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Bioabsorbable stents: only bad news?

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Coronary stenting has become an integral part of percutaneous coronary intervention (PCI) procedures, providing structural support to the treated vessel and preventing acute recoil, restenosis, and late negative remodelling occurring after simple balloon dilation. The introduction of scaffold bioabsorbable device (BRS), able to provide temporary structural support to a vessel, while eluting an antiproliferative drug, and be reabsorbed in a time-predictable fashion, represent the latest technological innovation in percutaneous intervention.[1] The rational and the potential advantages for the use of BRS during PCI are numerous and mostly self-evident.

Of particular interest is the possibility of re-establishing normal morphology and physiology (motility, vessel geometry, and shear stress) of the vessel once the reabsorption is complete, allowing to limit the antiplatelet treatment in the long term, which is necessary to avert stent thrombosis.[2] Form a technical-procedural stand-point, the reabsorption of the BRS could offer advantages in complex anatomical situations such as bifurcation stenting, or PCI in ostial regions in which could reduce the overhanging of the implanted stent *Table 1*.

Only bad news? The first bad news followed the publication of the 3 years results of the ABSORB II trial.[3] This was a randomized trial comparing ABSORB BRS device with everolimus eluting stent (EES), designed to test the hypothesis of return of normal vessel' function after PCI with BRS. The vasomotility after BRS or EES was similar. On the other hand, there was also a significant increase in the target vessel infarct rate, as well as target vessel revascularization rate for the BRS group.

Unquestionably, the major limitation of ABSORB BRS device has been, so far, the increased risk of device thrombosis.[4] Stent thrombosis carries a 20% increased mortality risk, thus jeopardizing patient' safety. The early experience with ABSORB BRS was reassuring as far as safety concerns, but the first worrisome data, regarding an increased risk of stent thrombosis, aroused from the European Multicenter Registry GHOST-EU (Gauging coronary Healing with bioresorbable Scaffolding plaTforms in Europe).[5] Data from the registry, in fact, demonstrated a device thrombosis rate of 2.1% at 6 months, which jeopardized patients safety when compared with the outcome previously observed with first-generation drug-eluting stents.[6] The increased risk of stent thrombosis has been confirmed by the results of various randomized clinical trials. A recent meta-analysis by Sorrentino *et al*,[7] based on seven clinical trials comparing BRS and EES, outlined a temporal trend for the risk of thrombosis constantly increasing

Table 1 Potential advantages of BRS and their clinical prove

Potential advantages	Clinical prove
Complete reabsorption in time	
Restoration of normal vessel's geometry	
Positive late remodelling	
Abolishment of late and very late adverse events after reabsorption	
Possibility to reduce antiplatelet therapy in the long term	
Possibility of later surgical procedure on the treated vessel	
Increased vasomotility when compared with metal stents	

proven to be proven unproven

during the early and very late phases after the procedure (*Figure 1*). Mechanisms potentially associated with the increased risk of thrombosis with ABSORB BRS include the device structure and 'scaffold dismantling'. The thickness of the struts is noteworthy, considering that the latest generation metal stents reach a thickness of 60-80 μm. Experimental models and computer analysis demonstrated that the thickness of the struts influences turbulence of blood flow after stent implant in a manner directly proportional to the struts protrusion inside the vessel lumen.[8] 'Scaffold dismantling', defined as an anomalous reabsorption process of not completely endothelialized struts, implies the collapse of the struts inside the vessel lumen during the reabsorption process.[9]

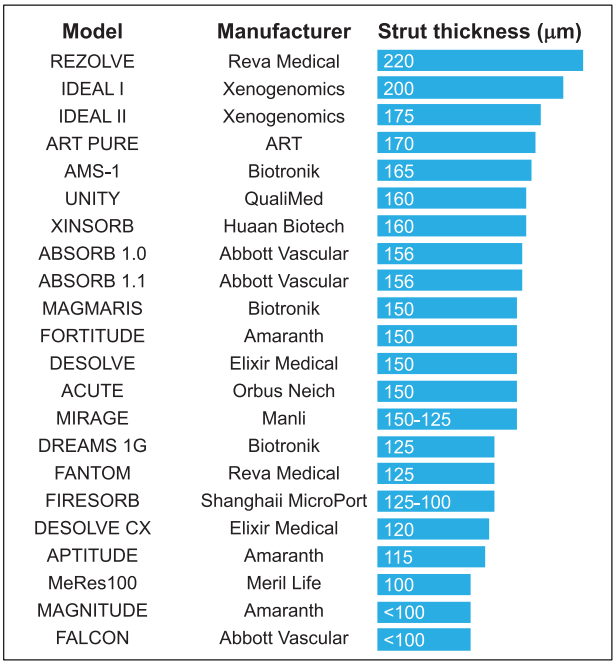

Figure 1 Thickness of the struts for BRS presently in use and future directions. Progressive reduction of the struts thickness to decrease device thrombogenicity.

Not all the news is bad. A significant reduction of the incidence of thrombosis has been demonstrated when the technical details of the implant procedure are carefully respected. The structural limitations determining an increased risk of thrombosis after BRS are amplified by suboptimal implantation technique (malapposition, edge dissection, etc.), or inappropriate selection of complex lesions (small caliber vessel, long calcific lesions, scaffolds overlapping). It has been proven that the implant assisted by intravascular imaging modalities, the careful preparation of the lesion (1:1 ratio between pre-dilation balloon and scaffold diameter, no significant residual stenosis), as well as the correct sizing of the device, and the post-dilation after the implant (PSP technique), could all significantly mitigate the risk of thrombosis.[10,11] Of particular interest are the 5 years results of ABSORB trial, recently published.[12] After complete device reabsorption, the outwards vessel remodelling was more significant and frequent for the ABSORB BRS when compared with metal stents. Likewise was documented the complete recuperation of the jailed lateral branches at the bifurcation site.[13] Encouraging results, as far as thrombogenicity, are emerging for the new magnesium BRS.

Table 2 depicts the main BRS so far utilized in clinical practice, and the future devices still under development. Current technology developments aim at decrease thrombogenicity, improve mechanical properties by utilizing molecules other than poly-lactic acid, and, possibly, reducing the time necessary for complete reabsorption of the device, so as to anticipate the possible benefits over the metal stents.

Conflict of interest: none declared.

Table 2 Various BRS in the pre-clinical or clinical phase

Scaffold	Company	Material	Drug	Strut thickness (μm)	Reabsorption (months)	Approval stage
Absorb GT1 BRS	Abbott Vascular	PLA	Everolimus	156	24-36	EC Seal
DESOLVE/DESOLVE NXT	Elixir	PLA	Novolimus	150/120	24-36	EC Seal
ART PBS	Terumo/ART	PLA	—	170	12-24	EC Seal
Fortitude/Aptitude/ Magnitude	Amaranth Medical	PLA	—	150/115/<100	12-24	Clinical Study
NeoVas	Lepu Medical Technology	PLA	Sirolimus	180	—	Clinical Study
Mirage	Manli	PLA	—	125-150	14	Clinical Study
MeRes100	Meril LifeSciences	PLA	—	100	24	Clinical Study
Xinsorb	Huaan Biotch	PLA	Sirolimus	150-160	—	Clinical Study
Firesorb	Shanghai MicroPort Medical	PLA	Sirolimus	100-125	—	Clinical Study
Fantom	REVA Medical	DT-PC	Sirolimus	125	—	EC Seal
Magmaris	Biotronik	Magnesium	Sirolimus	120-150	12	EC Seal

DT-PC, tyrosine polycarbonate; EC, European Community; PLA, poly-lactic acid.

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