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Two year efficacy and safety of small versus large ABSORB bioresorbable vascular scaffolds of ≤18 mm device length: A subgroup analysis of the German-Austrian ABSORB RegIstRy (GABI-R)

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ABSTRACT

Aims: The ABSORB bioresorbable vascular scaffold raised safety concerns due to higher rates of scaffold thrombosis (ScT) and adequate scaffold diameter and length for scaffold technology. Smaller scaffold diameter (SScD, 2.5 mm) was an infrequently quoted predictor of major adverse cardiac events (MACE). Therefore, we evaluated the impact of SScD compared to large scaffold diameter (LScD, ≥3 mm) of ≤18 mm device length on 2 year outcome in the all-comer real life GABI-R cohort.

Methods and Results: We compared patients with implanted LScD (1341 patients) vs. SScD (444 patients) of ≤18 mm device length. Patients with LScD more often presented with ST-elevation myocardial infarction (35.8% vs. 20.6%, p < 0.0001) and single-vessel disease (50.6% vs. 36.5% p < 0.0001). After a 24 months follow-up, there was no difference in regard of MACE (9.66% vs. 12.31%, p = 0.14) or definite/probable ST (2.47% vs. 2.82%, p = 0.71). Despite no difference in target lesion revascularisations (TLR) (5.81% vs. 7.71%, p = 0.18), there was a higher need for target vessel revascularisation (TVR) in the SScD-group (11.57% vs. 7.51%, p < 0.05).

Conclusion: Compared to LScD, SScD of ≤18 mm device length demonstrated comparable safety in regard to MACE and ScT as well as efficacy in regard to TLR. Resorbable scaffold technology should not be restricted to large vessel diameters.

Clinical Trial Registration: https://clinicaltrials.gov/ct2/show/NCT02066623.

1. Introduction

The poly-L-lactid acid based everolimus eluting bioresorbable scaffold (BVS; Abbott Vascular, Santa Clara, CA, USA) was developed to overcome disadvantages of drug eluting metallic stents like impaired vasomotion or ongoing neoatherosclerosis [1]. In several randomized controlled trials, the BVS compared to contemporary everolimus eluting metallic stents has shown similar results in terms of target lesion failure, but higher device-oriented adverse event rates, especially scaffold thrombosis, were reported [2–6]. Common predictors of adverse events with BVS were small vessel diameter (<2.5 mm), residual stenosis and mal-apposition [7,8]. Puricel et al. showed that underexpansion of 2.5 mm scaffolds to <2.4 mm in small vessels is associated with higher ScT rates [8].

Abbreviations: BVS, bioresorbable vascular scaffold(s); DES, drug-eluting-stent (s); IVUS, intravascular ultrasound; LScD, large scaffold diameter (≥ 3 mm); MACE, major adverse cardiac events; MI, myocardial infarction; NSTEMI, Non– ST-segment elevation myocardial infarction; OCT, optical coherence tomography; PCI, percutanous coronary intervention; PSP, predilatation, sizing, postdilatation; SA, Stable Angina; ScT, Scaffold thrombosis; STEMI, ST-segment elevation myocardial infarction; SScD, small scaffold diameter (2.5 mm); TLF, target lesion failure; TLR, target lesion revascularization; TVF, target vessel failure; TVR, target vessel revascularization; UA, Unstable Angina.

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A subgroup analysis of the ABSORB III trial cohort, however, came to the conclusion that expansion of 2.5 mm scaffolds to <2.63 mm implies a higher risk of ScT compared to stent thrombosis rates in DES in vessel diameters <2.63 mm (1). On the one hand, this data raised the general question about which lesions are suitable for the treatment with BVS at all [19]. On the other hand, it lead to the development of an improved implantation technique with optimal vessel sizing and mandatory pre and post-dilatation. The latter technique was described as predilatation/sizing/post dilatation (PSP)-technique [9].

The latest and biggest randomized trial, the Absorb IV trial, in which PSP-technique was compulsory, did show non-inferiority in terms of event rates for BVS compared to drug eluting stents (DES) [10]. However, this latter trial had strict, controlled randomized trial based inclusion criteria. To evaluate the procedural results and safety of BVS in a real-life population, the German-Austrian ABSORB RegIstRy (GABI-R) was developed [11].

