osaka.jp (S. Hoshida).

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treated using coronary artery bypass of the left internal thoracic artery (LITA) to the left ascending coronary artery (LAD) 14 years previously. She also had left subclavian and vertebral arterial stenoses, which were treated using balloon expandable stents. The left vertebral artery was treated with a Palmaz stent 14 years previously, and the proximal site of the left subclavian artery was treated with an Express LD stent (Boston Scientific, Marlborough, MA, USA) 5 years previously. However, exercise stress myocardial perfusion imaging revealed anterior to apex left ventricular myocardial ischemia. Doppler echo examination confirmed the presence of left subclavian stenosis. The peak systolic velocity at the stenosis was 2.7 m/s. Systolic pressure gradient was over 20 mmHg by intra-arterial pressure study. Angiography revealed that the LITA bypass graft was patent to the LAD. In this patient, myocardial ischemia was evoked by the stenosis of left subclavian artery that was more proximal from the junction of LITA used as coronary bypass graft. CSSS was diagnosed with these examinations.

We treated the left subclavian arterial stenosis with endovascular therapy. An additional surgical option was not selected because of its invasiveness. A 9-Fr occlusion balloon tipped guiding catheter (Optimo; Tokai Medical, Kasugai, Japan) was advanced to the ostium of the subclavian artery through a transfemoral approach. We observed that the vertebral Palmaz stent was protruded from the ostium and the jailed subclavian artery on high-resolution angioscopy (Zemporshe; Taisho Biomed Instruments, Osaka, Japan) and OFDI (FastView; Terumo, Tokyo, Japan) (Fig. 1). We could not examine the jailed stent strut with intravascular ultrasound (IVUS; AltaView, Terumo) because of the presence of metallic artifacts. OFDI showed an adherent stent strut thrombus, and 3D imaging revealed that a 0.014-in. guidewire was successfully penetrated into the appropriate stent strut (Fig. 2). We finally performed stent strut deformation by using a 0.014-in. guidewire compatible high-pressure non-compliant balloon (5.0-mm diameter; Shiden HP, Kaneka, Japan) up to 30 atm. We successfully examined the dilated stent strut up to 4 mm diameter, and the dilated stent strut was observed using high-resolution angioscopy and OFDI (Fig. 3). Pressure gradient disappeared after angioplasty. Anterior to apex left ventricular myocardial ischemia was not observed in exercise stress myocardial perfusion imaging after endovascular therapy.

Discussion

Here, we report a case of complex CSSS treated using angioplasty with high-resolution angioscopy and OFDI. OFDI revealed severe stenosis due to jailed stent strut thrombus. Moreover, 3D-OFDI demonstrated successful guidewire passage through the stent strut. High-resolution angioscopy could be used to observe stent strut deformation with high imaging quality.

