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Safety and clinical performance of a drug eluting absorbable metal scaffold in the treatment of subjects with de novo lesions in native coronary arteries: Pooled 12-month outcomes of BIOSOLVE-II and BIOSOLVE-III

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Abstract

Objectives: Based on outcomes of the BIOSOLVE-II study, a novel second generation drug-eluting absorbable metal scaffold gained CE-mark in 2016. The BIOSOLVE-III study aimed to confirm these outcomes and to obtain additional 12-month angiographic data.

Background: Bioresorbable scaffolds are intended to overcome possible long-term effects of permanent stents such as chronic vessel wall inflammation, stent crushing, and fractures.

Methods: The prospective, multicenter BIOSOLVE-II and BIOSOLVE-III studies enrolled 184 patients with 189 lesions (123 patients in BIOSOLVE-II and 61 patients in BIOSOLVE-III). Primary endpoints were in-segment late lumen loss at 6 months (BIOSOLVE-II) and procedural success (BIOSOLVE-III).

Results: Mean patient age was 65.5 ± 10.8 years and mean lesion reference diameter was 2.70 ± 0.43 mm. In BIOSOLVE-III, there were significantly more type B2/C lesions than in BIOSOLVE-II (80.3% versus 43.4%, $P < 0.0001$) and significantly more moderate-to-severe calcifications (24.2% versus 10.7%, $P = 0.014$). At 12 months, there was no difference in late lumen loss between the two studies; in the overall population, it was 0.25 ± 0.31 mm in-segment and 0.39 ± 0.34 mm in-scaffold. Target lesion failure occurred in six patients (3.3%) and included two cardiac deaths, one target-vessel myocardial infarction, and three clinically driven target lesion revascularizations. No definite or probable scaffold thrombosis was observed.

Conclusion: The pooled outcomes of BIOSOLVE-II and BIOSOLVE-III provide further evidence on the safety and performance of a novel drug-eluting absorbable metal scaffold with constant clinical and angiographic performance parameters at 12 months and no definite or probable scaffold thrombosis.

KEYWORDS

clinical trials, coronary artery disease, percutaneous coronary intervention (PCI), stent bioabsorbable, stent restenosis, thrombosis

1 | INTRODUCTION

Bioresorbable vascular scaffolds (BRS) were developed to overcome some of the possible long-term effects of permanent stents. The absence of a permanent caged vessel segment might reduce effects such as chronic vessel wall inflammation, stent crushing, and fractures, preserve options of noninvasive vessel lumen imaging, and facilitate surgical or percutaneous repeat coronary revascularization [1–3].

The second generation drug-eluting absorbable metal scaffold (DREAMS 2G, Biotronik AG, Buelach, Switzerland) was successfully tested in the BIOSOLVE-II study and the device gained CE-mark in June 2016. The aim of BIOSOLVE-III was to confirm the positive outcomes of BIOSOLVE-II with the commercial, slightly modified product (now being called Magmaris) and to collect additional 12-month angiographic data. These data are highly relevant as 12 months reflect the end of the absorption time [4].

2 | MATERIALS AND METHODS

2.1 | Study design and population

The study designs of BIOSOLVE-II and BIOSOLVE-III have been previously described [5]. In brief, BIOSOLVE-II and BIOSOLVE-III are prospective, multicenter studies assessing the safety and performance of DREAMS 2G in de novo lesions at 13 (BIOSOLVE-II) and 8 (BIOSOLVE-III) centers in Europe, South America, and Asia. From October 2013 to May 2015, 123 patients were enrolled in BIOSOLVE-II, and from March to September 2016, 61 patients were enrolled in BIOSOLVE-III. The study conduct was in compliance with the Declaration of Helsinki, Good Clinical Practice, ISO14155, the studies were approved by the institutional ethics committees, and all patients provided written informed consent prior to any study procedures.

Inclusion and exclusion criteria are listed at ClinicalTrials.gov (NCT01960504 and NCT02716220). The main inclusion criteria were stable or unstable angina or documented silent ischemia, a maximum of two single *de novo* lesions in two separate coronary arteries, reference vessel diameter of 2.2–3.7 mm for device diameters of 2.5 to 3.5 mm, lesion length ≤21 mm, and a diameter stenosis ≥50% and <100%. Main exclusion criteria were severe calcification, three-vessel disease, ostial target lesions within 5 mm of vessel origin, target lesions involving a side branch >2 mm, target lesion located in or supplied by an arterial or venous bypass graft, and unsuccessful predilatation.

Both studies had clinical follow-ups at 1, 6, 12, 24, and 36 months. Angiographic follow-up was scheduled at 6 months for BIOSOLVE-II and at 12 months for BIOSOLVE-III. Furthermore, angiographic data at 36 months will be collected in BIOSOLVE-II. If additional angiographic follow-ups were performed, this information was collected as well.

2.2 | Study device

DREAMS 2G has been described previously [4]. It is made from magnesium alloy scaffold with a strut thickness and width of 150 μm. The scaffold is covered by sirolimus in combination with a bioresorbable PLLA-polymer, the same drug–polymer combination that is successfully used in the commercially available Orsiro drug-eluting stent (Biotronik AG, Buelach, Switzerland) [6–8]. The device was available in diameters of 2.5, 3, and 3.5 mm and length of 15, 20, and 25 mm for BIOSOLVE-II, and diameters of 3 and 3.5 mm, and length of 15, 20, and 25 mm for BIOSOLVE-III.

