Successful bailout stenting strategy against rare spontaneous retrograde dissection of partially absorbed magnesium-based resorbable scaffold: A case report

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Abstract

BACKGROUND
In the development of coronary stent technology, bioresorbable scaffolds are promising milestones in improving the clinical treatment of coronary artery disease. The “leave nothing behind” motto is the premise of the fourth revolution in percutaneous coronary intervention (PCI). Studies proving the safety and efficacy of the magnesium-based resorbable scaffolds (MgBRSs) include the BIOSOLVE-I and BIOSOLVE-II trials and the latest BIOSOLVE-IV registry. However, spontaneous retrograde dissection of a partially absorbed MgBRS may still occur, albeit rarely.

CASE SUMMARY
We describe an unusual case of coronary artery disease in a patient who had undergone a successful PCI 8 mo earlier, where an MgBRS was implanted into the left anterior descending artery (LAD) and left circumflex artery with drug-coated balloons for a ramus intermedius branch stenosis to achieve the “leave nothing
A 45-year-old man was admitted to the cardiovascular department with complaints of worsening chest tightness, dyspnea, and left shoulder pain that had worsened over the preceding weeks.
History of present illness
The chest tightness progressed and worsened. The patient described it as a dull, non-spreading tightness over the retrosternal area. However, angina occurred more commonly in the morning. Each episode lasted a few minutes and usually subsided after taking a short rest. He experienced slight limitations in his daily activities.

History of past illness
The patient had a history of hypertension, dyslipidemia, coronary artery disease, and he had undergone percutaneous coronary intervention (PCI) eight months ago using a new MgBRSs over the left anterior descending artery (LAD) and left circumflex artery. He was on several medications for many years, including angiotensin-receptor blockers, calcium channel blockers, and HMG-CoA (3-hydroxy-3-methylglutaryl-coenzyme A) reductase inhibitors. He had no known history of allergies.

Personal and family history
He had a family history of coronary artery disease. He was also a chain smoker (20 cigarettes per day), with more than 20 years of smoking history before he quit smoking in 2018. He denied any illicit drug or alcohol use.

Physical examination
The patient’s body-mass index was approximately 29.7 (kg/m²), indicating obesity. His blood pressure was 120/79 mmHg with a regular heart rate of 72 beats per minute. Cardiac examination, including auscultation for carotid bruits, jugular venous pulse, heart sounds, and murmurs was normal.

Laboratory examinations
On admission, laboratory data, such as blood cell count, electrolytes, and biochemistry blood analysis, were within normal limits. A 12-lead electrocardiogram showed normal sinus rhythm with low voltage and borderline right axis deviation. Myocardial perfusion scans were previously performed to determine the extent and location of myocardial ischemia and revealed partial reversibility with notable ischemia at the apical segment.

Imaging examinations
Chest radiography showed normal cardiac size and configuration. Patients underwent post-implantation intravascular ultrasound (IVUS) and optical coherence tomography (OCT) evaluation during admission. The main OCT imaging findings were near total resorption of the MgBRS struts eight months after implantation without substantial vessel recoil, which could have been caused by early radial strength deficiency (Figure 1). A distal edge vascular response (EVR) was apparent (Figure 2A).

Further imaging work-up
For distal EVR (Figure 2A), the patient underwent coronary angiography following balloon angioplasty (Figure 2B), which led to type B dissections in the partially absorbed MgBRS of the LAD. Coronary angiography revealed localized parallel strips and a double lumen separated by a radiolucent area during dye injection with obvious residual enhancement after imaging contrast clearance (Figure 2C).

FINAL DIAGNOSIS
The final diagnosis was spontaneous retrograde dissection of a partially absorbed MgBRS.

TREATMENT
A 6F EBU SH guiding catheter (Cordis Corporation, Miami Lakes, FL, United States) was uneventfully inserted into the left coronary artery via the patient’s right radial artery. Workhorse guidewires are usually used during this procedure, including the RUNTHROUGH NS Extra Floppy (Terumo Medical Corporation, Somerset, NJ, United States). Subsequent bailout stenting was accomplished with revascularization of entry and exit sites created by spontaneous dissection and by complete sealing of
Figure 1 Intravascular ultrasound 8 mo prior, optical coherence tomography and coronary angiography findings. A-C: The treated segments are proximal cross-section (A), middle cross-section (B), distal cross-section (C). Post-implantation intravascular ultrasound images of the magnesium-based metal scaffolds show good apposition of struts. Real-time optical coherence tomography pullbacks vividly demonstrate almost complete resorption of the struts at the 8th month. MRS: Magnetic resonance spectroscopy; LAD: Left anterior descending artery.

Figure 2 Coronary angiography images. A: Edge vascular response adjacent to the distal edges after implantation of fully magnesium-based resorbable scaffold; B: Optimal balloon angioplasty; C: Coronary dissection occurs with rapid spreading out (in antero-cranial view).

