Case Reports

Bioresorbable Scaffolds in Spontaneous Coronary Artery Dissection:

Long-Term Follow-Up in 4 Patients

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Spontaneous coronary artery dissection is a rare condition, and diagnosis and treatment are challenging among patients who present with acute coronary syndrome. Typically, the condition affects young females who have no underlying atherosclerotic disease. To date, few cases of bioresorbable scaffold implantation for the treatment of spontaneous coronary artery dissection have been reported. Therefore, we describe the cases of 4 patients whom we treated with scaffolds. We evaluated the long-term results by using intravascular ultrasound and optical coherence tomographic scanning. ***(Tex Heart Inst J 2017;44(6):405-10)***

Key words: *Absorbable implants; aneurysm, dissecting/diagnosis; blood vessel prosthesis; coronary vessels/diagnostic imaging/pathology; multimodal imaging/methods; percutaneous coronary intervention/instrumentation; rupture, spontaneous; tissue scaffolds; treatment outcome; vascular diseases/therapy*

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Spontaneous coronary artery dissection (SCAD) is an infrequent and often misdiagnosed coronary artery disease that occurs in 0.1% to 1.1% of patients in most angiographic series, and it represents 0.1% to 4% of all acute coronary syndromes.[1,2] Typically, it affects young women who have no underlying atherosclerotic disease.[3]

No consensus has been reached regarding the optimal treatment of patients with SCAD, but conservative management is typically considered best for stable patients. Percutaneous coronary intervention (PCI) may be considered for patients with ongoing chest pain, ischemia, ST-segment elevation, or hemodynamic instability, especially when the dissection affects major arteries, jeopardizing large areas of the myocardium.[4]

Patients undergoing PCI usually receive permanent metallic stents. However, bioresorbable scaffolds (BRSs) have been proposed as an alternative because they enable the dissection to be sealed and promote healing. Furthermore, BRSs can potentially restore the structure and functional characteristics of the treated coronary segment, particularly in cases of long dissections in which multiple overlapping stents are indicated. The use of metallic stents in this situation has been associated with a high rate of adverse events.[5]

We briefly describe the cases of 4 patients with SCAD whom we treated with BRSs and whose long-term results we documented through intravascular ultrasound (IVUS) and optical coherence tomography (OCT). All 4 patients were taking novel antiplatelet agents at the time of diagnosis. None had predisposing or precipitating factors for SCAD, such as fibromuscular dysplasia.

Case Reports

Patient 1

A 49-year-old woman, a former smoker, was admitted to the hospital for a non-ST-segment-elevation myocardial infarction (NSTEMI) that occurred during exercise. A coronary angiogram revealed a long type 2 SCAD[6] from the mid to distal segment of the left anterior descending coronary artery (LAD) (Fig. 1). The diagnosis was confirmed by IVUS and OCT, which further delineated an extensive false lumen that was filled with hematoma, compressing the true lumen. We implanted 3 overlapped ABSORB® Bioresorbable Vascular Scaffolds (Abbott Vascular; no longer commercially available) (sizes, 5 × 28 mm at the distal and mid segments and 3 × 28 mm proximally). The angiographic and IVUS results at the end of the procedure were excellent; the struts were well apposed, and the scaffold was well expanded with Thrombolysis In Myocardial Infarction (TIMI) grade 3 flow and no remaining stenosis or edge dissection. The overlapped BRSs caused notable straightening of the LAD. At one