To answer the most prominent questions in scaffold technology, i.e. adequate scaffold diameter and length- on long term outcome, we analyzed a subgroup of GABI-R with short scaffold length ($\leq$18 mm) and different scaffold diameters (LScD vs SScD). Since in a real life setting, also for economic reasons, neither quantitative coronary analysis (QCA) nor intravascular imaging (intravascular ultrasound (IVUS) or optical coherence tomography (OCT)) are used routinely (only 7.5% in GABI-R, 12), we focused on scaffold diameter rather than vessel diameter, because scaffold diameter is definitely the most objective parameter reflecting vessel size in routine percutaneous coronary intervention (PCI). Consequently, with the current analysis, we evaluated the longterm impact of scaffold diameter (SScD vs. LScD) on clinical outcomes at 24 months in the real-life GABI-R cohort of patients treated with BVS.

2. Methods

2.1. Patient cohort

The rationale, design and results of the GABI-R registry were published before [11–13]. In brief, the GABI-R was a prospective, observational and multicenter registry (ClinicalTrials.gov NCT02066623) of consecutive patients that underwent BVS implantation at 92 sites in Germany and Austria between November 2013 and January 2016 with no core lab installed. Dual antiplatelet therapy was mandatory for at least 12 months for all patients. Follow-up was conducted at 30 days, six months and two years. 5 year follow-up is planned, but has not been completed for all patients [11–13].

The primary endpoints were (a) major adverse cardiac events (MACE), a composite of cardiac death or clinically driven target vessel revascularisation (TVR) or myocardial infarction (MI) and (b) target lesion failure (TLF), a composite of cardiac death or clinically driven target lesion revascularisation (TLR) or target vessel MI. Target vessel failure (TVF) was defined as a composite of cardiac death or target vessel MI or clinically driven TVR [12]. Scaffold thrombosis was defined according to the Academic Research Consortium [14]. Clinical events were evaluated by an independent committee [12].

2.2. Study Design

To evaluate the impact of scaffold diameter on clinical outcomes we compared all patients with implantation of a 3.0 or 3.5 mm diameter BVS (LScD) to patients with scaffold diameters of 2.5 mm (SScD). As scaffold technology may have the most benefit in shorter lesions, we included only patients treated with $\leq$18 mm BVS lengths. Bifurcation lesions were excluded. Long term differences in clinical outcomes after a 2 year follow-up were evaluated.

2.3. Statistical analysis

All analyses are solely based on non-missing values. Categorical data were analysed as absolute numbers and percentages, and continuous variables are presented as means with standard deviations. All p-values are empirical and are not adjusted for multiple testing. For categorical and continuous variables, they were calculated by Pearson's Chi-squared test or Wilcoxon's rank sum test, respectively. Time-to-event data were visualised using cumulative incidence functions (CIF), regarding all-cause death as concurrent risk. P-values for the homogeneity of time-to-event curves (CIF) were calculated by Gray's test. All statistical analyses were performed using SAS® software, version 9.4 for Windows. Copyright © 2002–2012 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

3. Results

3.1. Baseline and procedural characteristics

Out of the 3231 patients enrolled in the GABI-R, 1787 met the inclusion criteria. Complete 2 year follow-up was available in 98.5% (1761/1787) of patients. SScD implantation was performed in 444 patients in whom 600 separate segments were treated with BVS. Thus, in some patients >1 lesion were treated with BVS. Accordingly, in the LScD group 1341 patients with 1601 separate segments underwent BVS implantation. Unfortunately, for 2 patients out of these 1787, the BVS diameter was not documented by the operators. These patients' data are only considered in the total columns and statistics, respectively, and were therefore excluded for final statistical analysis.

The patients were predominantly male (75.9%), aged 61.1 years on average and displayed a high cardiovascular risk profile with arterial hypertension, hyperlipidemia, diabetes, current or previous smoker status being present in 72.4%, 54.8%, 21.3% and 57.1%, respectively. Acute coronary syndromes (ACS) indicated revascularisation in 53.4%.

