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Case Report

# Different behaviors of bioresorbable vascular scaffold in different types of calcified lesion: Insights from intravascular imaging

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ABSTRACT

A 55-year-old male underwent percutaneous coronary intervention (PCI) for left anterior descending artery chronic total occlusion. After lesion preparation with non-compliant (NC) balloon, two bioresorbable vascular scaffolds (2.5/28 mm, 3.0/28 mm, Absorb BVS, Abbott Vascular, Santa Clara, CA, USA) were implanted followed by 1:1 sized NC balloon post-dilatation at 20 atm. Final intravascular ultrasound (IVUS) showed acceptable BVS expansion in diffusely calcified lesions.

Twenty-one months' follow-up coronary angiography revealed severe restenosis with reocclusion at the distal edge of the distal BVS. After recanalization with a 1.0 mm balloon, optical coherence tomography (OCT) was performed. Quantitative analysis comparing OCT and IVUS at the index procedure demonstrated that minimum scaffold area at follow-up became significantly smaller and with higher eccentricity, suggesting severe recoil at the lesions with thick calcium spot, whereas these changes were not observed at the lesion with relatively thin calcification. The lesions were successfully revascularized with drug-eluting stents and final OCT showed symmetric expansion of metallic stents.

Our case demonstrates that different types of calcification can have an impact on BVS expansion and recoil. In calcified lesions, an optimal implantation technique is mandatory to achieve the best possible results, and characterization of calcified lesions with intravascular imaging may be helpful to decide PCI strategy with BVS.

<**Learning objective:** Calcified lesions represent a challenging lesion subset for bioresorbable vascular scaffold (BVS) because of less radial strength of the latter. Quantitative analysis with intravascular imaging demonstrated that different types of calcification can have an impact on BVS expansion and recoil. In calcified lesions, an optimal implantation technique is mandatory to achieve the best possible results, and characterization of calcified lesions with intravascular imaging may be helpful to decide percutaneous coronary intervention strategy with BVS.>



## Introduction

Bioresorbable vascular scaffold (Absorb BVS, Abbott Vascular, Santa Clara, CA, USA) is a unique device with temporal anti-proliferative drug-eluting and vessel-scaffolding properties, which has a potential benefit to restore normal function and anatomy of the treated vessel. Given the lesser radial strength of BVS compared to that of metallic stents, calcified lesions are one of the most challenging lesion subsets for percutaneous coronary intervention (PCI) with BVS. Recently, Panoulas et al. reported feasibility and safety of BVS implantation for calcified lesions (n = 62) in comparison with non-calcified lesions (n = 101) with a 14-month median follow-up (composite of all-cause death, myocardial infarction, and any revascularization: 10.9% in calcified lesions vs 12.9% in non-calcified lesions, $p = 0.546$) [1]. Ohya et al. reported comparable angiographic outcomes of BVS implantation for moderate to severe calcified lesions when compared with

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cobalt-chromium everolimus-eluting stent (post-procedure and at 13-month follow-up) [2]. However, in these studies, calcified lesions were defined based on binary determination of presence or absence of calcification, and their severity was stratified according to conventional angiographic findings [3]. The impact of calcium quantification (degree of arc, thickness, etc.) on device performance and clinical outcomes may differ. This case demonstrates different behavior of BVS in different types of calcified lesions with insights from intravascular imaging.

## Case report

A 55-year-old male underwent PCI for a left anterior descending artery chronic total occlusion (Fig. 1A). After antegrade wiring in the true lumen, pre-dilatation was performed at high pressure (16 atm) with a 2.5 mm non-compliant (NC) balloon for the distal segment and a 3.0 mm NC balloon for the proximal segment of the lesion. Intravascular ultrasound (IVUS) confirmed acceptable lesion preparation with expansion of the occluded lesion and multiple fragmentations of the calcification. Following vessel sizing with IVUS, two BVS ($2.5 \times 28$ mm, $3.0 \times 28$ mm) were implanted with minimal overlap (Fig. 1B). Post-dilatation was performed with NC balloons (3.0 mm to 20 atm for the proximal segment and 2.5 mm to 20 atm for the distal segment). Final IVUS showed acceptable BVS expansion in a diffusely calcified lesion (final minimum scaffold area: 3.60 $mm^2$ in the lesion treated with the 2.5 mm BVS) (Fig. 2A–F). The patient received dual antiplatelet therapy with a combination of aspirin (100 mg/day) and prasugrel (10 mg/day) for 12 months after the procedure, thereafter he continued aspirin only.