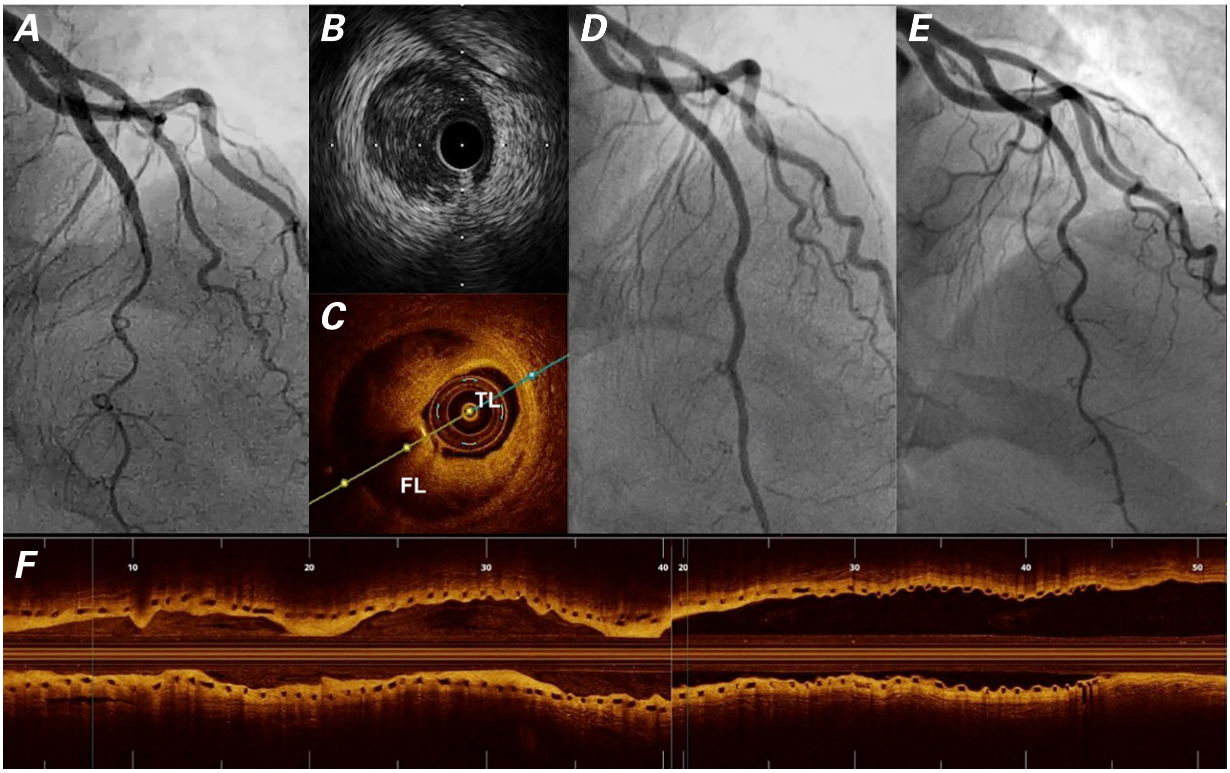

Fig. 1 *Patient 1.* ***A****) Angiogram shows type 2 spontaneous coronary artery dissection from the mid to the distal segment, confirmed by an* ***B****) intravascular ultrasonogram and an* ***C****) optical coherence tomogram (axial view) showing the dissection with a true lumen (TL) compressed by an extensive false lumen (FL) filled with intramural hematoma.* ***D****) Angiogram shows immediate straightening of all bends in the artery after implantation of 3 overlapped bioresorbable scaffolds.* ***E****) Angiogram after one year shows the healed vessel with its structure restored.* ***F****) Optical coherence tomogram (long view) shows results at one year.*

Supplemental motion image is available for Figure 1C.

year, angiograms and OCT revealed that the vessel had healed and returned to its original structure. There was no restenosis, TIMI grade 3 flow was present, and all the struts—which typically disappear 4 to 5 years after implantation—were covered with neointima.

Patient 2

A 59-year-old woman, an obese, active smoker, was admitted to the hospital with an anterior ST-segment-elevation myocardial infarction (STEMI), and she was given thrombolysis. Transthoracic echocardiograms showed anterior hypokinesis with mild impairment of the left ventricular ejection fraction. Angiograms revealed a spiral type 1 SCAD of the LAD from the ostium to the first diagonal branch and TIMI grade 3 flow (Fig. 2). During intervention, IVUS was used to confirm positioning of the guidewire in the true lumen, and 2 Absorb BRSs were implanted within the left main coronary artery (3 × 28 mm) and LAD (3.5 × 28 mm). A small gap was left between the 2 BRSs. Angiographic results were excellent after intervention and at one-year follow-up on OCT. There was no restenosis, TIMI grade 3 flow was present, and all the struts were covered with neointima.