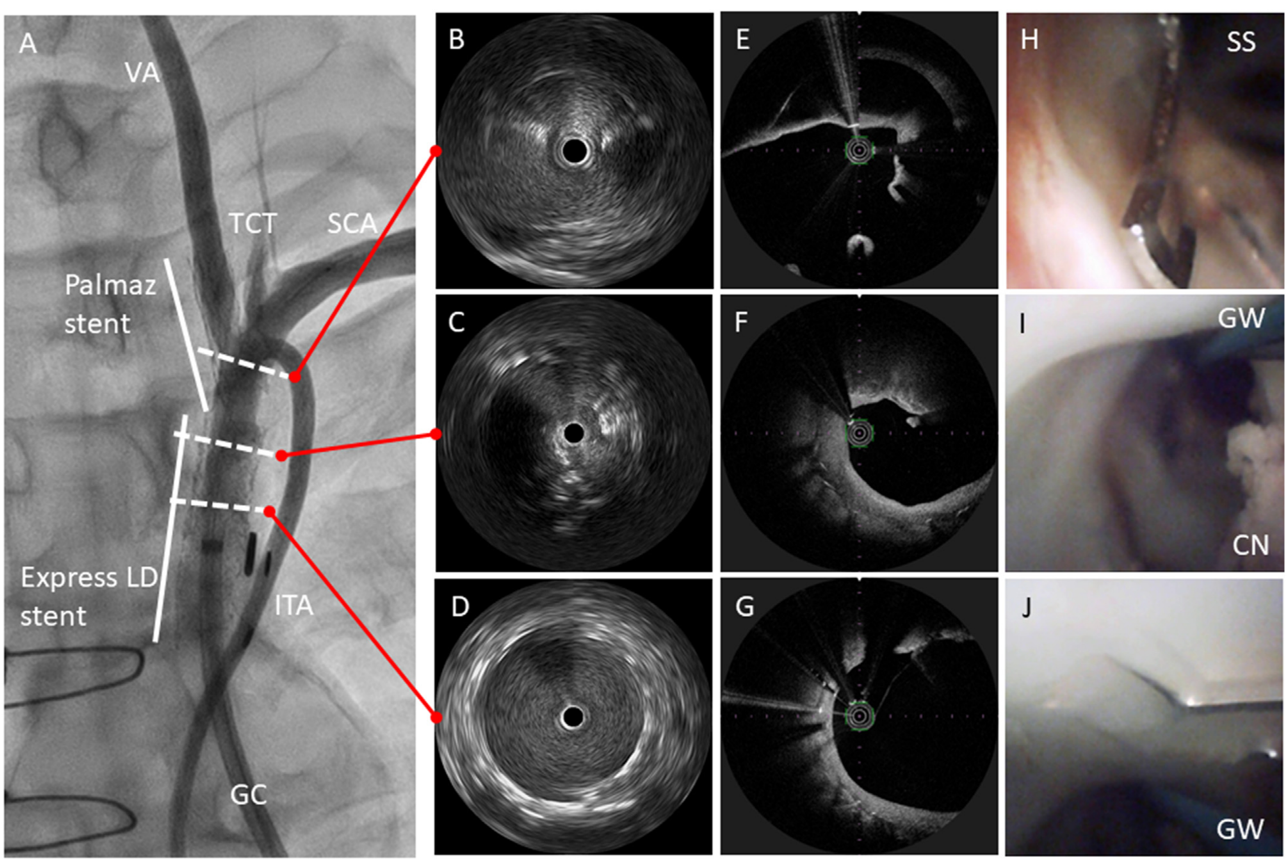

Fig. 1. (A) Angiogram showing the protruded Palmaz stent in the left subclavian artery at the proximal site of branching of the left internal thoracic artery. The Express LD stent was deployed just at the ostium of the left subclavian artery. (B–D) Intravascular ultrasound images demonstrating an acoustic shadow due to the metallic stent and calcified nodule. (E–G) Optical frequency domain images revealing a stent strut thrombus and a mural calcified nodule. (H–J) Zemporshe angioscopic images clearly showing protruded stent struts, calcified nodule, and embedded stent struts in the neointima. Straight white line, stent-implanted site; dotted white line, imaging site.
VA, vertebral artery; TCT, thyrocervical trunk; SCA, subclavian artery; ITA, internal thoracic artery; GC, guiding catheter; SS, jailed stent strut; GW, guidewire; CN, calcified nodule.

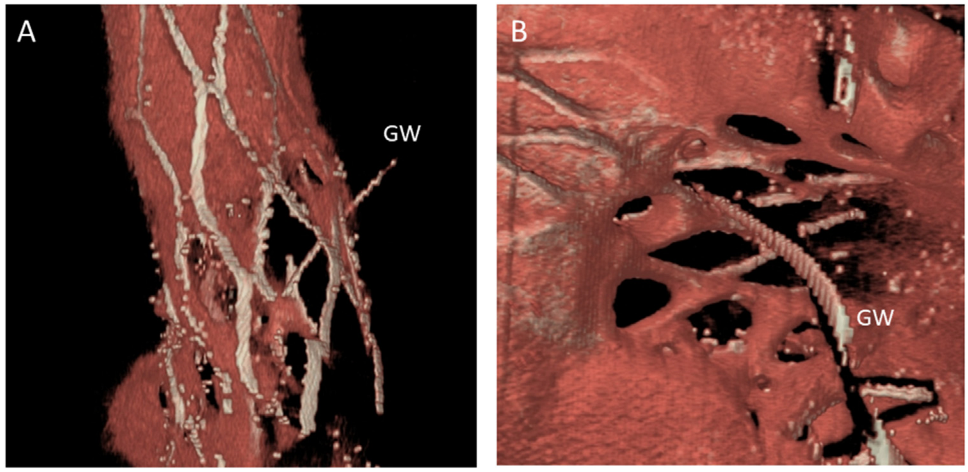

Fig. 2. (A) Three-dimensional optical frequency domain image (vessel view) demonstrating guidewire passage through the jailed Palmaz stent strut directing for the subclavian artery. (B) Unfolded stent image (carpet view) confirming guidewire passage through the appropriate stent strut.
GW, guidewire.

