Bioresorbable vascular scaffold: promises and the fallen child-as-king?

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THE BIORESORBABLE VASCULAR SCAFFOLDS ‘BVS’

The main limitation of percutaneous coronary intervention compared to open-heart surgery is the insertion of a foreign body (usually a stent) inside the coronary artery. This is associated with foreign body inflammation that triggers restenosis, neoatherosclerosis and late-occurring stent thrombosis. As such, BVS were considered as a possible solution as early as the late 60s by Dotter with preclinical work,1 and then with the first human study by Higaki and Tamai in the late 90s. In these two preliminary experiments, device materials had weak radial strength and came with the risk of scaffold thrombosis (ScT). In addition, long-term preliminary studies of the Higaki-Tamai stent showed pathological remodelling of the artery during the first 3 years. Based on these studies, this early concept was soon abandoned. In 2004 following concerns of late drug-eluting stent (DES) thrombosis and its association with hypersensitivity reaction to permanent polymer, we saw a renewed interest in bioresorbable polymers. First, durable polymers on metallic DES were progressively swapped for lower dose, bioresorbable polymers. Second, a modified version of BVS that combines a novel stent design, a semicrystalline poly L-lactic acid (PLLA) backbone and a coating with everolimus was considered. This seminal work resulted in the first drug-eluting BVS, and subsequently in its first human implantation.

BVS IS FEASIBLE

The first promise was easily held; although its deliverability remains slightly below the current DES standard, BVS can be implanted in virtually all types of lesions. However, very accurate sizing with qualitative comparative analysis or intravascular ultrasound imaging (or optical coherence tomography (OCT)) is necessary to minimise malapposition, or the rupture of the scaffold backbone. We also learnt that edge dissections could originate from the manufacturing process of the scaffold (laser cutting without polishing).

BVS AND ITS PROMISES

The announcement of the first clinical BVS implantation by Ormiston3 generated optimism during the great DES depression of 2006: BVS could potentially eradicate long-term adverse events (restenosis, late stent thrombosis and the newly described neoatherosclerosis) but could also result in possible coronary restoration with physiological vasomotion. Early studies with intravascular imaging were encouraging: early healing (capping) and the foundation of a new concept: the golden tube with positive vessel remodelling, disappearance of atherosclerotic plaque and progressive lumen enlargement. The child-asking was born! In indirect comparisons, BVS was considered as good as the gold standard, everolimus-eluting metallic stents (EES) during the early clinical follow-up (7–34 months), after which, BVS appeared to perform better than EES. Although the first implantation was performed soon after its development thereafter, there was then a prolonged period of clinical research in highly selected patient populations and full commercial launch was only effective in late 2012. This resulted in an extension of usage to more complex lesions and patient populations and allowed comparison of the early promise from pioneering clinical research to real world contemporary practice. So, what have we learnt so far?

BVS IS EFFICIENT

This promise remains a topic of debate. The very first clinical trial results with direct comparison between BVS and DES were available at TCT 2014 (over 10 years from first clinical implant), with the presentation of the EverBio-24 and ABSORB-II.5 Key findings were as follows: no difference between devices on clinical end points with a reduced cumulative duration of secondary angina.

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pectoris with BVS in ABSORB-II; but an increased in-segment late-lumen loss—a surrogate marker of efficacy—with BVS in EverBio-2. The ABSORB III trial subsequently confirmed these results. Nevertheless, the power of these studies taken individually remains insufficient to conclude about individual clinical end points, especially device thrombosis. Furthermore, the study designs with generous thresholds chosen for non-inferiority have favoured BVS (such as a wide δ margin of 4.5% in ABSORB III° 7).

**SCT AND THE FALLEN (CHILD-AS-) KING**

A firestorm arose in early 2014 from the observational GHOST-EU registry,° 7 which showed an increased rate of ScT in unselected patients, with an incidence of >2% at 6 months. These results were confirmed by other studies. Intravascular imaging studies at time of ScT identified similar causative factors: scaffold malexpan-
sion, dissection, malapposition and insufficient antplate-
let therapy.° Subsequently it was shown that, careful patient and lesion selection with a dedicated implantation technique significantly reduces the risk of ScT as demonstrated by Puricel et al.° Nevertheless and as already experienced by Dotter or Higaki and Tamai, BVS thrombogenicity remains higher than with DES. This was nicely illustrated by Joner 10 using an arterioven-
ousous shunt model, this group demonstrated how accentuated fibrin deposition forms in the vicinity of the struts with the formation of a ‘chronic thrombus’. This demonstra-

_**BVS AND THE FUTURE***

Taking all items together, the question is whether we took a step forwards or backwards with BVS as in 2006 with the ESC DES Firestorm.° This is of particular interest given that beside BVS the latest DES platforms have signif-

icantly evolved, combining low-dose of bioreabsorbable polymer with low-dose antiproliferative drugs on thin-

layered metal backbones. So, it is urgent to ..... wait! Given that the potential benefit of BVS should be seen after 3 years (once the scaffold has resorbed), for now we need to wait for these long-term results. In the interim physicians should carefully weigh the individual risks (eg, prolonged dual antplatelet therapy) versus the potential benefits of BVS on an individual patient basis and con-

sider it primarily in simple non-calciﬁed lesions or longer lesions (possible vascular restoration therapy), with thor-

ough lesion preparation and using a dedicated implantation technique to maximise the chances of success.

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