Patient 3

A 50-year-old woman with a history of tonsillectomy and appendectomy was admitted to the hospital with an anterior NSTEMI. A coronary angiogram revealed an LAD with occlusion from the 2nd diagonal branch to the end of the LAD and TIMI grade 0 flow (Fig. 3). After the guidewire was crossed, IVUS confirmed the diagnosis of a type 1 SCAD. We performed direct implantation of a 2.5 × 28-mm Absorb BRS, which we postdilated with a 3 × 10-mm BEO NC noncompliant balloon (SIS Medical; Winterthur, Switzerland).

An angiogram and IVUS obtained after the procedure showed an excellent result: all the struts were covered with neointima, and there was no restenosis. In addition, the patient was asymptomatic. At one year, OCT revealed a small dissection of the distal LAD. (The clinical impact of remaining dissections in small vessels is unknown.)

Patient 4

A 46-year-old woman, an active smoker with prior tonsillectomy, was admitted to the hospital with an anterior STEMI. She underwent unsuccessful thrombolysis and rescue PCI. Angiograms with contrast media injection

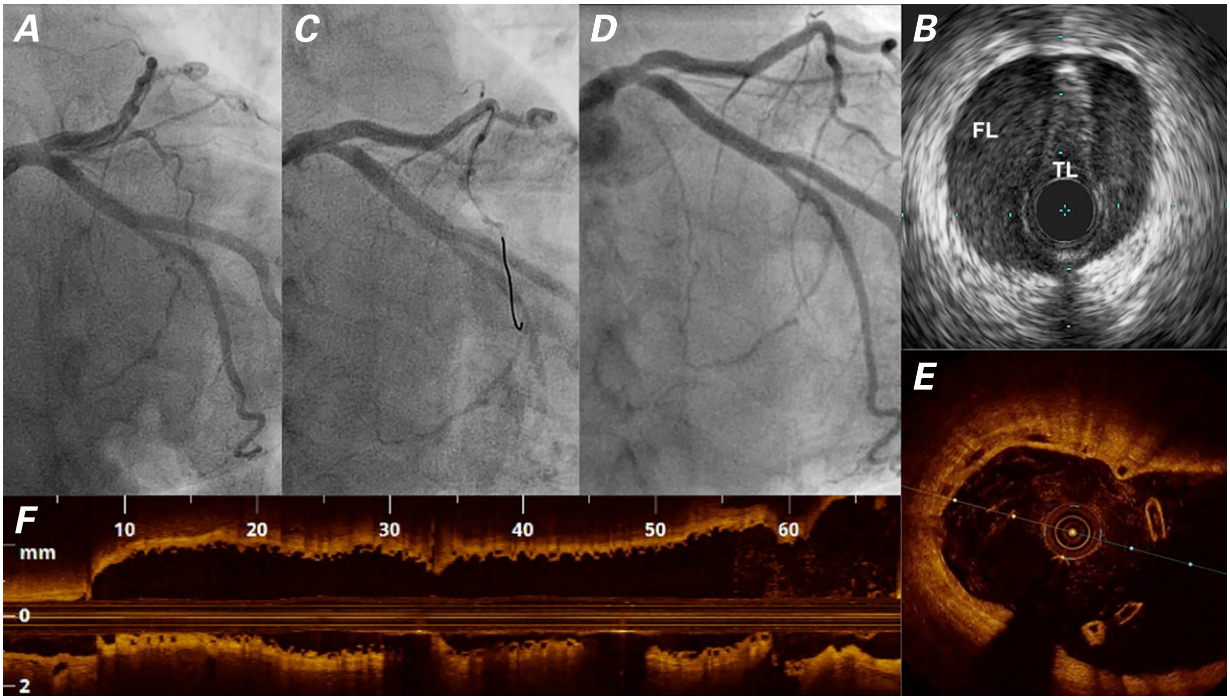

Fig. 2 *Patient 2.* ***A****) Angiogram shows a linear intraluminal filling defect extending to the mid left anterior descending coronary artery, corresponding with a spiral type 1 spontaneous coronary artery dissection from the ostium to the first diagonal branch.* ***B****) Diagnostic intravascular ultrasonogram confirms the correct position of the guidewire in the true lumen (TL) and shows an enlarged false lumen (FL).* ***C****) Angiogram shows final results after intervention. At one year, the* ***D****) angiogram and optical coherence tomograms in the* ***E****) axial view and* ***F****) long view at the bifurcation show excellent results.*

Supplemental motion image is available for Figure 2E–2F.

showed a spiral type 1 SCAD from the proximal LAD to the end of the vessel and TIMI grade 0 flow. Under IVUS guidance, we directed the guidewire into the true lumen and directly implanted a 3.5 × 23-mm ABSORB BRS. Flow improved to TIMI grade 3, but this caused a double lumen to form from the distal edge of the BRS with involvement of the diagonal branches (Fig. 4). At 2-month follow-up, the dissected segment remained, so we placed the patient on optimal medical therapy to promote spontaneous healing.