Twenty-one months later, follow-up coronary angiography (CAG) was performed due to recurrent anginal symptoms and revealed severe restenosis with reocclusion at the distal edge of the BVS (Fig. 1C). After recanalization with a 1.0-mm balloon, optical coherence tomography (OCT) showed high eccentricity of BVS suggesting severe recoil at the lesion with a visually thick calcification spot (Fig. 2a, b, e, and f), which was not observed in other segments of the lesion with a relatively thin calcification (Fig. 2c and d). There was no obvious evidence of thrombus at the occluded segments. After pre-dilatation with a 2.5-mm NC balloon, two drug-eluting stents (DES: Ultimaster $2.75 \times 38$ mm, $3.5 \times 38$ mm; Terumo Corporation, Tokyo, Japan) were implanted, with subsequent high-pressure post-dilatation with a 3.0-mm NC balloon to 26 atm for the middle segment (Fig. 1D). Final OCT showed well expanded metallic stents with symmetric shape along the whole restenotic calcified lesion (Fig. 2a'–f').

In view of the different BVS expansion and morphology observed between the different types of the calcified lesions at the follow-up, we retrospectively analyzed calcium morphology and compared quantitative measurements of intravascular imaging including scaffold area (SA) and eccentricity index (EI: a ration of the minimum and maximum scaffold diameter) at each lesion of interest. OCT and IVUS images were coregistered using fiduciary side branches, calcium locations and known pullback speeds. Firstly, OCT measurements of continuous cross-section per frame (distance: 0.2 mm/frame) were performed at the representative lesions with different types of calcification. Thereafter IVUS measurements were also performed at the coregistered lesion sites using the same distance in OCT assessments (Lesion 1–3 in Fig. 3). Regarding calcium morphology, calcium thickness was measured for each calcium by OCT as: (1) a maximum length between luminal and abluminal border of calcium; or (2) a visible maximum depth of calcium edges in case of unclear abluminal border due to light signal attenuation. Calcifications which were not eligible for measurements due to limitation of depth penetration of OCT, or poor visualization due to heterogeneity of plaque including lipid and necrotic debris, were excluded from analysis, even with their detection by IVUS. These analyses demonstrated that, between the index procedure and the 21-month follow-up, minimum SA became significantly smaller with higher eccentricity at the lesions with thicker calcium spot [thickness: median 0.68 mm (interquartile range: 0.59–0.78)], whereas these changes were not observed at the lesion with thinner calcification [thickness: median 0.28 mm (interquartile range: 0.20–0.34)] (Fig. 3).

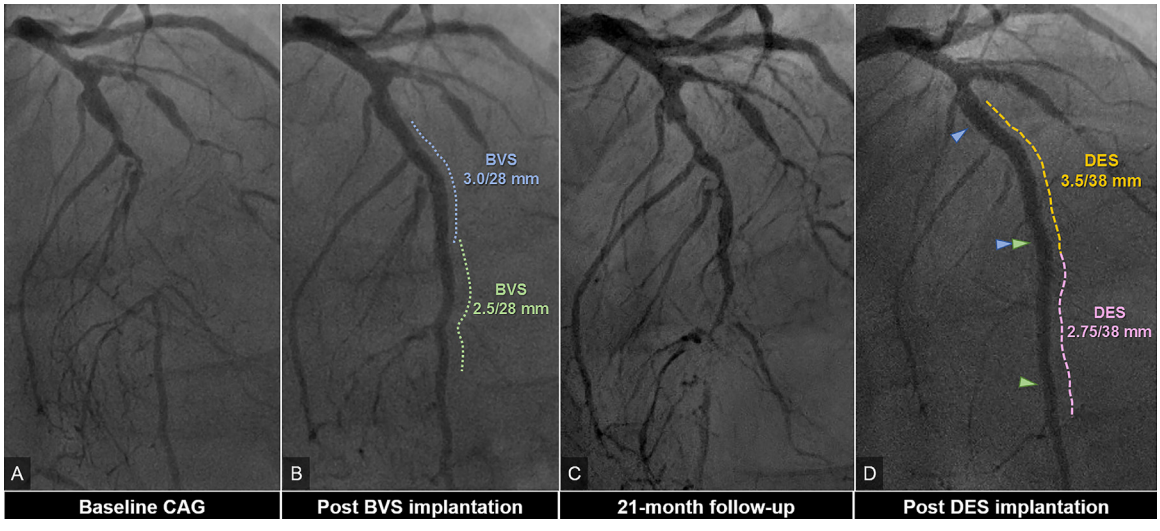


**Fig. 1.** A series of CAG; index percutaneous coronary intervention with BVS and target lesion revascularization with DES. (A) Baseline CAG. (B) CAG after BVS implantation for LAD chronic total occlusion (each of blue and green dashed line indicates the lesion where BVS was implanted). (C) Twenty-one-month follow-up CAG. (D) CAG after DES implantation for LAD restenosis (each of yellow and pink dashed line indicates the lesion where DES was implanted. Each of blue and green arrow head indicates both proximal and distal edge of previously implanted BVS). BVS, bioresorbable vascular scaffold; CAG, coronary angiography; DES, drug-eluting stent; LAD, left anterior descending artery.

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