## **IMAGES IN INTERVENTION**

## Longitudinal Elongation, Axial Compression, and Effects on Strut Geometry of Bioresorbable Vascular Scaffolds



## Insights From 2- and 3-Dimensional Optical Coherence Tomography Imaging

Yohei Ohno, MD,\* Guilherme F. Attizzani, MD,\*† Davide Capodanno, MD, PHD,\*‡ Claudia I. Tamburino, MD,\* Giovanni Longo, MD,\* Yusuke Fujino, MD,§ Piera Capranzano, MD, PHD,\*‡ Corrado Tamburino, MD, PHD\*‡

Recently described, metallic drug-eluting stent longitudinal distortion is a mechanical phenomenon that leads to stent compression and strut separation ("pseudofracture") during percutaneous coronary intervention (1). Conversely, bioresorbable vascular scaffolds (BVS; Absorb, Abbott Vascular, Santa Clara, California) implantation may be associated with scaffold elongation (i.e., longitudinal stretching), but the mechanisms associated with this phenomenon are still not completely elucidated (2). Herein, we report 2 representative cases that further refine the description of its mechanisms.

Two patients underwent uneventful implantation of BVS because of unstable angina. Optical coherence tomography (OCT) (Ilumien, St. Jude Medical, Saint Paul, Minnesota) assessments were performed after BVS deployment. None of the cases underwent balloon post-dilation. One patient in whom a 3.0  $\times$ 18-mm BVS was implanted at 16 atm revealed a BVS length by OCT of 20.6 mm (14.4% longer than predicted by nominal length); in addition, this patient demonstrated reduced thickness of BVS struts (mean strut thickness 131  $\pm$  7 µm) (Figure 1). Conversely, the other patient had a 3.5  $\times$  18-mm BVS implanted at 10 atm, and no elongation compared with the predicted length was revealed by OCT evaluation (i.e., OCT measured length 18 mm); furthermore, the thickness of the struts was larger compared with the elongated scaffold (mean strut thickness 154  $\pm$  2 µm, similar to the value provided by the manufacturer of 156 µm) (**Figure 1**).

Although elongation occurred without compromising scaffold strut integrity in this early experience (i.e., neither disruption nor fracture were revealed), we hypothesized that BVS longitudinal stretching could be associated with a reduction in scaffold strut thickness, as well as with alteration in the scaffold cell conformation, as herewith demonstrated by high-resolution intravascular imaging. Although we acknowledge that the clinical impact of elongation and alteration in scaffold cell conformation deserves further investigation, we speculate that it might affect the following scenarios during BVS implantation: 1) bifurcations (i.e., impairment of side branch access); 2) ostial lesions (i.e., protruding the scaffold into the left main coronary artery or in the aorta

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From the \*Division of Cardiology, Ferrarotto Hospital, University of Catania, Catania, Italy; †Harrington Heart and Vascular Institute, University Hospitals, Case Medical Center, Cleveland, Ohio; ‡Excellence Through Newest Advances (ETNA) Foundation, Catania, Italy; and the §New Tokyo Hospital, Chiba, Japan. Dr. Attizzani has received consulting fees from Medtronic and St. Jude Medical, Inc. Dr. Tamburino has received speaker honoraria from Abbott Vascular. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose. Drs. Ohno and Attizzani contributed equally to this work.



In **A**, one can depict the elongated (compared with nominal length) scaffold, whereas axial compression (mean strut thickness  $131 \pm 7 \mu m$ ) of the struts compared with the nonelongated scaffold is revealed in **B** and **C**. Notably, 3-dimensional (3-D) reconstruction (**D**) demonstrates alteration in scaffold cell conformation compared with the 3-D reconstruction of nonelongated scaffold (**H**). The nonelongated scaffold is demonstrated in **E**, whereas **F** and **G** show noncompressed struts (i.e., mean strut thickness  $154 \pm 2 \mu m$ ). OCT = optical coherence tomography.

without intention to do so); 3) overlapping (i.e., performing longer overlapping than expected); and 4) eventually leading to longitudinal geographic miss (i.e., landing the scaffold in a diseased region distal or proximal to the target landing zone).

**REPRINT REQUESTS AND CORRESPONDENCE**: Dr. Yohei Ohno, Division of Cardiology, Ferrarotto Hospital, University of Catania, Via Citelli 29, Catania 95124, Italy. E-mail: y-ohno@umin.ac.jp.

## REFERENCES

**1.** Williams P, Mamas M, Morgan K, et al. Longitudinal stent deformation: a retrospective analysis of frequency and mechanisms. EuroIntervention 2012;8:267-74. **2.** Attizzani GF, Ohno Y, Capodanno D, et al. New insights on acute expansion and longitudinal elongation of bioresorbable vascular scaffolds in-vivo and at bench test: a note of caution on reliance to compliance charts and nominal length. Catheterization Cardiovasc Interv 2015;85:E99-107.

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