At one year, the patient reported chest pain on moderate effort. An angiogram showed that the dissection had not healed, so we performed PCI. Under OCT and IVUS guidance, we confirmed a widely patent BRS in the true lumen. Immediately distal to the BRS, we identified a true lumen and an enlarged false lumen. A comparison of the OCT and IVUS images obtained at specific sites along the LAD revealed that the true and false lumens communicated at multiple points up to the distal segment. We confirmed correct distal positioning of the guidewire in the true lumen and performed angioplasty, followed by implantation of the BRSs. We implanted a 2.5 × 28-mm ABSORB BRS distally, and then a 3.5 × 28-mm BRS proximally, the latter of which we overlapped with the existing BRS. Consequently, the 2nd diagonal branch abruptly occluded, and we reopened it with a PT²™ Light Guide Wire (Boston Scientific Corporation; Natick, Mass.) and balloon angioplasty (1.5 × 10 mm at an inflation pressure of 10 atm). We decided to protect and predilate the 3rd diagonal branch with the same balloon. Next, we implanted a new 3 × 12-mm ABSORB BRS in the mid segment of the LAD, overlapping the proximal and distal ones. Final results on angiograms were good, and the OCT revealed good apposition with a small dissection in the LAD. The patient was asymptomatic at 6-month follow-up.

Discussion

Spontaneous coronary artery dissection is a rare condition, and its diagnosis and treatment are challenging. Risk factors for SCAD vary and include age <60 years, female sex, fibromuscular dysplasia, systemic inflammation, connective tissue disorders, and pregnancy. These risk factors are often compounded by precipitating stressors.[4]

No guidelines exist for managing SCAD. It has been suggested that patients without ongoing ischemia with preserved coronary flow (TIMI grade 3), single vessel involvement, or distal vessel involvement may benefit from conservative medical management. However, these

