Veryan Medical: Improving Stent Performance With 3-D, Helical Geometry

by Mary Thompson

One of the most interesting emerging competitors in the peripheral vascular stenting space is UK-based **Veryan Medical Ltd.** The privately held, venture-funded company has developed a unique yet straightforward method of producing lower-extremity stents it believes will be more resistant to both fracture and restenosis – by changing the stent shape from a straight tube to a 3-D helical geometry.

According to company CEO Chas Taylor, who spoke recently with *Medtech Insight*, this helical configuration mimics the natural, gentle helical shape of the vascular system and facilitates a more natural "swirling" blood flow pattern in the treated vessel. This swirling flow pattern is important, Taylor says, because it reduces areas of blood stagnation, where atherosclerotic deposits often form, and improves oxygen and nutrient transfer in the vessel, all of which should help limit the intimal cell growth that leads to restenosis. In addition, the helical shape improves the biomechanical performance of the stent, he explains, by removing the stent's stress points and enabling it to flex around a midpoint, which increases the device's ability to withstand the compression, extension, and flexion forces in the lower leg that often lead to stent fracture.

Using its patented technology, the company has constructed its own peripheral vascular stent, the *BioMimics 3D*, which received the CE mark in November. (*See Exhibit 1.*) However, according to Taylor, the technology could be applied to "nearly any existing nitinol stent" to transform a straight stent into a 3-D helical configuration. The process, which is employed as the last step in stent manufacture, involves heating the stent and placing it on a specially designed mandrel (or spindle) with a specific, corkscrew-like shape. After the stent is removed and cooled, it retains the helical shape of the mandrel. Although most of the research and development work the company has performed to date has involved self-expanding stents made of nitinol, Taylor says preclinical studies show the technology can be applied to balloon-expandable stents as well.

The original idea for Veryan's technology came out of **Imperial College, London** (Veryan was spun out of Imperial College in 2003) from work initially performed by Colin Caro, MD, DSc, a bioengineer who is an expert in the physiology of blood flow and the dynamics of the vascular system. Caro published work as far back as the 1970s showing that the vascular system has a natural helical shape, which creates a swirling blood flow in the vessels. Caro's subsequent work demonstrated that vascular disease occurs most often in vessel areas where this swirling flow is dampened – that is, areas of low wall shear stress (low blood flow velocity against the vessel wall) and flow stagnation. The latter explains, Taylor says, why most vascular disease occurs in the superficial femoral artery (SFA) and smaller popliteal vessels of the lower leg, which exhibit less of this swirling flow.

Caro's discoveries also support Veryan's reasoning that a helical-shaped stent designed to mimic the vascular system's natural helical geometry and facilitate this swirling flow should perform better in vivo than a straight tube stent. In a healthy, unstented SFA, when the knee bends, the vessel compresses by as much as 10% to 20%, Taylor explains. However, if a straight stent, particularly a long stent, is implanted into the SFA, the stent reduces the vessel's ability to accommodate the compressive deformation that occurs when the knee bends because the stent is stiffer than the native artery. As a result, the unstented portions of the vessel tend to kink or bunch, he says, which inhibits healthy blood flow and imposes strain on the stent structure. By contrast, a helical-shaped stent enables the vessel to absorb those forces in a more natural manner without as much kinking and strain.

Building on Caro's work, Veryan set out to demonstrate in both clinical and preclinical studies that a helical-shaped stent would outperform a straight stent in the lower extremities. The company was specifically interested in three areas of unmet need in terms of existing peripheral arterial disease (PAD) stenting technologies: restenosis, stent fracture, and vessel management (i.e., vessel kinking). In preclinical work, Veryan compared the fracture resistance of its BioMimics 3D stent, which is designed to provide optimized helical geometry, versus several existing straight stents and found that the BioMimics device was substantially more resistant to fracture, withstanding a mean compressive deformation of more than 16%, which was higher than any other stent tested (most competitive devices fractured at

Exhibit 1

Veryan Medical's BioMimics 3D Stent

SOURCE: Veryan Medical

around 10% to 12%). The firm also performed studies in pigs showing that the helical stent resulted in much lower levels of neointimal cell growth than straight stents, suggesting that the helical device could improve blood flow characteristics and reduce restenosis in the vessel.

This work led to the firm's 76-patient safety and feasibility CE mark study, MIMICS, conducted at eight sites in Germany. MIMICS randomized patients to receive either the BioMimics 3D device or a straight stent control (primarily the *LifeStent* from **CR Bard Inc.**). Interim data from that trial, involving 12-month follow-up on 50 patients, were presented at the 2012 *VIVA* meeting, and showed a trend toward lower major adverse events (death, amputation, and clinically driven target lesion revascularization) with the BioMimics stent versus the control (91.4% vs. 84.2%, according to the latest data analysis). Moreover, additional data (not presented at *VIVA 2012*) on vessel kinks in a small number of patients showed a kink rate of 4% (1/23) in the BioMimics stent versus 40% (4/10) in the control. Taylor expects the final 12-month MIMICS trial results to be available in Q1 2013.