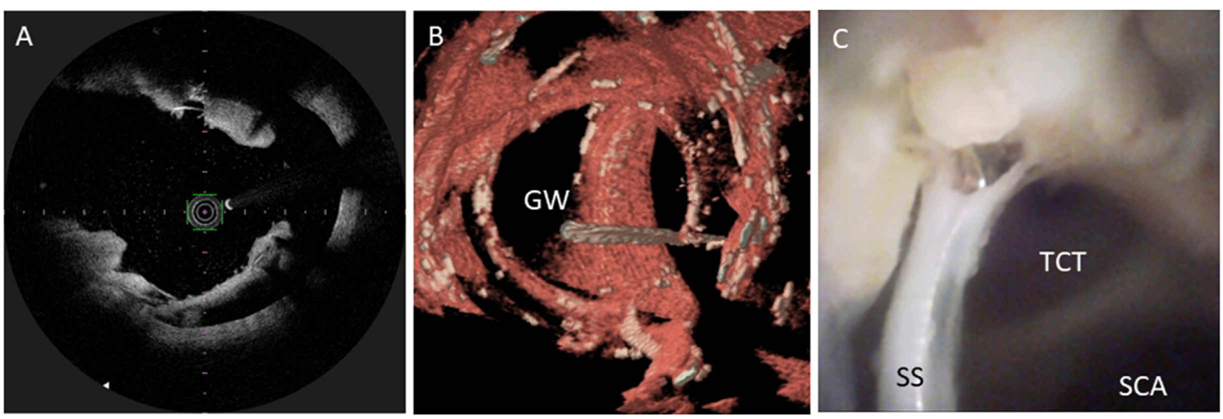

Fig. 3. (A, B) Optical frequency domain images showing the successfully dilated Palmaz stent strut. (C) Zemporshe angioscopic image demonstrating vessel branches through the dilated stent strut.
GW, guidewire; TCT, thyrocervical trunk; SCA, subclavian artery; SS, stent strut.

OFDI has higher resolution than IVUS in coronary artery disease (CAD), and has higher sensitivity for detecting thrombus and calcified lesions than IVUS [4]. 3D-OFDI is also useful in the bifurcation strategy for CAD [5]. However, there has been no report on the use of 3D-ODFI for craniocervical intervention. Zemporshe is a high-resolution angioscopic system developed for peripheral vascular use. It is equipped with a camera of 0.48-megapixel equivalent resolution at the tip of the catheter. It yields images with higher quality and larger angular field than any other angioscopy systems. The diameter of this high-resolution angioscopic catheter is 1.8 mm. It may be difficult to deliver this catheter through severely rugged lesions. Angioscopic imaging is reported to be useful for the diagnosis of vascular thrombus, plaque behavior, and stent strut neointimal coverage in peripheral artery disease [6–8]. This is the first report on the clinical use of Zemporshe.

In this case, the diagnosis of CSSS was complicated. We finally confirmed the presence of flow-limiting stenosis due to the jailed stent strut with thrombus on 3D-OFDI. We could not detect the stent strut configuration with IVUS imaging because of metallic artifacts. We were able to ensure appropriate guidewire passage through the stent strut with the aid of 3D-OFDI. The stent strut was safely dilated, and the consequent strut deformation was ideal. Although the early type Palmaz stent was hard to be deformed due to its closed-cell thick stainless steel struts, we safely and successfully dilated the stent strut. Stent strut deformation without thrombus was clearly observed with Zemporshe angioscopic imaging.

In conclusion, new imaging technologies are promising tools for ensuring the efficacy and safety of craniocervical intervention.

Conflict of interest

Authors declare that there is no conflict of interest.

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