2.3 | Endpoints

The primary endpoints were late lumen loss at 6-month follow-up (BIOSOLVE-II) and procedure success (BIOSOLVE-III). Procedure success was defined as final diameter stenosis of <30% by quantitative coronary angiography without occurrence of in-hospital death, Q-wave or non-Q-wave myocardial infarction or repeat target lesion revascularization (TLR). Secondary endpoints were target lesion failure, a composite of cardiac death, target vessel Q-wave and non-Q-wave myocardial infarction according to the Society for Cardiovascular Angiography and

FIGURE 1 Study flow-chart.*Two patients of BIOSOLVE-II did not receive an implant and counted for procedural success only

Interventions definitions [9], or clinically driven TLR; and scaffold thrombosis [10]. Secondary angiographic endpoints were in-segment and in-scaffold binary restenosis rate, diameter stenosis, and late lumen loss. A clinical event committee adjudicated all adverse events, and angiographic data were analyzed by an independent core laboratory. Endpoints up to 6 months have been reported previously [4,5].

2.4 | Procedure

Predilatation was mandatory. The size of the predilatation balloon had to be $\leq$0.5 mm smaller than the reference vessel diameter but not larger than the reference vessel; its length had to be shorter or the same as the lesion length. Only one study device per lesion was allowed, although in bailout situations a second DREAMS 2G could be used, and, in case of failure, an Orsiro drug-eluting stent. Postdilatation could be performed at the discretion of the investigator, but the maximum inner diameter of the DREAMS 2G (as indicated on the label) was not allowed to be exceeded. In addition, the postdilatation balloon had to be shorter than the scaffold. Dual antiplatelet therapy was recommended for a minimum of 6 months.

If no scaffold could be implanted, the patient counted for procedure success only, but was excluded from further follow-up.

2.5 | Statistical analysis

Data are presented using descriptive statistical methods. For continuous variables, means $\pm$ standard deviations are presented, and for categorical data, absolute and relative frequencies. For clinical outcomes at 12 months, the follow-up time window of 30 days was considered and the denominator was based on patients with either follow-up assessment or a respective clinical event. When appropriate, 95% confidence intervals were calculated. Comparisons amongst the groups were done using the Fisher's exact, Chi-Squared or Wilcoxon signed rank tests. All statistical analyses were performed with SAS 9.4 (SAS Institute, Cary, NC, USA).

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3 | RESULTS

Of 184 patients with 189 lesions enrolled in BIOSOLVE-II and BIOSOLVE-III, the scaffold could not be implanted in two patients of BIOSOLVE-II because of insufficient predilatation. From the remaining patients, data at 12 months were available in all but two (Figure 1).

TABLE 1 Baseline clinical and lesion characteristics

	Overall *N* = 184	BIOSOLVE-II *N* = 123	BIOSOLVE-III *N* = 61	p-value
Mean age, years	65.5 $\pm$10.8	65.2 $\pm$ 10.3	66.3 $\pm$ 11.8	0.487
Male gender	117 (63.6)	78 (63.4)	39 (63.9)	0.945
Hypertension	146 (79.3)	101 (82.1)	45 (73.8)	0.188
Hypercholesteremia	114 (62)	74 (60.2)	40 (65.6)	0.477
Diabetes	46 (25)	36 (29.3)	10 (16.4)	0.058
Insulin dependent	12 (26.1)	11 (30.6)	1 (10)	0.252
Noninsulin dependent	34 (73.9)	25 (69.4)	9 (90)	
History of smoking	102 (55.4)	67 (54.5)	35 (57.4)	0.709
Previous percutaneous coronary interventions	76 (41.3)	52 (42.3)	24 (39.3)	0.704
History of myocardial infarction	43 (23.4)	29 (23.6)	14 (23)	0.925
History of stroke or TIA	11 (6)	7 (5.7)	4 (6.6)	>0.999
Cancer	17 (9.2)	10 (8.1)	7 (11.5)	0.461

Abbreviations: AHA/ACC, American Heart Association/American College of Cardiology; CABG, coronary artery bypass graft; TIA, transient ischemic attack.
Data are shown as mean $\pm$ SD or *n* (%).