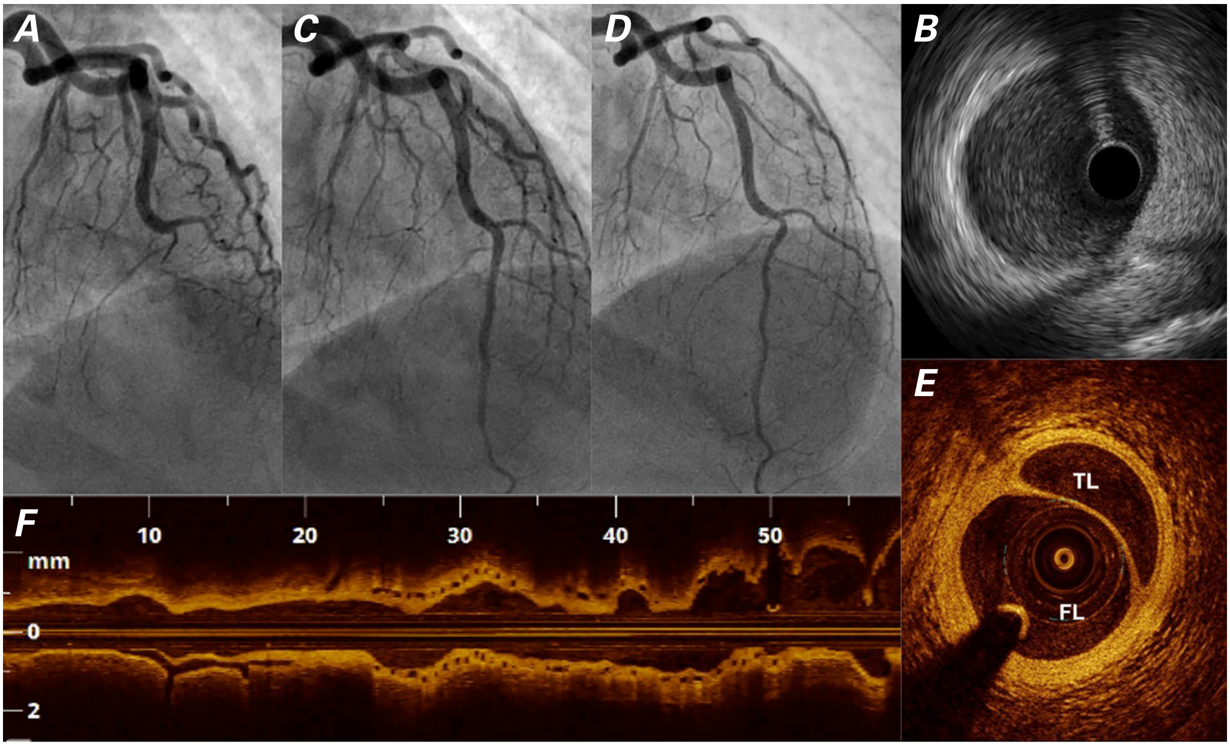

Fig. 3 *Patient 3.* ***A****) Angiogram shows the left anterior descending coronary artery (LAD) with occlusion from the 2nd diagonal branch to the end of the vessel and Thrombolysis in Myocardial Infarction grade 0 flow.* ***B****) Diagnostic intravascular ultrasonogram shows a type 1 spontaneous coronary artery dissection after the guidewire is crossed. Angiograms show results* ***C****) after intervention and* ***D****) at one year. Optical coherence tomograms in* ***E****) axial and* ***F****) long views, obtained at one year, show excellent results with a small dissection on the distal LAD.*

Supplemental motion image is available for Figure 3E–3F.

patients are at risk of retrograde extension, progression of the dissection, simultaneous involvement of other major epicardial vessels, and recurrent acute myocardial infarction. Patient age, anatomic features of the coronary vessel, extent of the dissection, and clinical presentation contribute to large variability in clinical outcomes and mandate that decisions regarding optimal management be made for each patient.

Percutaneous coronary intervention may be an option for patients who are unstable, especially those whose dissection affects major arteries, although PCI in the presence of SCAD is challenging. Identifying the true lumen during guidewire insertion can be difficult and might lead to extension and worsening of the dissection. Similarly, repeated injections of contrast media can further propagate SCAD in the proximal arterial sections. The hematoma of the dissected segment can also propagate antegrade or retrograde during angioplasty, further compromising arterial blood flow and extending the dissection. Long dissections often necessitate placement of multiple overlapping stents to preserve the patency of the coronary lumen. Because dissections often involve distal coronary segments, which are too small for stent implantation, stenting should be avoided in patients who have preserved coronary flow beyond the site of dissection and extensive hematomas within the vessel wall. There are strategies that may improve outcomes in such patients, including stenting only the proximal portion of the dissection; targeting the presumed entry point of a hematoma identified by OCT or IVUS, with the aim of sealing the flap or entry point, enabling the hematoma to heal; selecting longer stents to adequately cover both edges of the lesion; and, for longer lesions, following a multistep approach of stenting the distal and proximal edges and then the middle part of the dissection, to prevent intramural hematoma propagation.[4] Late stent malapposition after healing of the SCAD substantially increases the risk of late stent thrombosis.[7] Conceptually, BRSs are appealing for treating unstable patients with SCAD who need PCI, although, to date, few cases have been reported.[8-14]