Patients in the SScD-group were slightly older (62.7 vs. 60.6 years, $p < 0.001$) and conferred a higher cardiovascular risk burden, with higher rates of arterial hypertension (78.7% vs. 70.2%, $p < 0.001$), hyperlipidemia (60.0% vs. 53.0%, $p < 0.05$), a history of previous MI (25.4% vs. 18.7%, $p < 0.01$), CABG (4.1% vs. 2.1%, $p < 0.05$) and prior PCI with stenting (37.6% vs. 22.1%, $p < 0.0001$). Acute Coronary Syndromes were the more common indication for BVS implantation in the LScD group (55.8% vs. 45.9%, $p < 0.01$) driven by higher ST-segment elevation MI (STEMI) rates (35.8% vs. 20.6%, $p < 0.01$). STEMIs were more common in the LScD group (35.8% vs. 20.6%, $p < 0.0001$). Baseline patient characteristics are presented in table 1.

Patients in the LScD group were more likely to have a single as compared to multi-vessel disease (50.6% vs. 36.5%, $p < 0.001$). Treated lesions were predominantly *de novo* (96.5% vs. 94.7%, $p = 0.05$) and ACC/AHA classification A and B1 type lesions (75.5% vs. 76.5%, $p = 0.64$). Intracoronary imaging (IVUS, OCT) was only performed in 6.5% of patients, postdilatation in 68.7% of PCIs with an overall high procedural success rate of 99.2%. Baseline procedural and lesion characteristics are presented in Table 2.

Table 1
Baseline characteristics of patients with implantation of a bioresorbable scaffold with small (≤2.5 mm) compared to large (≥3.0 mm) nominal diameters. Displayed are percentages and numbers or mean and standard deviation; P-values: Chi-squared test or Mann-Whitney-Wilcoxon test. Abbreviations: CAD – Coronary Artery Disease; MI – Myocardial Infarction; CABG – Coronary Artery Bypass Graft; PCI – Percutaneous Coronary Intervention; ACS – Acute Coronary Syndrome; STEMI – ST-elevation Myocardial Infarction.

	Small Nominal Scaffold Diameter	Large Nominal Scaffold Diameter	Total	P-value
Patients	444	1341	1787	
Female gender	27.5% (122/444)	23.0% (309/1341)	24.1% (431/1787)	0.06
Age in years	62.70 ± 11.03	60.59 ± 11.19	61.12 ± 11.19	<0.001
Cardiovascular Risk Factors				
Current or previous smoker	52.1% (215/413)	58.8% (750/1275)	57.1% (965/1689)	<0.05
Diabetes	23.0% (101/440)	20.8% (276/1325)	21.3% (377/1766)	0.35
Hyperlipoproteinemia	60.0% (257/428)	53.0% (675/1273)	54.8% (932/1701)	<0.05
Family history of CAD	39.5% (154/390)	39.0% (460/1179)	39.1% (614/1569)	0.87
Arterial hypertension	78.7% (344/437)	70.2% (925/1317)	72.4% (1270/1755)	<0.001
Medical History				
Atrial fibrillation	6.4% (28/440)	6.0% (79/1317)	6.1% (108/1758)	0.78
Renal failure	7.9% (35/442)	7.5% (100/1330)	7.6% (135/1773)	0.78
Previous MI	25.4% (111/437)	18.7% (247/1320)	20.4% (358/1758)	<0.01
Prior coronary angiography	44.3% (191/431)	27.9% (367/1317)	32.0% (559/1749)	<0.0001
Prior CABG	4.1% (18/444)	2.1% (28/1337)	2.6% (46/1782)	<0.05
Prior PCI with stenting	37.6% (162/431)	22.1% (293/1325)	26.0% (456/1757)	<0.0001
Prior heart surgery (other than CABG)	0.9% (4/441)	0.4% (5/1328)	0.5% (9/1770)	0.17
Indication for procedure				
ACS	45.9% (204/444)	55.8% (748/1341)	53.4% (953/1786)	<0.01
STEMI	20.6% (42/204)	35.8% (268/748)	32.5% (310/953)	<0.01
Non-STEMI	49.5% (101/204)	42.0% (314/748)	43.7% (416/953)	0.05
Unstable Angina	29.9% (61/204)	22.2% (166/748)	23.8% (227/953)	<0.05
Stable Angina	38.7% (172/444)	31.2% (419/1341)	33.1% (591/1786)	<0.01
Silent myocardial ischemia	4.3% (19/444)	3.8% (51/1341)	3.9% (70/1786)	0.65
Other	12.6% (56/444)	10.1% (136/1341)	10.8% (192/1786)	0.15
Undetermined	0.9% (4/444)	0.9% (12/1341)	0.9% (16/1786)	0.99

