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Very Late Scaffold Thrombosis

Intracoronary Imaging and Histopathological and Spectroscopic Findings

Lorenz Räber, MD, PhD,* Salvatore Brugaletta, MD, PhD,† Kyohei Yamaji, MD, PhD,* Crochan J. O'Sullivan, MD,‡ Shuji Otsuki, MD,† Tobias Koppara, MD,§ Masanori Taniwaki, MD,* Yoshinobu Onuma, MD, PhD,‖ Xavier Freixa, MD,† Franz R. Eberli, MD,‡ Patrick W. Serruys, MD, PhD,¶ Michael Joner, MD,§ Manel Sabaté, MD, PhD,† Stephan Windecker, MD*

ABSTRACT

BACKGROUND Bioresorbable scaffolds provide transient lumen support followed by complete resorption.

OBJECTIVES This study examined whether very late scaffold thrombosis (VLScT) occurs when resorption is presumed to be nearly complete.

METHODS Patients with VLScT at 3 tertiary care centers underwent thrombus aspiration followed by optical coherence tomography (OCT). Thrombus aspirates were analyzed by histopathological and spectroscopic examination.

RESULTS Between March 2014 and February 2015, 4 patients presented with VLScT at 44 (case 1), 19 (cases 2 and 4), and 21 (case 3) months, respectively, after implantation of an Absorb Bioresorbable Vascular Scaffold 1.1 (Abbott Laboratories, Abbott Park, Illinois). At the time of VLScT, all patients were taking low-dose aspirin, and 2 patients were also taking prasugrel. OCT showed malapposed scaffold struts surrounded by thrombus in 7.1%, 9.0%, and 8.9% of struts in cases 1, 2, and 4, respectively. Scaffold discontinuity with struts in the lumen center was the cause of malapposition in cases 2 and 4. Uncovered scaffold struts with superimposed thrombus were the predominant findings in case 3. OCT percent area stenosis at the time of VLScT was high in case 1 (74.8%) and case 2 (70.9%) without evidence of excessive neointimal hyperplasia. Spectroscopic thrombus aspirate analysis showed persistence of intracoronary polymer fragments in case 1.

CONCLUSIONS VLScT may occur at advanced stages of scaffold resorption. Potential mechanisms specific for VLScT include scaffold discontinuity and restenosis during the resorption process, which appear delayed in humans; these findings suggest an extended period of vulnerability for thrombotic events. (J Am Coll Cardiol 2015;66:1901–14)

From the *Swiss Cardiovascular Center Bern, Department of Cardiology, Bern University Hospital, Bern, Switzerland; †Cardiology Department, Thorax Institute, IDIBAPS, Hospital Clinic, University of Barcelona, Barcelona, Spain; ‡Cardiology Department, Triemlispital, Zurich, Switzerland; §CvPath Institute, Gaithersburg, Maryland; ‖Thoraxcenter, Erasmus University Hospital, Rotterdam, the Netherlands; and the ¶International Centre for Cardiovascular Health, Imperial College London, London, United Kingdom. This study was supported by institutional grants and a grant from the Swiss National Science Foundation (33CM30_140336 I 1). Dr. Räber is on the advisory board of Abott Vascular; and received speaker fees from St. Jude Medical. Drs. Windecker, Sabaté, and Serruys have received research grants and speaker fees from Abbott Vascular. Dr. Windecker has received speaker's honoraria from AstraZeneca, Eli Lilly, Boston Scientific, Biosensors, Biotronik, Medtronic, and Edwards; and has received grants to the institution from Abbott Vascular, Boston Scientific, Biosensors, Biotronik, Medtronic, and Edwards. Dr. Onuma is on the advisory board of Abbott Vascular. Dr. Freixa is a proctor for St. Jude Medical. Dr. Eberli has received institutional grants from Abbott Vascular, Biotronik, and Terumo. Dr. Joner has received institutional grants from Abbott Vascular, Biosensors, Biotronic, Boston Scientific, CeloNova, Medtronic, MicroPort, Stentys, OrbusNeich Medical, SINO Medical Technology, Terumo, and W.L. Gore. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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ABBREVIATIONS AND ACRONYMS

BVS = bioresorbable vascular scaffold

CAD = coronary artery disease

DAPT = dual antiplatelet therapy

DES = drug-eluting stent(s)

IR = infrared

LCX = left circumflex artery

OCT = optical coherence tomography

RVD = reference vessel diameter

VLScT = very late scaffold thrombosis

VLST = very late stent thrombosis

Metallic drug-eluting stents (DES) have improved clinical outcomes of patients undergoing percutaneous coronary interventions (PCIs) compared with balloon angioplasty and bare-metal stents (1). Although newer-generation metallic DES have further advanced the safety and efficacy profile compared with first-generation devices (2–4), the persistence of a metallic cage has been suggested to prevent complete arterial healing. Fully bioresorbable scaffolds have been introduced into clinical practice (5), with the objectives of preserving native vessel geometry, providing for adaptive vessel remodeling with late lumen gain (6), restoring physiological vasomotion (7), and avoiding late adverse events including restenosis and thrombosis (8).