TABLE 2 Quantitative coronary analysis and procedural details

Preprocedure	Overall N = 189	BIOSOLVE-II N = 123	BIOSOLVE-III N = 66	p-value
Target vessel				0.568
LAD	79 (41.8)	47 (38.2)	32 (48.5)	
LCX	43 (22.8)	29 (23.6)	14 (21.2)	
RCA	64 (33.9)	45 (36.6)	19 (28.8)	
RI	3 (1.6)	2 (1.6)	1 (1.5)	
Lesion class				**<0.0001**
Type A	4 (2.1)	1 (0.8)	3 (4.5)	
Type B1	78 (41.5)	68 (55.7)	10 (15.2)	
Type B2	90 (47.9)	51 (41.8)	39 (59.1)	
Type C	16 (8.5)	2 (1.6)	14 (21.2)	
Calcification				**0.014**
Little or none	159 (84.6)	109 (89.3)	50 (75.8)	
Moderate to heavy	29 (15.4)	13 (10.7)	16 (24.2)	
Lesion angulation				**0.0002**
Severe bend	2 (1.1)	0 (0)	2 (3)	
Moderate	18 (9.6)	5 (4.1)	13 (19.7)	
None	168 (89.4)	117 (95.9)	51 (77.3)	
Bifurcation lesion	15 (8)	2 (1.6)	13 (19.7)	**<0.0001**
Thrombus present	4 (2.1)	3 (2.5)	1 (1.5)	>0.9999
DS, %	54 ± 11.3 [52.3;55.6]	55.2 ± 10.3 [53.3;57.1]	51.6 ± 12.7 [48.4;54.8]	0.053
Lesion length, mm	12.6 ± 5.1 [11.8;13.3]	12.6 ± 4.5 [11.8;13.4]	12.5 ± 6 [11;14]	0.463
MLD, mm	1.22 ± 0.35 [1.17;1.27]	1.19 ± 0.32 [1.14;1.25]	1.27 ± 0.40 [1.17;1.37]	0.132
RVD, mm	2.70 ± 0.43 [2.64;2.76]	2.68 ± 0.40 [2.61;2.75]	2.74 ± 0.49 [2.62;2.86]	0.711
Procedure	**N = 189**	**N = 123**	**N = 66**	
Predilatation	189 (100)	123 (100)	66 (100)	-
Balloon diameter, mm	2.92 ± 0.37 [2.87;2.97]	2.87 ± 0.36 [2.81;2.93]	3.02 ± 0.37 [2.94;3.11]	**0.006**
Max pressure, atm	14.7 ± 4.2 [14.1;15.2]	14.8 ± 4.4 [14.1;15.5]	14.4 ± 3.9 [13.50;15.29]	0.618
Cum. inflation time, sec	20.8 ± 18.3 [18.4;23.3]	20.5 ± 18.6 [17.5;23.6]	21.4 ± 17.8 [17.3;25.5]	0.657
Scaffold				
Length, mm	20.7 ± 3.2 [20.2;21.1]	21.4 ± 2.3 [21.0;21.8]	19.5 ± 4.2 [18.5;20.4]	**0.0003**
Diameter, mm	3.18 ± 0.26 [3.15;3.22]	3.13 ± 0.25 [3.08;3.17]	3.28 ± 0.25 [3.22;3.34]	**<0.0001**
Max pressure, atm	14 ± 2.3 [13.7;14.3]	14 ± 2.4 [13.6;14.4]	14 ± 2.1 [13.5;14.5]	0.727
Inflation time, sec	26.9 ± 16.6 [24.5;29.2]	24 ± 15.9 [21.2;26.9]	31.8 ± 16.9 [27.8;35.8]	**0.0008**
Postdilatation	129 (69)	74 (61.2)	55 (83.3)	**0.002**
Balloon diameter, mm	3.33 ± 0.38 [3.27;3.40]	3.28 ± 0.39 [3.20;3.37]	3.41 ± 0.37 [3.31;3.51]	0.078
Max pressure, atm	18 ± 4 [17.3;18. 7]	18.1 ± 4.5 [17.1;19]	17.9 ± 3.2 [17.1;18.8]	0.932
Cum. inflation time, sec	26.8 ± 22.8 [23;30.6]	26.7 ± 23.2 [21.7;31.7]	26.9 ± 22.2 [21;32.9]	0.842
Postprocedure	**N = 189**	**N = 123**	**N = 66**	
RVD in-scaffold, mm	2.77 ± 0.40 [2.71;2.83]	2.78 ± 0.36 [2.72;2.85]	2.75 ± 0.47 [2.63;2.86]	0.307
RVD in-segment, mm	2.71 ± 0.40 [2.66;2.77]	2.69 ± 0.39 [2.62;2.76]	2.76 ± 0.43 [2.65;2.86]	0.368
MLD in-scaffold, mm	2.49 ± 0.34 [2.44;2.54]	2.45 ± 0.32 [2.40;2.51]	2.55 ± 0.37 [2.46;2.64]	0.085
MLD in-segment, mm	2.19 ± 0.41 [2.13;2.25]	2.16 ± 0.40 [2.09;2.23]	2.23 ± 0.42 [2.13;2.34]	0.452
Acute gain in-scaffold, mm	1.26 ± 0.40 [1.21;1.32]	1.25 ± 0.35 [1.19;1.31]	1.28 ± 0.47 [1.17;1.40]	0.860
DS in-scaffold, %	9.8 ± 7.3 [8.7;10.8]	11.7 ± 5.2 [10.8;12.6]	6.2 ± 9.3 [3.9;8.5]	**<0.0001**
DS in-segement, %	19.5 ± 7.5 [18.4;20.6]	19.7 ± 8.3 [18.2;21.2]	19.2 ± 5.7 [17.7;20.7]	0.765
12 months	**N = 99**	**N = 45**	**N = 54**	
LLL in-scaffold, mm*	0.39 ± 0.34 [0.32;0.46]	0.39 ± 0.27 [0.30;0.47]	0.39 ± 0.39 [0.29;0.50]	0.830
LLL in-segment, mm*	0.25 ± 0.31 [0.19;0.31]	0.24 ± 0.22 [0.18;0.31]	0.25 ± 0.37 [0.15;0.35]	0.730