3.2. Six month follow-up

99.3% (SScD) and 99.0% (LScD) of the analyzed patients were recorded with a 6 month follow-up. MACE were recorded in 3.83% in the SScD-group compared to 3.21% in the LScD-group. Confirmed TLF was reported in 2.48% (SScD) vs 1.94% (LScD). TVF rates were reported in 3.83% (SScD) vs. 2.91% (LScD). ScT was observed in 1.35% (SScD) compared to 1.19% (LScD). All of the above mentioned differences in event rates proved to be statistically non-significant.

3.3. Two year follow-up

The 2 year follow-up was available for 98.9% (SScD) and 98.4% (LScD), respectively (see Table 3 and Fig. 1, respectively). MACE occurred in 12.31% of the SScD group and in 9.66% of the LScD group. This difference was driven by significantly increased TVR rates in the SScD-group (11.57% vs. 7.51%, p < 0.05), with no significant difference in cardiac death (0.45% vs. 0.75%, p = 0.51) or MI rates (4.64% vs. 4.67%, p = 0.98).

Definite ScT occurred in 1.80% (SScD) and 1.77% (LScD) and probable ScT in 1.03% (SScD) vs. 0.71% (LScD). Per definition, unknown deaths are rated as possible ScT (14). Thus, the higher number of unknown deaths in the LscD group lead to higher possible ScT rates (1.93% vs. 0.52%, p = 0.05).

In regard of the treated lesion, both groups had comparable TLF rates of in total 6.29% at 2 years. In particular, TLR rates did not differ significantly (6.7% SScD vs. 4.61% LScD, p = 0.11). In regard of the treated vessel, the higher need for TVR at 2 years in the SScD group (11.57% vs. 7.51%, p < 0.05) resulted in higher TVF rates (11.79% vs. 8.27%, p < 0.05).

4. Discussion and limitations

4.1. Discussion

This analysis of the real-life GABI-R patient cohort treated with BVS demonstrated that SScD implantation confers no lack of safety after 2 years compared to LscD implantation with ≤18 mm device length. MACE and ScT rates did not differ significantly. In regard to efficacy, BVS demonstrated comparable TLF rates in both groups. The higher rates of TVF in the SScD-group may be explained by the higher cardiovascular risk burden in this cohort.

Putting the outcome of the GABI-R cohort of patients treated with BVS in perspective to those treated with bare metal (BMS) and drug eluting stents (DES), respectively, and to the different generation DES over time, BVS show results comparable to BMS and second generation DES. In a *meta*-analysis, Mahmoud et al compared the outcome of second generation DES vs. BMS. They reported MACE rates of 17.0% for DES and 19.8% for BMS, MI rates of 8.5% vs. 10.3% and TLR rates of 5.1% vs. 10.4%, respectively, which are comparable to the 10.3%, 4.7% and 5.1% in the GABI-R cohort [15]. Looking at the latest generation DES, TLF rates at 12 months in the randomized controlled BIOFLOW V trial were 6% with the Orsiro® DES and 10% with the Xience® DES [16]. The most recent randomized controlled trial, comparing first generation BVS with mandatory PSP to the Xience® DES included 2′604 patients and showed 1 year TLF rates of 8% (BVS) vs. 6% (DES). The safety concern of higher ScT rates with BVS was not seen after 1 year in this trial (BVS 0.7% vs. DES 0.3%) [10]. In contrast, the GABI-R cohort displayed a much higher ScT risk with 2.6% at 2 years, which might be due to the BVS learning curve with a decline in ScT rates after implementation of PSP technique during the inclusion period [11,12]. Whereas the ABSORB IV ScT rates are comparable to second generation DES or BMS (0.8% vs. 1.4%), the GABI-R ScT rates are higher [15]. Jeger et al. targeted the question of the optimal treatment strategy in coronary arteries with <3 mm diameter by comparing DES implantation to application of a drug coated balloon and reported 12 months MACE rates of 7.5% vs. 7.3% and TVR rates of 3.4% vs 4.5%. Thus, MACE and TVR rates were lower than in the GABI-R SScD-group [17]. Kereiakes et al. showed that BVS implantation in <2.25 mm vessel diameter was an independent predictor of ScT and TLF at 3 years [3]. In our analysis, there was no difference between the SScD group compared to LScD group in regards of MACE, definite/probable ScT and even TLF or

