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Letter

RESEARCH LETTER

3-Year Clinical Outcomes of Ultrathin Biodegradable Polymer-Coated Sirolimus-Eluting Stents

T-Flex Registry With High-Risk Subgroups

Second-generation drug-eluting stents (DES) displayed supreme advantages over bare-metal stents and first-generation DES by subduing restenosis, in-stent restenosis, and stent thrombosis. However, the permanent presence of durable polymers incited prolonged arterial wall inflammation, delayed healing, and neoatherosclerosis formation, which led to sequelae such as late and very late stent thrombosis. These sequelae, later termed as late catch-up phenomena, impelled iterations in current second-generation DES. One of these latest iterations is thinner struts. Thinner struts accelerate endothelialization, alleviate inflammation, and decrease arterial damage, neoatherosclerosis formation, and thrombogenicity. Reduced strut thickness also affords greater flexibility, thus enhancing deliverability and trackability across complex vasculature.[1] Moreover, earlier meta-analyses have associated ultrathin DES with 16%, 12%, and 19% reduction in target lesion failure at 1, 2, and 3 years, respectively.[1,2]

At 1-year follow-up, the T-Flex registry demonstrated excellent safety and clinical performance.[3] However, whether these benefits persist over a longer surveillance period is uncertain. We therefore report the 3-year safety and clinical performance with this ultrathin (60-μm) biodegradable polymer-coated sirolimus-eluting stent (SES) (Sahajanand Medical Technologies) with a unique long dual Z (LDZ) link design on a cobalt-chromium stent platform in an all-comer population including high-risk subgroups such as patients with diabetes mellitus, small coronary vessels (≤2.5 mm), ST-segment elevation myocardial infarction, and total occlusions.

The T-Flex registry was an observational, multicenter, single-arm, investigator-initiated, retrospective registry comprising all-comer patients with coronary artery disease who were treated with at least 1 ultrathin biodegradable polymer-coated SES designed with the LDZ link, between May 2016 and January 2017. This registry used broad eligibility criteria and minor exclusion criteria to reflect routine clinical practice. The study protocol was approved by the institutional ethics committee. The registry complied with the principles of good clinical practice and the Declaration of Helsinki. All patients provided written informed consent for data collection and their analysis for research purposes. In certain patient subgroups wherein emergency index procedures were performed, consent was obtained from the patient's designee. All data including follow-up were obtained retrospectively either by extraction from existing databases in consecutive fashion where index and follow-up data existed or obtained by telephonic contact 1 and 3 years after stent implantation. The primary endpoint assessment consisted of target lesion failure, defined as the composite of cardiac death, target-vessel myocardial infarction, and clinically indicated target lesion revascularization at 3 years. Stent thrombosis was an additional safety endpoint, classified and defined by the Academic Research Consortium.[3]

At the end of 1, 2, and 3 years, 1,143 (95.0%), 1,103 (91.7%), and 1,059 (88.0%) patients were followed up, respectively. A total of 1,203 patients (mean age 56.6 ± 10.7 years) were analyzed. Of the 1,430 lesions, 1,194 (83.5%) were complex (ie, type B2/C), and 208 (17.3%) were total occlusions. Moreover, 239 (16.7%), 205 (14.3%), and 117 (8.2%) target lesions were bifurcation, moderate or severely calcified, and tortuous lesions, respectively. Acute, subacute, late, and very late stent thrombosis occurred in 1 (0.1%), 3 (0.3%), 5 (0.5%), and 1 (0.1%) patients, respectively, at 3-year follow-up. Clinical outcomes at 3-year follow-up are outlined in **Table 1**.

Strengths of the T-Flex registry are the all-comer population. Study population and lesion complexity were highly reflective of routine clinical practice. Second, this report of 3-year outcomes permits documentation of relatively late-occurring adverse safety events. Third, the T-flex registry is 1 of few

TABLE 1 3-Year Clinical Outcomes for Overall Study Overall Patient Population and High-Risk Subgroups

	At 3-Year Follow-Up				
	Total Patients (N = 1,203)	Diabetes Mellitus (n = 387)	Small Vessel (≤2.5 mm) (n = 374)	Total Occlusion (n = 208)	ST-Segment Elevation Myocardial Infarction (n = 291)
Patients at follow-up	1,059 (88.0)	335 (86.6)	318 (85.0)	179 (86.1)	252 (86.6)
Patients lost to follow-up	144	52	56	29	39
All-cause death, %	2.7 (1.9-3.9)	3.9 (2.3-6.5)	3.8 (2.2-6.5)	5.0 (2.7-9.2)	4.8 (2.7-8.1)
Cardiac death, %	1.1 (0.7-2.0)	1.5 (0.6-3.5)	1.3 (0.5-3.2)	1.7 (0.6-4.8)	2.0 (0.9-4.6)
Noncardiac death, %	1.6 (1.0-2.6)	2.4 (1.2-4.6)	2.5 (1.3-4.9)	2.8 (1.2-6.4)	2.8 (1.4-5.6)
All myocardial infarction, %	4.8 (3.7-6.3)	7.5 (5.1-10.8)	6.9 (4.6-10.2)	8.9 (5.6-14.0)	7.9 (5.2-11.9)
TV-MI, %	3.1 (2.2-4.3)	3.3 (1.8-5.8)	4.1 (2.4-6.9)	3.4 (1.6-7.1)	4.0 (2.2-7.2)
CI-TLR, %	3.9 (2.9-5.2)	4.8 (3.0-7.6)	4.1 (2.4-6.9)	3.9 (1.9-7.9)	4.8 (2.7-8.1)
Overall stent thrombosis, %	1.0 (0.5-1.7)	1.2 (0.5-3.0)	2.2 (1.1-4.5)	0.6 (0.1-3.1)	1.6 (0.6-4.0)
TLF, %	8.1 (6.6-9.9)	9.6 (6.9-13.2)	9.4 (6.7-13.1)	8.9 (5.6-14.0)	10.7 (7.8-15.1)

Values are n (%), n, or mean (95% CI). 95% CIs are calculated by Wilson score.
CI-TLR = clinically indicated target lesion revascularization; TLF = target lesion failure; TV-MI = target-vessel myocardial infarction.

studies providing insights into long-term clinical events with a stent available in 60-μm strut thickness across all diameters and lengths. This is at variance with the Orsiro SES (Biotronik), which has a 60-μm strut thickness for smaller stent diameters ranging from 2.25 to 3.0 mm, but 80 μm for larger stent diameters ranging from 3.5 to 4.0 mm. Fourth, it is assumed the price to pay for thinner struts is compromised radial force. Indeed, a recent meta-analysis supportive of the benefits of ultrathin strut stents has not been able to provide reassurance of the durability these stents in complex lesions such as heavily calcified lesions, ostial lesions, and chronic total occlusions.[1] However, although 17.3% lesions in this registry were total occlusions, no signal even remotely suggestive of a clinically relevant problem due to insufficient radial force was observed. Neither has such a problem been reported in the BIORESORT (Comparison of BIOdegradable Polymer and DuRablE Polymer Drug-eluting Stents in an All COmeRs PopulaTion) small coronary vessel subgroup[4] or calcified coronary lesion subgroup,[5] which reported implantation of ultrathin strut stents. Limitations include retrospective, single-arm, and observational study design and the lack of head-to-head comparison with other latest generation stents.

The results of the T-Flex registry demonstrate satisfactory and sustained long-term clinical outcomes after implantation of ultrathin biodegradable polymer-coated SES with the LDZ link in an all-comer population with high-risk subgroups.

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