The role of BRSs in treating patients with coronary artery disease is not clear, given the current limitations of the technology and the increased risk of stent thrombosis seen in clinical trials.[15] Moreover, in the presence of SCAD, the sizing of vessels may be challenging because the true lumen is distorted; improper sizing of BRSs increases the risk of early stent thrombosis.[4]

Intravascular ultrasound readily depicts the true and false lumens, without the need for contrast media. It

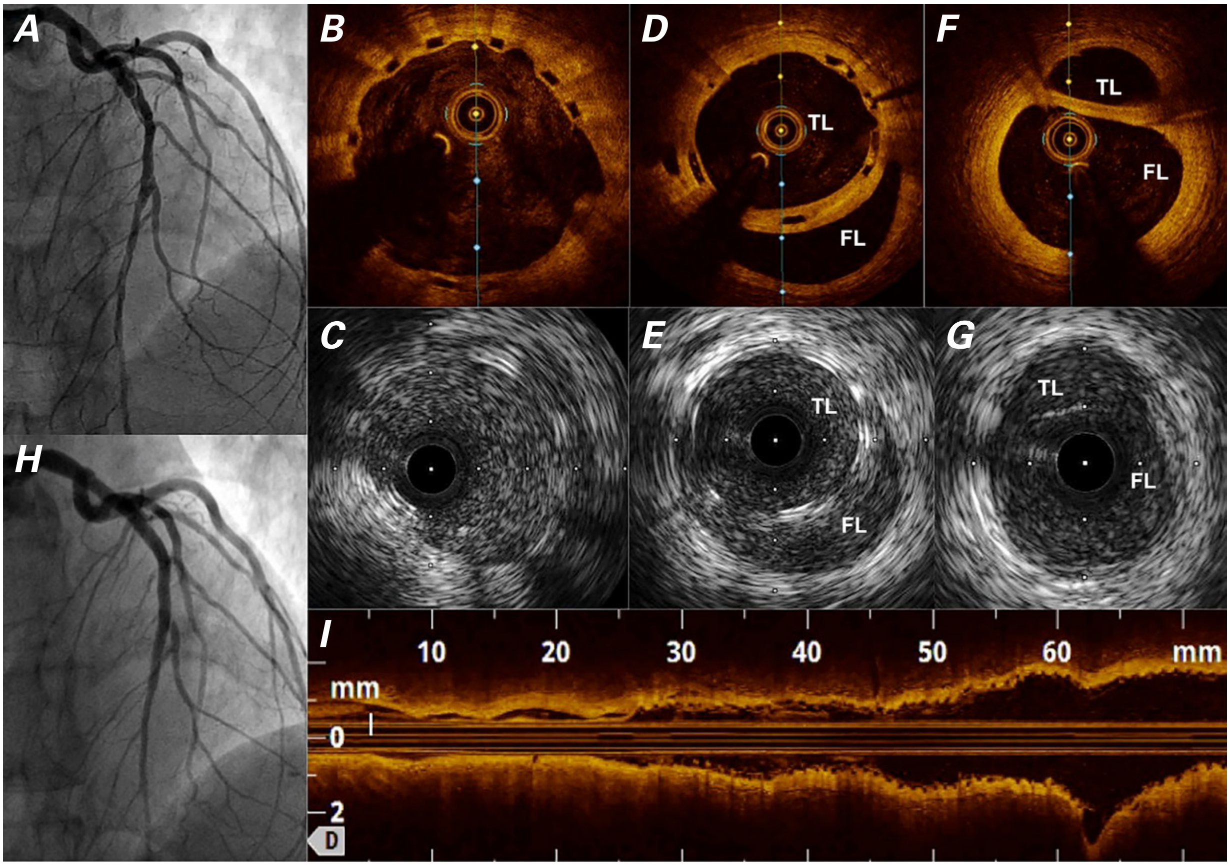

Fig. 4 *Patient 4.* ***A****) Angiogram during first bioresorbable scaffold (BRS) implantation shows remaining dissection of the left anterior descending coronary artery (LAD) distally. At one year, corresponding* ***B****) optical coherence tomogram (OCT) (axial view) and* ***C****) intravascular ultrasonogram (IVUS) confirm a widely patent BRS implanted in the true lumen (TL) of the proximal LAD.* ***D****),* ***E****) Corresponding images show the previous BRS implanted in the TL and, immediately distal to that, a double lumen with a large false lumen (FL).* ***F****),* ***G****) Corresponding images show the guidewire in the FL, and a smaller TL.* ***H****) Angiogram shows the result after BRS implantation.* ***I****) Optical coherence tomogram (long view) after implantation of 3 BRSs reveals good apposition with a small dissection in the very distal LAD.*

Supplemental motion image is available for Figure 4B, 4D, and 4F.

enables thrombosis in the false lumen to be seen, and it can help to differentiate normal vessel walls from atherosclerotic plaque and SCAD. Importantly, ultrasound penetrates deeply into the vessel wall, providing a full picture of the longitudinal and circumferential extension of the false lumen. Because of these advantages, IVUS was our imaging technique of choice for most of our patients at baseline. Our use of OCT for follow-up enabled us to objectively evaluate scaffold performance at a much higher resolution.[4,16,17]

Bioresorbable scaffolds may have advantages over conventional metallic stents. Their superior conformability and flexibility help preserve tissue biomechanics and vessel structure. In contrast, metallic stents may alter biomechanics and vessel structure, and the resultant chronic irritation and flow disturbances may contribute to neointimal proliferation and adverse events.[18,19]