Table 2
Procedural and lesion characteristics of percutaneous coronary implantation of a bioresorbable scaffold with small (≤2.5 mm) compared to large (≥3.0 mm) nominal diameters. Displayed are percentages and numbers or mean and standard deviation; P-values: Chi-squared test or Mann-Whitney-Wilcoxon test. Abbreviations: PCI – Percutaneous Coronary Intervention; CABG – Coronary Artery Bypass Graft; ACC/AHA – American College of Cardiology/American Heart Association. # Number of pretreated lesions only.

	Small Nominal Scaffold Diameter	Large Nominal Scaffold Diameter	Total	P-value
Results of diagnostic coronary angiography				
1-vessel-disease	36.5% (162/444)	50.6% (678/1341)	47.0% (840/1787)	<0.001
2-vessel-disease	35.1% (156/444)	28.1% (377/1341)	29.9% (535/1787)	<0.01
3-vessel-disease	28.4% (126/444)	21.3% (285/1341)	23.0% (411/1787)	<0.01
Imaging before PCI				
Intravascular ultrasound	2.0% (9/444)	3.2% (43/1340)	2.9% (52/1785)	0.2
Optical coherence tomography	2.9% (13/444)	3.9% (52/1340	3.6% (65/1785)	0.35
Lesion Characteristics:				
Treated Segments	600	1601	2205	
Lesion Stenosis (%) before PCI	86.54 ± 11.15	86.82 ± 11.47	86.73 ± 11.38	0.35
Length of treated lesion	13.42 ± 5.87	12.91 ± 4.94	13.05 ± 5.21	0.39
Type of Lesion				
Complete occlusion	3.7% (22/600)	3.6% (57/1599)	3.6% (79/2201)	0.91
De-novo stenosis	94.7% (568/600)	96.5% (1543/1599)	96.0% (2113/2201)	0.05
Restenosis	1.2% (7/600)	0.4% (7/1599)	0.6% (14/2201)	0.06
In-stent-restenosis	1.0% (6/600)	0.9% (14/1599)	0.9% (20/2201)	0.78
CABG	0.3% (2/600)	0.2% (3/1599)	0.2% (5/2201)	0.52
Type of Lesion				
ACC/AHA Classification Type A	31.7% (190/600)	36.3% (581/1599)	35.1% (771/2199)	<0.05
ACC/AHA Classification Type B1	44.8% (269/600)	39.2% (627/1599)	40.7% (896/2199)	<0.05
ACC/AHA Classification Type B2	17.8% (107/600)	17.3% (276/1599)	17.4% (383/2199)	0.75
ACC/AHA Classification Type C	5.7% (34/600)	7.2% (115/1599)	6.8% (149/2199)	0.40
Percutaneous Coronary Intervention				
Only scaffold(s) implanted	89.3% (528/591)	90.0% (1413/1570)	89.7% (1943/2165)	0.65
Only stent(s) implanted	8.3% (49/591)	8.2% (128/1570)	8.3% (179/2165)	0.92
Both scaffold(s) and stent(s)	2.3% (14/600)	1.8% (29/1601)	2.0% (43/2205)	0.43
Number of scaffolds implanted				
1 scaffold implanted	81.5% (489/600)	85.3% (1366/1601)	84.2% (1857/2205)	<0.05
2 scaffolds implanted	8.3% (50/600)	4.6% (74/1601)	5.6% (124/2205)	<0.001
3 scaffolds implanted	0.5% (3/600)	0.1% (2/1601)	0.2% (5/2205)	0.10
Procedure success	99.2% (595/600)	99.2% (1587/1600)	99.2% (2185/2203)	0.96
Pre-Implantation Treatment				
Predilation per lesion	100.0% (563/563)	99.9% (1467/1468)	100.0% (2030/2031#)	0.54
Maximum balloon diameter (mm)	2.48 ± 0.37, n = 563	2.87 ± 0.52, n = 1467	2.76 ± 0.51, n = 2030	<0.0001
High-pressure balloon	34.7% (195/562)	40.9% (599/1464)	39.2% (794/2026)	<0.05
Cutting balloon	2.0% (11/563)	4.3% (63/1468)	3.6% (74/2031)	<0.05
Scoring balloon	3.7% (21/563)	2.5% (36/1468)	2.8% (57/2031)	0.12
Rotablation	0.2% (1/563)	0.0% (0/1468)	0.0% (1/2031)	0.11
Post-Implantation Treatment				
Post-dilation per lesion	68.0% (408/600)	69.0% (1103/1599)	68.7% (1511/2201)	0.66
High-pressure balloon	89.0% (363/408)	91.5% (1009/1103)	90.8% (1372/1511)	0.13
Maximum balloon diameter (mm)	2.87 ± 0.41, n = 408	3.42 ± 0.38, n = 1102	3.27 ± 0.46, n = 1510	<0.001