(Continues)

TABLE 2 (Continued)

Preprocedure	Overall N = 189	BIOSOLVE-II N = 123	BIOSOLVE-III N = 66	p-value
RVD in-scaffold, mm	2.64 ± 0.44 [2.55;2.72]	2.63 ± 0.41 [2.51;2.75]	2.64 ± 0.47 [2.51;2.77]	0.966
RVD in-segment, mm	2.59 ± 0.48 [2.49;2.68]	2.58 ± 0.44 [2.45;2.72]	2.59 ± 0.51 [2.45;2.73]	0.966
MLD in-scaffold, mm	2.08 ± 0.44 [1.99;2.17]	2.11 ± 0.40 [1.99;2.23]	2.05 ± 0.48 [1.92;2.18]	0.663
MLD in-segment, mm	1.93 ± 0.47 [1.84;2.03]	1.96 ± 0.40 [1.84;2.08]	1.91 ± 0.52 [1.77;2.05]	0.828
DS in-scaffold, mm	21.2 ± 10.9 [19.1;23.4]	19.8 ± 8.8 [17.1;22.4]	22.5 ± 12.3 [19.1;25.8]	0.317
DS in-segment, mm	25.3 ± 12.3 [22.9;27.8]	24 ± 10.7 [20.8;27.2]	26.5 ± 13.5 [22.8;30.2]	0.525
Binary restenosis in-scaffold	3 (3.03)	0 (0)	3 (5.56)	0.249
Binary restenosis in-segment	6 (6.06)	2 (4.44)	4 (7.41)	0.686

Abbreviations: DS, diameter stenosis; LAD, left anterior descending; LCX, left circumflex; LLL, late lumen loss; MLD, minimal lumen diameter; RCA, right coronary artery; RI, Ramus intermedius; RVD, Reference vessel diameter. *LLL was assessed for 97 lesions.
Lesion details are presented per core laboratory assessments. Not all assessments are available for all lesions. Data are shown as mean ± SD or *n* (%), [95%CI].

Patients were 65.5 ± 10.8 years old, 41.3% ($n = 76$) had prior percutaneous coronary interventions and 23.4% ($n = 43$) previous myocardial infarctions (Table 1). Per core laboratory assessment, mean lesion length was 12.6 ± 5.1 mm and mean reference vessel diameter was 2.7 ± 0.43 mm (Table 2). Bifurcation lesions were involved in 8% ($n = 15$) and thrombus in 2.1% ($n = 4$). There was a significant difference between the studies in that far as BIOSOLVE-III patients had significantly more type B2/C lesions (80.3% versus 43.4%, $P < 0.0001$), significantly more lesions with moderate-to-severe calcification (24.2% versus 10.7%, $P = 0.014$), more bifurcation lesions (19.7% versus 1.6%, $P < 0.0001$) and were more severely bend.

Predilatation was performed in all lesions and postdilatation in 69% (129/187). Dual antiplatelet therapy was stopped in 47.7% (84/176) prior to the 12-month follow-up. Figure 2 shows the angina status at baseline and follow-up. No patient was symptom-free at baseline versus 85.8% at 12 months. Stable angina, unstable angina and silent ischemia were present in 13.1%, 0.6%, and 0.6% of patients, respectively.

Angiographic late lumen loss at 12 months was available for 35.5% (43/121) of patients in BIOSOLVE-II (assessment not mandated per protocol) and 88.5% (54/61) in BIOSOLVE-III (Figure 3). It was nearly identical for BIOSOLVE-II and BIOSOLVE-III, and was 0.25 ± 0.31 mm (in-segment) and 0.39 ± 0.34 mm (in-scaffold) in the overall cohort (in-segment late lumen loss of 0.24 ± 0.22 mm in BIOSOLVE-II versus 0.25 ± 0.37 mm in BIOSOLVE-III and in-scaffold late lumen loss of 0.39 ± 0.27 mm versus 0.39 ± 0.39 mm). Of the 11 patients with a second scaffold (10 overlapping, 1 end-to-end), one had a nonclinically driven TLR at 12-month follow-up and for the remaining patients with angiographic follow-up ($n = 5$), mean in-stent late lumen loss was 0.38 ± 0.19 mm and a mean in-segment late lumen loss of 0.17 ± 0.32 mm.