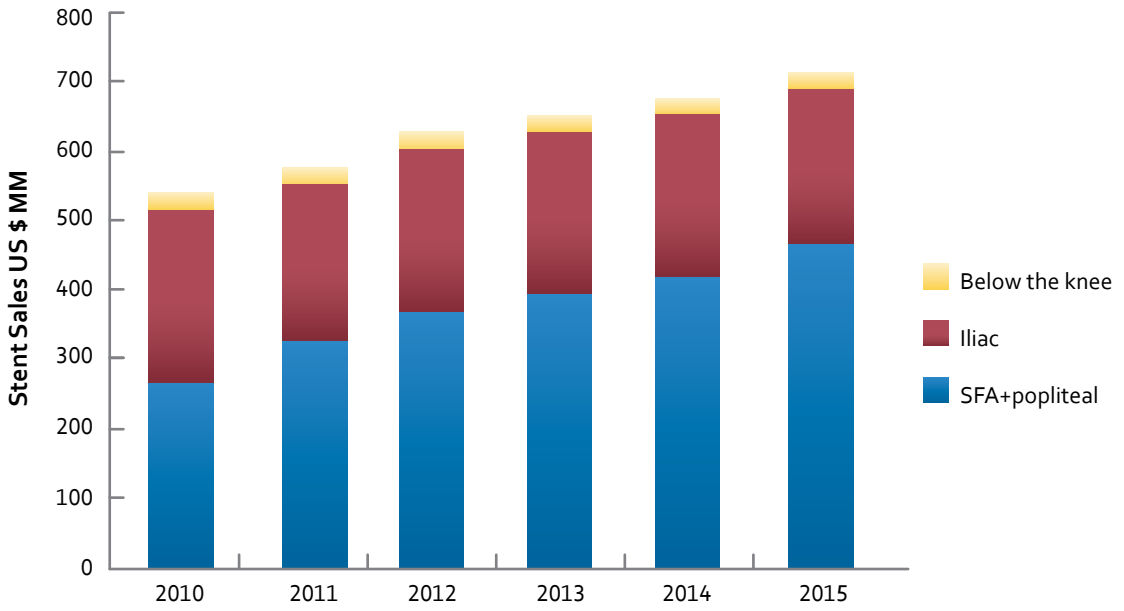
Veryan, which has not yet launched the BioMimics 3D device, is planning its next steps, including deciding whether it will enter the market by licensing the technology to another company operating in the stenting space or by launching on its own. "We're currently ramping up production [of the BioMimics 3D device] so that we could launch into selected markets OUS," Taylor says. And, the company is in discussions with a number of potential corporate partners. Veryan also has initiated talks with the FDA to gain some clarity on the US regulatory route. As part of that process, the firm is exploring whether there are any expedited US regulatory pathways that would enable it to gain faster US market approval by applying the technology to a stenting platform that is already approved in the US or is in the process of being approved.

Although Taylor believes Veryan's technology is an important advance for the peripheral stenting field, he acknowledges that stents alone will not be enough to address the PAD problem. Consequently, he views drug-coated balloons (DCBs) and peripheral stents as complementary, rather than competitive, technologies. "Drug-coated balloons have shown some very interesting results, and although they're still fairly early, I think any company that's in the peripheral market is probably going to need both [stent and DCB] technologies." As for the possibility of combining Veryan's helical stent with a DCB in the future, Taylor says that is clinically very interesting, but raises issues of cost and reimbursement and whether or not these combination therapies prove to be cost-effective. "Personally, I wouldn't like to run a clinical trial to look at [such a combination] because it's very hard to determine which of the technologies is responsible for the improvement." A trial like that is more likely to be performed as a postmarket study, he says. Taylor also expresses uncertainty about the US regulatory process for DCBs. It took the FDA a long time to approve **Cook Medical Inc.**'s *Zilver PTX* peripheral drug-eluting stent (DES), he points out, so it's going to be "very interesting" to see how the US approval pathway goes for DCBs.

Meanwhile, Veryan is looking at additional ways to leverage its technology platform, including the possibility of applying the technology to existing DES platforms, to create "market-beating stent technologies." According to the company, the US market for peripheral stents in the lower extremities was valued at just over $600 million in 2012 and is expected to reach over $700 million by 2015, with applications in the SFA and popliteal arteries accounting for the largest segment of the market. (*See Exhibit 2.*)

Exhibit 2

US Lower Limb Arterial Stent Market Forecast, 2010-2015E



SOURCE: Veryan Medical