TLR. As vessel diameter is not reliably quantified in real life PCI, our analysis focuses on scaffold diameter only.

Interestingly, non-inferiority in terms of percentage diameter stenosis at angiographic follow-up for BVS compared to drug eluting stents was also observed in the very recently published Intracoronary Scaffold Assessment a Randomized evaluation of Absorb in Myocardial Infarction (ISAR-Absorb MI) trial [18].

Whereas, in our analysis, treatment of the target lesion was successful in nearly 95% of patients after 2 years, with no difference in TLF or TLR rates between groups, there were higher TVF rates in the SScD group, mainly driven by higher TVR rates. This might be explained by the higher cardiovascular risk burden within the SScD group with significantly higher rates of multivessel disease, prior MI or previous PCI. However, is has to be noted that there was a tendency (although not statistically significant) toward an increasing gap in the TLF rates in both groups if 6-month follow-up data is compared to 2 year follow-up (6 month TLF: 2.48% SScd vs. 1.94% LScD; 2 year TLF: 7.71% SScD vs. 5.81% LScD).

Restricting BVS to ≤18 mm device length in small vessels may currently be necessary to further successfully develop this novel technology. With the current thick struts, the scaffolds are generally considered to underperform in small vessels. Excluding more complex lesions (longer and/or overlap), as performed in the current analysis, may be a safer and thus more adequate approach facilitating the introduction of future better and thinner devices even in small vessels. In conclusion, our analysis favors a more pre-emptive procedure than followed in the past.

The other currently available bioresorbable, magnesium based scaffold, the Magmaris®, has shown TLF rates of 4.3% after 12 months with only 1 ScT in 400 patients [19]. In BIOSOLVE-IV however, strict inclusion criteria apply and small vessels with a diameter of less than 3 mm are excluded. Importantly no device with a nominal diameter of 2.5 mm is currently available [19].

In conclusion, in a real life cohort in which BVS implantation was to the discretion of the operator, SScDs with ≤18 mm device length were as safe as LScDs, and as efficacious in regards of TLF. Restricting the development of next generation resorbable devices on scaffold diameters >3 mm cannot be supported by our data.

4.2. Limitations

The limitations of GABI-R were discussed before [12]. In brief, the GABI-R was an all-comer cohort and no randomized trial with

Table 3
Two year outcome of patients with implantation of a bioresorbable scaffold with small (≤2.5 mm) compared to large (≥3.0 mm) nominal diameters. Displayed are percentages and numbers; P-values: Chi-squared test or Mann-Whitney-Wilcoxon test. MACE – composite of cardiac death, clinically driven target vessel revascularisation (TVR) or myocardial infarction (MI); Target Lesion Failure (TLF) – composite of cardiac death, clinically driven target lesion revascularisation (TLR) or target vessel MI. Target vessel failure (TVF) – composite of cardiac death, target vessel MI or clinically driven TVR.