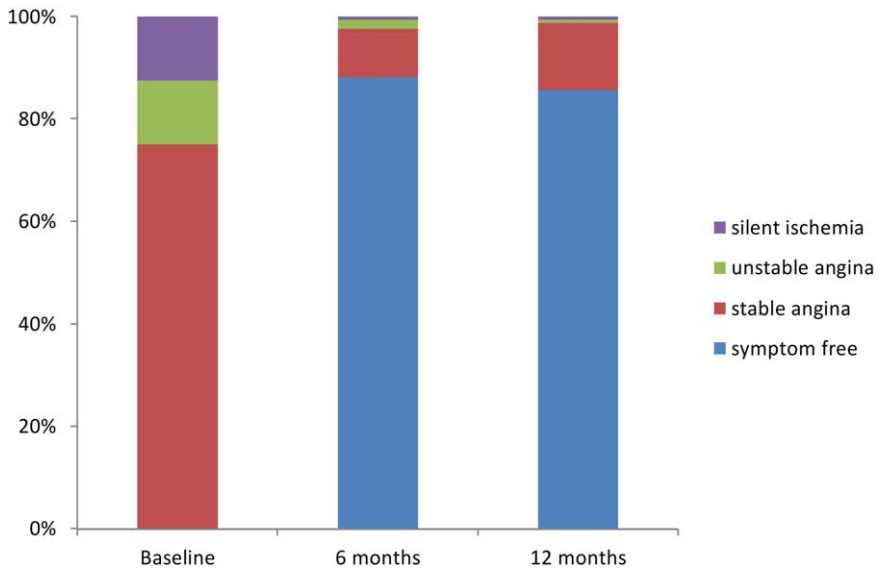

FIGURE 2 Angina status at baseline and 6- and 12-month follow-up. No patient was symptom-free at baseline versus 85.8% at 12-month follow-up

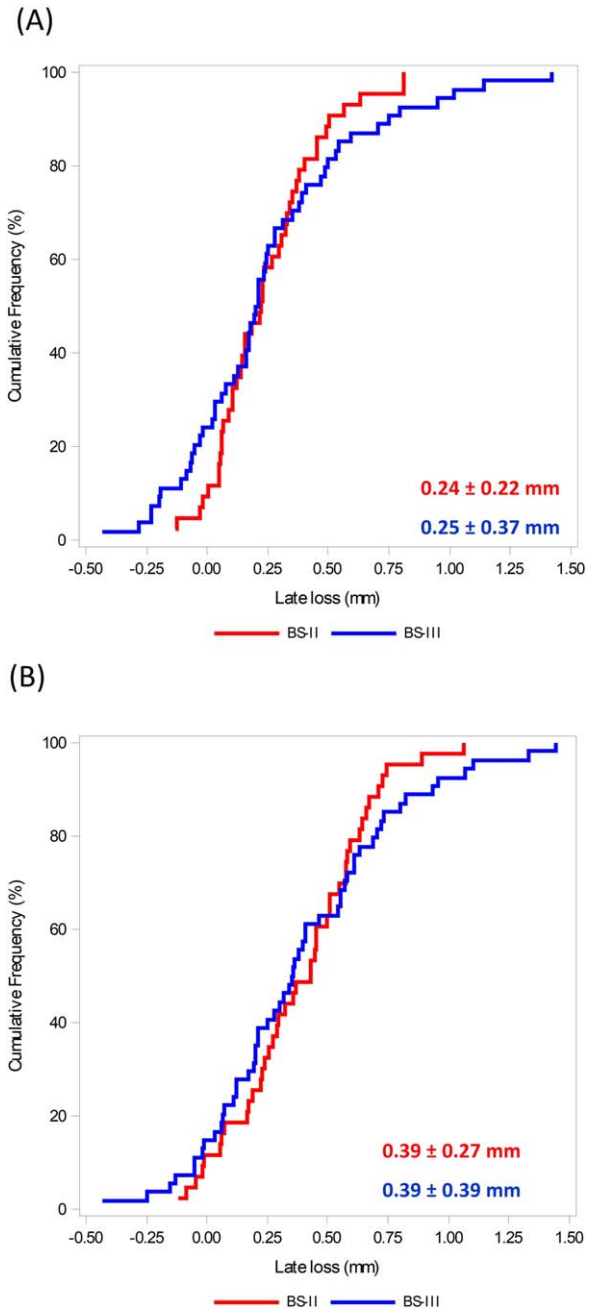

FIGURE 3 In-segment (A) and in-scaffold late lumen loss (B) at 12-month follow-up

Figure 4 shows a case example, which demonstrates the resorption of the device and a homogeneous endothelialization and completion of the healing process despite initial malapposition, dissection, and plaque protrusion.

Target lesion failure was observed in six patients (3.3% [95%CI:1.2;7.1]) (Table 3). Two cardiac deaths (1.1% [95%CI:0.1;4]) occurred, one sudden death on day 2 likely because of ventricular arrhythmia caused by an initial ST-segment myocardial infarction (the autopsy report confirmed the absence of scaffold thrombosis), and one unwitnessed death on day 134). One target-vessel myocardial infarction (0.6%, [95%CI:0;3.1] occurred in the BIOSOLVE-II group and was caused by a temporary no-reflow after scaffold implantation. Three clinically driven TLR (1.7% [95%CI:0.3;4.8]) occurred on postprocedure day 84, 161, and 180, and no additional target lesion failure occurred between 6 and 12 months. Two noncardiac deaths were reported, one on postprocedure day 163 because of cancer and one because of urosepsis with multi-organ failure on day 370.

