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Delayed Disruption of a Bioresorbable Vascular Scaffold

A 59-year-old man underwent percutaneous coronary intervention for a focal lesion at the ostium of the left circumflex artery (LCX) with a $3.5 \times 12.0$ mm everolimus-eluting Absorb bioresorbable vascular scaffold (BVS) (Abbott Vascular, Santa Clara, California). This was followed by post-dilation with a $3.5$-mm double-layered OPN NC (SIS Medical AG, Winterthur, Switzerland), which allowed super high-pressure dilation (presumed balloon diameter: $3.85$ mm at $30$ atm) (Figs. 1A and 1B). Post-procedural optical coherence tomography (OCT) showed excellent results without evidence of scaffold disruption (Figs. 1a to 1h). At 6 months, the patient underwent repeat coronary angiography due to recurrence of exertional angina. This showed severe focal restenosis of the BVS at LCX ostium (Figs. 1C and 1D). The OCT revealed significant neointimal hyperplasia within a disrupted (Figs. 1b to 1e) and

FIGURE 1 Comparison of Angiographic and OCT Images After Index Procedure and at 6-Month Follow-Up

(A) Pre-procedural angiogram demonstrating a focal lesion at left circumflex artery (LCX) ostium (arrow) and a patent drug-eluting stent (DES) previously implanted in the ostial left anterior descending artery (LAD). (B) Post-procedural angiogram showing an excellent result after implantation of a $3.5 \times 12.0$ mm bioresorbable vascular scaffold (BVS) with satisfactory lesion preparation, followed by post-dilation with a $3.5$-mm noncompliant balloon. (C) The 6-month follow-up angiogram showing a focal severe BVS restenosis at LCX ostium. (D) The 6-month follow-up angiogram after gentle pre-dilation with a $2.0$-mm balloon performed to allow adequate contrast flush through the tight stenosis, in order to obtain optical coherence tomography (OCT) images. (a) Adequate BVS expansion and good positioning with minimal protrusion of the proximal BVS edge into left main artery (LM). (b) Small neo-carina created with BVS and old DES struts (arrowheads). (c) Scaffold diameter (SD) and scaffold area (SA) were $3.03/3.14$ mm and $7.45$ mm², respectively. (d to g) Adequate BVS expansion without evident disruption. (h) OCT longitudinal view showing good positioning and adequate expansion of the BVS. (a) Elliptical deformation of the BVS. (b) Overlapping BVS struts suggesting disruption (arrow). Intimalization of the small neo-carina created with BVS and DES struts (arrowheads). (c) Recoil of the BVS. SD and SA were $2.26/2.71$ mm and $5.01$ mm², respectively. (d) Complete BVS disruption resulting in overlapping struts (arrow) as well as segmental absence of BVS struts (arrowheads). (e) Overlapping BVS struts suggesting disruption (arrow). (f and g) Acceptable lumen and scaffold areas without evidence of BVS disruption, at a distance $>8$ mm from the LCX ostium. (h) OCT longitudinal view, showing a focal restenosis at LCX ostium. SB = side branch. Continued on the next page.
severely recoiled scaffold (reduction in scaffold area from 7.45 mm$^2$ to 5.01 mm$^2$ in Figs. 1c and 1c). Because of a concomitant significant lesion at distal left main artery ([LM]; lumen area: 3.98 mm$^2$), the T-stenting technique was successfully performed with a 3.5 × 18.0 mm BVS from the LM into the left anterior descending artery and a 3.0 × 12.0 mm drug-eluting stent in the LCX ostium.

One of the potential causes for BVS disruption is stent overexpansion, which should be avoided as BVS distensibility is up to 0.5 mm (1). However, this was not the cause in this case, as we chose an appropriately sized noncompliant balloon for post-dilation and confirmed no evidence of BVS overexpansion or disruption at post-procedural OCT. Another possible cause for the delayed disruption observed in this case is the anatomical location at the LCX ostium, where even conventional metallic stents have failed to produce consistent favorable outcomes (2). This fact may be attributed to the acute angulation and hinge motion at LM to LCX, where a stent/scaffold is subjected to torsion, flexion, and rotational forces (3–5) that may lead to stent/scaffold fatigue, fracture, and subsequent restenosis or thrombosis at follow-up. This hypothesis is supported by the fact that BVS disruption was not observed at the distal part of the BVS (Figs. 1f and 1g) but rather at its proximal part, just at the LCX ostium (Figs. 1b to 1e).

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Transcatheter aortic valve replacement (TAVR) is an established and accepted therapeutic option for both inoperable and high-risk surgical patients with severe aortic stenosis. Precise prosthetic valve positioning in the 3-dimensional (3D) aortic annulus is a critical component of a successful TAVR procedure. Improper positioning of the prosthetic valve (e.g., too high or too low in the annulus) may result in device embolization, coronary obstruction, or paravalvular leak. Proper valve positioning is best achieved by working in a 2-dimensional x-ray fluoroscopic view that is perpendicular to the native valve/annulus (e.g., the “coplanar view”). Various imaging techniques and modalities, including standard aortic root x-ray angiography, multidetector computed tomography, and 3D angiographic reconstructions of the aortic root generated by rotational C-arm x-ray angiography,

**FIGURE 1** Steps in Determining TAVR Coplanar View Using 3D Echo-X-Ray Navigation

(A) The integrated marking feature allows for the placement of a colored “marker” to highlight a particular structure or target. Colored markers are placed on or near the center of each of the coronary cusps in the en face 2-dimensional view (right panel). (B) In the long-axis view, the 3 colored markers are individually dragged (table side control, using a standard wireless computer mouse) such that each is aligned at or near the level of the aortic annulus (left panel). These 2 separate steps result in the colored markers approximating the center (en face location) and nadir (long-axis location) of each coronary cusp of the native aortic valve. (C) The x-ray fluoroscopic gantry can then be rotated by the operator to a position such that the 3 colored markers (corresponding to the approximate locations of the 3 coronary cusps in 3D space) are aligned (noncoronary cusp [NCC], right coronary cusp [RCC], and left coronary cusp [LCC] from left to right on the screen; white line) and coplanar in fluoroscopy (in this case a left anterior oblique 7, caudal 4 projection). (D) X-ray angiography confirms the optimal angiographic deployment view for the x-ray gantry determined by coplanar marker alignment (white line) in the 3D echo-X-ray navigation, demonstrating an appropriate angiographic deployment view for use during TAVR. (E) Immediately after TAVR and during sinus rhythm, the colored markers remain in coplanar alignment to the aortic annulus while the final valve orientation confirms an ideal optimal angiographic deployment projection. The green check mark (C to E) depicts the head of the transesophageal echocardiography probe that has been automatically co-registered with the x-ray system.