	Small Nominal Scaffold Diameter	Large Nominal Scaffold Diameter	Total	p-value
Patients with 2 year follow-up	98.9% (439/444)	98.4% (1320/1341)	98.5% (1761/1787)	0.50
All-Cause Mortality	1.80% (8/444)	2.99% (40/1336)	2.69% (48/1782)	0.18
Cardiovascular Death	0.45% (2/444)	0.90% (12/1336)	0.79% (14/1782)	0.35
Cardiac Death	0.45% (2/444)	0.75% (10/1336)	0.67% (12/1782)	0.51
Vascular Death	0.00% (0/444)	0.15% (2/1336)	0.11% (2/1782)	0.41
Non-cardiovascular Death	0.68% (3/444)	0.67% (9/1336)	0.67% (12/1782)	1
Myocardial Infarction (MI)	4.64% (18/388)	4.67% (53/1134)	4.66% (71/1524)	0.98
Scaffold thrombosis				
Definite	1.80% (7/388)	1.77% (20/1129)	1.78% (27/1519)	0.97
Probable	1.03% (4/388)	0.71% (8/1129)	0.79% (12/1519)	0.54
Definite or probable	2.82% (11/390)	2.47% (28/1133)	2.56% (39/1525)	0.71
Possible	0.52% (2/388)	1.93% (22/1139)	1.57% (24/1529)	0.05
Stent thrombosis				
Definite	0.00% (0/53)	0.00% (0/105)	0.00% (0/159)	n.d.
Probable	0.00% (0/53)	1.87% (2/107)	1.24% (2/161)	0.32
Definite or probable	0.00% (0/53)	1.87% (2/107)	1.24% (2/161)	0.32
Possible	0.00% (0/53)	2.78% (3/108)	1.85% (3/162)	0.22
Combined Endpoints				
Major Adverse Cardiac Events (MACE)	12.31% (48/390)	9.66% (110/1139)	10.32% (158/1531)	0.14
Target Lesion Failure (TLF)	7.71% (30/389)	5.81% (66/1136)	6.29% (96/1527)	0.18
Cardiac death	0.45% (2/444)	0.75% (10/1336)	0.67% (12/1782)	0.51
TV-MI	3.35% (13/388)	3.09% (35/1132)	3.15% (48/1522)	0.80
TLR	6.70% (26/388)	4.61% (52/1129)	5.13% (78/1519)	0.11
Target Vessel Failure (TVF)	11.79% (46/390)	8.27% (94/1137)	9.16% (140/1529)	<0.05
Cardiac death	0.45% (2/444)	0.75% (10/1336)	0.67% (12/1782)	0.51
TV-MI	3.35% (13/388)	3.09% (35/1132)	3.15% (48/1522)	0.80
TVR	11.57% (45/389)	7.51% (85/1132)	8.54% (130/1523)	<0.05

BVS implantation left to the discretion of the operator. Fewer patients than originally planned were enrolled. Lack of a standardized or imaging guided sizing process have to be mentioned, too. The cohort furthermore includes patients with the initial implantation technique and the then established PSP technique since 2014. In addition, the reference vessel diameter was mainly quantified by visual estimation and therefore has to be considered inconsistent. Thus, in a real life cohort, scaffold diameter may be the most objective parameter for statistical analysis.

4.3. Conclusion

In a real life cohort in which BVS implantation was to the discretion of the operator, SScD implantation of ≤18 mm device length was as safe as LScD implantation, and as efficacious in regard to TLF. Restricting the development of next generation resorbable devices on scaffold diameters of ≥3 mm cannot be supported by our data.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcha.2020.100501.