3.1 | Discussion

Pooled outcomes of the BIOSOLVE-II and BIOSOLVE-III studies further confirm the safety and performance of DREAMS 2G at 12 months with clinical outcomes comparable to contemporary drug-eluting stents. In particular the absence of definite or probable scaffold thrombosis is remarkable. A recent state of the art paper raised concerns related to the higher device thrombosis risks of polymeric BRS within the first few years prior to complete bioresorption [3]. In contrast to current CE-marked drug-eluting polymeric scaffolds with a resorption time up to 3 years, the magnesium scaffold backbone is nearly fully absorbed within one year and at 6 months struts are not discernable by optical coherence tomography (OCT) anymore [3,4,11,12]. Therefore the conclusion of overall safety related to scaffold thrombosis is already justified for DREAMS 2G/Magmaris in this early phase as 12-month outcomes somewhat reflect 3-year outcomes of ABSORB (Abbott Vascular, Santa Clara, California) for which so far, no scaffold thrombosis beyond the resorption period of 3 years was observed in the ABSORB and ABSORB-II studies [3,13,14]. Likewise, the recommended dual antiplatelet therapy for Magmaris is shorter than for polymeric scaffolds as recent state of the art papers discuss a prolonged dual antiplatet therapy covering the complete biodegradation time of the BRS [3,15].

Design features that might support the absence of scaffold thrombosis have been reported previously (e.g., metal-stent-like behavior and laser polishing for a smooth surface facilitating the embedding into the vessel wall, and reducing pulsatile shear stress), as well as OCT outcomes that showed no intraluminal mass and no malapposed struts at 6 and 12 months [4,11,12]. A porcine arterio-venous shunt model demonstrated significantly less platelet adherence, thrombus deposition, and inflammatory cell adhesion for DREAMS 2G compared to ABSORB, and similar results to the Orsiro drug-eluting stent [16]. Furthermore, a study in porcine and rabbit models showed less thrombus formation for DREAMS 2G compared to ABSORB [17].

Performance parameters were assessed using late lumen loss and TLR. Constant late lumen loss between 6 and 12 months has been reported earlier for BIOSOLVE-II [11]. Interestingly, in BIOSOLVE-III, late lumen loss was nearly identical to BIOSOLVE-II despite more complex lesions with significant higher type B2/C lesions and calcification.

No target lesion failure was observed between 6 and 12 months, leading to a 12-month rate of 3.3%. In comparison, in a patient-level pooled meta-analysis including 3389 patients, 12-month target lesion failure was 6.6% for ABSORB, 5.2% for a contemporary everolimus-eluting permanent stent [18], and 5.7% for the 122 patients enrolled in the DESolve trial [19].