Patient 1's case illustrates that implanting a BRS can help to preserve and restore the vessel structure. The Absorb BRS, which we used in our patient, is more conformable than metallic stents, ultimately lessening vessel angulation and curvature.[20] Restoration of the vessel structure can take 6 months to one year after BRS implantation. In contrast, the structure of coronary vessels remains permanently altered after metallic stents are implanted.[21] This finding is of utmost importance in regard to patients with SCAD because they usually have tortuous vessels.[4]

Patient 2's case represents a complex situation in which 2 BRSs were implanted in the left main coronary artery and the LAD. The possibility of scaffold bioresorption is important for very young patients because it may overcome some other problems associated with the use of metallic stents, such as jailing of the side branches,[22] overhang at ostial lesions, and inability to graft the stented segment.

The cases of Patients 3 and 4 illustrate the challenges that an interventional cardiologist faces in treating SCAD, and they highlight the usefulness of advanced intracoronary imaging techniques. Dissections that do not heal spontaneously can lead to future hospitalizations and cardiovascular events.[4]

In patients who have SCAD without significant atherosclerotic lesions or calcification, predilation, which is usually mandatory during BRS implantation, can be skipped. Another advantage of using BRS implants in patients with SCAD is that there is usually no need for aggressive postdilation to achieve good strut apposition to the vessel wall. Good apposition was attained in all our patients, although balloon postdilation was used only in Patient 3. It is important to note that high-pressure postdilation can damage BRS struts.

To our knowledge, ours is the largest series of patients with SCAD treated with BRSs and who were monitored long-term with IVUS and OCT intracoronary imaging. This experience shows that BRSs may be an effective alternative to metallic stents when intervention for SCAD is necessary.

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