SEE PAGE 1915

The Absorb bioresorbable vascular scaffold (BVS) (Abbott Laboratories, Abbott Park, Illinois) consists of a poly (L-lactide acid) (PLLA) polymer backbone, a coating layer of poly (D,L-lactide acid), and the antirestenotic drug everolimus. The clinically available Absorb BVS 1.1 has in-phase zigzag hoops linked with bridges, providing improved vessel wall support and delayed resorption to preserve the mechanical integrity over at least 6 months (9,10). The Absorb BVS 1.1 has been compared with newer-generation metallic DES in 2 randomized trials to date. In the EVERBIO II (second Everolimus-Versus Biolimus-Eluting Stents in All-Comers) study, similar efficacy was seen at 9-month angiographic follow-up for the Absorb BVS as with the combined group receiving either a metallic everolimus-eluting stent (Promus Element, Boston Scientific Corporation, Marlborough, Massachusetts) or a biodegradable polymer biolimus-eluting stent (Biomatrix Flex, Biosensors International, Singapore) (11). Similar clinical efficacy at 1 year was also reported in the ABSORB II trial (A Clinical Evaluation of the Bioabsorbable Everolimus Eluting Coronary Stent System in the Treatment of Patients With de Novo Native Coronary Artery Lesions) comparing metallic everolimus-eluting stents with the Absorb BVS (12). Several reports have described the occurrence of predominantly early scaffold thrombosis, potentially related to the strut thickness of 150 μm and highlighting technical considerations regarding lesion preparation, scaffold expansion, and optimal antiplatelet therapy (13–15). Conversely, very late scaffold thrombosis (VLScT), more than 1 year after device implantation, has been reported only in isolated case reports (16–18). We aimed to characterize fully 4 cases of VLScT observed at 3 tertiary care centers by means of quantitative coronary angiography (QCA), optical coherence tomography (OCT), histopathological examination, and spectroscopic analysis of thrombus aspirates.

METHODS

All patients presenting with very late (>1 year) scaffold thrombosis after BVS (Absorb BVS 1.1, Abbott Vascular, Santa Clara, California) implantation at Bern University Hospital, Switzerland, Triemlispital, Zurich, Switzerland, and University Hospital Clinic of Barcelona, Spain were included in the present study and underwent quantitative coronary angioplasty analysis (all cases), OCT after thrombus aspiration (all cases), and histopathological (cases 1 to 3) and spectroscopic assessment (case 1) of the thrombus aspirate.

OPTICAL COHERENCE TOMOGRAPHY. OCT was performed using a commercially available system (C7-XR, Dragon Fly, LightLab, St. Jude Medical, St. Paul, Minnesota). All recorded data were sent to a core laboratory (Bern University Hospital, Switzerland) and were analyzed by a group of 3 experienced analysts (L.R., K.Y., M.T.) at an interval of 0.2 mm by using dedicated software (QCU-CMS version 4.69, LKEB, Leiden University, the Netherlands).

The lumen contour was drawn by semiautomated detection using QCU-CMS software, following the endoluminal contour of the neointima with manual correction wherever required. In case of thrombus with low attenuation, the lumen contour could still be drawn. In case of high attenuation, the lumen contour was extrapolated when the lumen contour was visible in at least 3 quadrants. The scaffold area was measured by joining the middle points of the signal-poor core of the abluminal side of the struts if at least 1 strut was clearly visible in every quadrant. Distal and proximal reference area and scaffold expansion were calculated as previously reported by the MUSIC (Multicenter Ultrasound Stenting in Coronaries) investigators (6). The neointimal thickness was measured from the abluminal border of the black strut core to the lumen. Uncovered struts were defined in the absence of a homogenous coverage by neointima. If the apposed struts were not covered by neointima but rather by irregular tissue, struts were categorized as “apposed uncovered with superimposed thrombus.” Malapposed struts were defined as struts where the abluminal surface was clearly separated from the vessel wall.