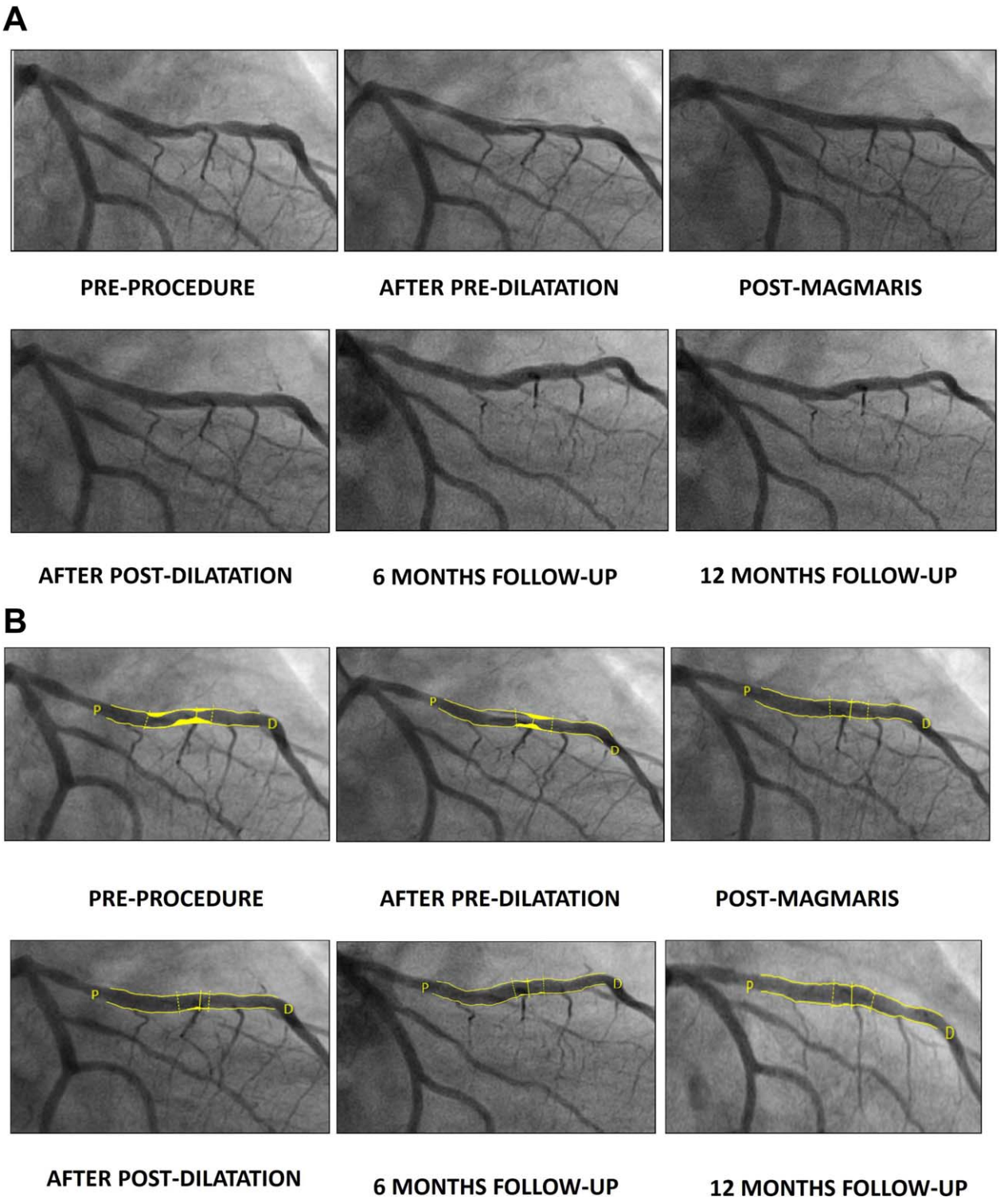

FIGURE 4 Case example. The angiographic assessments in panel (A) and panel (B) shows a mid LAD lesion with adequate lesion preparation in accordance to the "4Ps "with a balloon to artery ratio of 1:1 and achievement of less than 20% residual diameter stenosis. During predilatation a dissection occurred which was covered by the implanted DREAMS 2G (3 × 20 mm). At 6 and 12 months the lumen is well preserved. Optical coherence tomography in panel (C) shows well embedded struts at baseline. At 6 months, struts are hardly discernable anymore and embedded in the vessel wall with homogeneous endothelial coverage. The struts covering the septal branch at baseline disappeared over time. Lumen enlargement between 6 and 12 months is visible in all frames

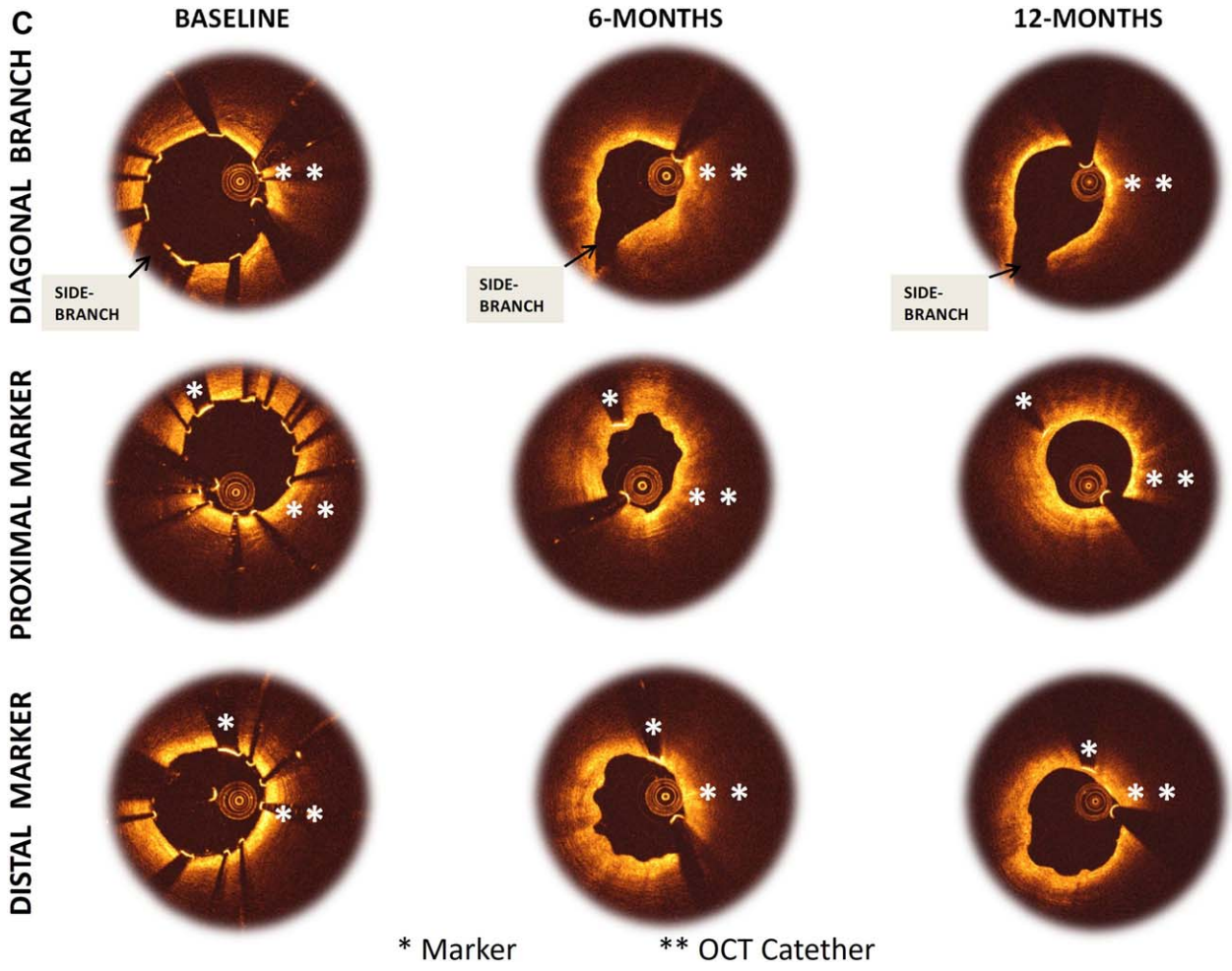

FIGURE 4 Continued

Even though these outcomes are encouraging, it should be appreciated that this is a novel technology requiring meticulous attention to patient selection and implant technique. Proper patient and lesion selection, proper sizing, and predialation and postdilatation ("4P"-strategy), as described in a recent consensus paper is paramount [20]. A summary of the consensus paper together with some current tips are provided below:

Patient and lesion selection: Patients who may benefit from a scaffold are those with a long life expectancy (>5 years), possible return to

TABLE 3 Clinical outcomes at 12-month follow-up

	Overall $N = 180$[a]	BioSolve-II $N = 119$	BioSolve-III $N = 61$	*P*-value
Target lesion failure	6 (3.3)	4 (3.3)	2 (3.3)	0.999
Cardiac death	2 (1.1)	1 (0.8)	1 (1.6)	0.999
TV-myocardial infarction	1 (0.6)	1 (0.8)	0 (0)	0.999
Clinically driven TLR	3 (1.7)	2 (1.7)	1 (1.6)	0.999
Coronary artery bypass graft	0 (0)	0 (0)	0 (00)	-
Death	4 (2.2)	2 (1.7)	2 (3.3)	0.605
Clinically driven TVR	5 (2.8)	4 (3.3)	1 (1.6)	0.664
Scaffold thrombosis				
Definite or probable	0 (0)	0 (0)	0 (0)	-
Possible	1 (0.6)	1 (0.8)	0 (0)	0.999

Abbreviations: TLR, target lesion revascularization; TV, target vessel; TVR, target vessel revascularization.
Data are shown *n* (%).
[a]Two patients had no scaffold implanted and were counted for procedural success only, and two patients had missed visits at follow-up, [b]denominator was 181 as one patient experienced a TLR, but had no 12-month visit..

vasomotion, no previous coronary interventions, discrete shorter lesions to be covered with a single scaffold and compliance to dual antiplatelet therapy. Currently, patients without adequate lesion preparation after predilatation, patients with a thrombus at the lesion site, with acute myocardial infarction, or for whom proper sizing cannot be achieved should not be treated.

Proper sizing: is mandatory as only accurate adjustment of vessel and scaffold diameter allows for well apposed struts and underestimation may require exceeding the maximal expansion diameter for postdilatation which may adversely affect the mechanical support of the scaffold. If uncertain, quantitative coronary angiography (QCA), intravascular ultrasound (IVUS), or OCT should be used. Thereby it should be kept in mind that QCA underestimates and IVUS overestimates true vessel dimensions by about 0.25 mm.

Predilatation: should be done with a noncompliant balloon with a 1:1 balloon-to-artery ratio until full expansion; residual diameter stenosis should be $\leq$20% (minimum 2.5 mm).

Implantation: Implanting balloon inflation should be done until full and homogenous expansion, but maximum rated burst pressure should be respected. QCA should be used to control the implant results; OCT or IVUS is useful during the learning phase.

Postdilatation is helpful optimizing scaffold strut embedding to limit shear stress related thrombus formation [21]. It should be done with a noncompliant balloon at $>$16 atm with the same or maximally 0.5 mm larger diameter compared to the Magmaris scaffold. Image enhancement technologies or marker wires help identifying the Magmaris markers; a change of projection plane may also be helpful.

3.2 | Limitations

Our series has potential limitations, (a) the fact that predominantly patients with limited clinical complexity and short lesions were included restricts the study interpretation to these patient and lesion characteristics, (b) as angiographic follow-up at 12 months was not mandatory, 12-month late lumen loss of only 35.5% of BIOSOLVE-II patients is available, (c) the implantation technique varied from the current "4P" strategy, (d) the lack of control hampers the comparison to other devices, and (e) patient numbers are not sufficient for a robust assessment of rare events such as scaffold thrombosis. Results need to be confirmed in larger patient series such as the currently enrolling BIOSOLVE-IV registry.

3.3 | Conclusion

Twelve-month data of BIOSOLVE-II were validated in BIOSOLVE-III providing further evidence on the safety and performance of a second generation absorbable metal scaffold with constant performance parameters at 12 months and no definite or probable scaffold thrombosis.

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CONFLICT OF INTEREST STATEMENT

MH reports study grants and personal fees from Biotronik, Abbott Vascular, Cardiac dimensions, and Philips, AA reports grants from Biotronik, RT reports personal fees from Biotronik and Abbott Vascular, PAL reports grants from Biotronik, NvM reports personal fees from Abbott Vascular and Pulsecath and grants from Medtronic, Pulsecath, Boston Scientific, and Edwards LifeSciences, SV reports personal fees from Biotronik, Elixir and Neovasc, CvB reports grants from Biotronik, Boston Scientific, and Medtronic, HGG and RW report that MedStar was the core laboratory of the study, and RW reports grant and personal fees from Abbott Vascular, AstraZeneca, Biosensors, Biotronik, Boston Scientific, Chiesi, personal fees of Amgen, Corindus, Lifetech Medical, Medtronic, Philips Volcano, PiCardia LTD, is an investor of MedAlliance, and grants from Edwards Lifesciences. All other authors have no conflict of interest to declare.

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