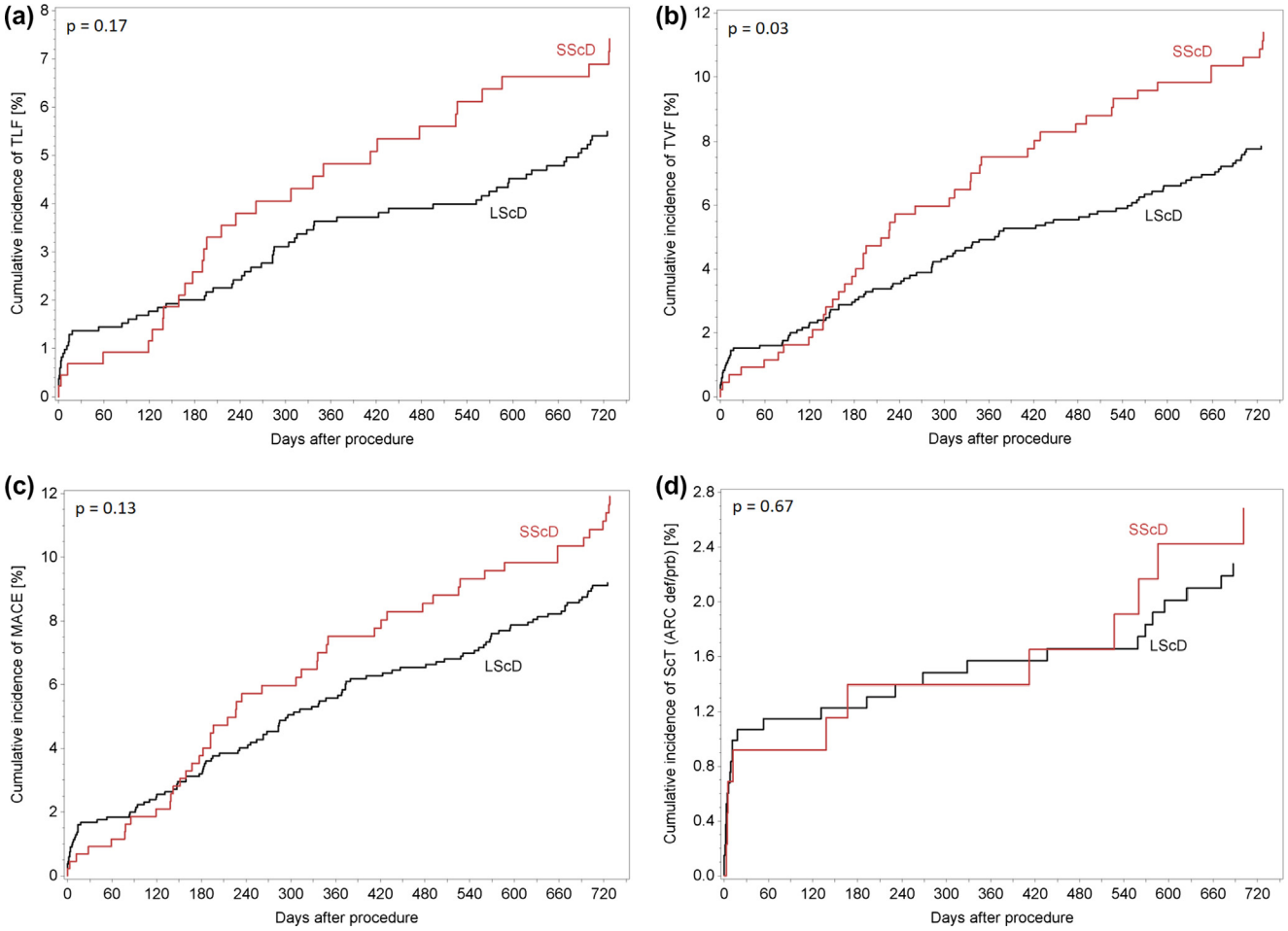

Fig. 1. Cumulative incidence functions (CIF) for the Endpoints (a) Target Lesion Failure (TLF - composite of cardiac death, clinically driven target lesion revascularisation (TLR) or target vessel myocardial infarction (MI)), (b) Target Vessel Failure (TVF - composite of cardiac death, target vessel MI or clinically driven target vessel revascularization (TVR)), (c) major adverse cardiac events (MACE - composite of cardiac death, clinically driven TVR or MI) and (d) definite or probable Scaffold Thrombosis (ScT) by the definition of the Academic Research Consortium (ARC). Differences in cumulative incidence functions between the two groups were evaluated by Gray's Test.

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