Following validation of possible complications associated with spontaneous dissection and final LAD coronary flow status, all rescue strategies and treatments were successful (Figure 4).

OUTCOME AND FOLLOW-UP

After the intervention treatment, oppressive retrosternal chest discomfort during
Figure 3 Optical coherence tomography images. A: Proximal cross-section; B: Middle cross-section; C: Distal cross-section. Optical coherence tomography results are consistent with the estimates of the prior image study and showed good apposition struts.

Figure 4 Coronary angiography images. Image of percutaneous coronary intervention reveals satisfactory outcomes in the antero-cranial view.

procedure subsided. Mild myocardial damage was observed (Max Troponin I: 10.5093 ng/mL) without ST segment elevation in electrocardiogram interpretation, and myocardial contractility was well preserved (left ventricular ejection fraction: 74%). The patient was closely followed-up for 10 mo in the cardiovascular outpatient department with cardiac rehabilitation, and follow-up period was uneventful.

DISCUSSION

This is the first case report of a rare spontaneous dissection of a partially absorbed MgBRS, successfully treated with bailout drug-eluting intracoronary stenting. PCI is a safe and effective procedure used to improve blood flow through the coronary circulation. Procedures that improve coronary revascularization, including atherectomy and radiation, involve the use of balloon angioplasty and intracoronary stenting with DES, bare metal stents, or resorbable scaffolds (BRS)\(^5\). Patients with long life expectancies and simple coronary artery disease benefit more from bioresorbable scaffold technology that provides short duration vessel support (12 mo) and a drug-delivery effect, compared to DES from permanent metallic stents that pose long-term limitations\(^6\).

Our real-world experience includes 21 consecutive subjects who underwent PCI with MgBRS at the Cardiology Department of Shin Kong Wu Ho-Su Memorial Hospital between May 2019 and August 2020. Data were collected from clinical and PCI records, which included demographic characteristics, PCI details, medical history, and in-hospital complications (Table 1).

Most of our patients were men, with ages ranging from 43 to 70 years. The rates of hypertension, dyslipidemia, and diabetes mellitus were 81%, 81%, and 33.3%, respectively. None of the patients had anemia or chronic kidney disease. We adhered to the implantation guidelines, including selection of de novo lesions, quantitative
Table 1 Baseline characteristics of patients

| Baseline characteristics                  | n (%)          |
|------------------------------------------|----------------|
| Age (mean ± SD)                          | 58.14 ± 8.60   |
| Male                                     | 19 (90.5)      |
| Hypertension                             | 17 (81.0)      |
| Hyperlipidemia                           | 17 (81.0)      |
| Smoking                                  | 4 (19.0)       |
| Diabetes mellitus                        | 7 (33.3)       |
| Insulin dependent                        | 0 (0)          |
| Non-insulin dependent                    | 7 (33.3)       |
| History of MI                            | 0 (0)          |
| Previous percutaneous intervention       | 4 (19.0)       |
| NSTEMI                                   | 0 (0)          |

SD: Standard deviation; MI: Myocardial infarction; NSTEMI: Non-ST-elevation myocardial infarction.

OCT provides a significantly superior resolution that allows precise evaluation of apposition struts, resorption, and relevant vessel wall pathology. Patients underwent post-procedural OCT or IVUS evaluation, a planned angiographic and OCT follow-up at 6 and 12 mo, if available, and scheduled clinical assessments. Double anti-platelet therapy was mandatory for at least 12 mo.

In the first-generation BRS era, the ABSORB Cohort B study used serial OCT imaging to examine the EVR and its relationship with in-scaffold vascular response (SVR) after Absorb Bioresorbable Vascular Scaffold (Abbott Vascular) implantation with a 3-year follow-up period. In a previous study, Zhang et al assumed that the geometric modification at the edges of the Absorb Bioresorbable Vascular Scaffold (Abbott Vascular) was not a separate pathological occurrence, but just an extension of the changes in luminal dimension revealed at the margins of the in-scaffold. The Magmaris EVR invasive imaging analysis in the Biosolve-II trial (123 patients) sub-study was a single-arm, prospective, multi-center study that included 20 patients. In the proximal and distal EVR assessments, segment- and frame-level analysis of the 5 mm segments proximal and distal to the actual MgBRS revealed that there were no meaningful changes in intracoronary imaging, including OCT, grayscale IVUS, and virtual histology IVUS.

The types of coronary artery dissection, according to the NHLBI classification system, include type A and B, which are clinically benign, whereas types C-F may lead to catastrophic clinical events unless they are promptly and safely treated. Laceration of the coronary endothelium and rupture of the vasa vasorum are possible pathological mechanisms that may explain the spontaneous separation of the layers of the vascular wall. Side effects of the degradation products from MgBRSs are not expected since magnesium plays a key role in many biological systems. However, no data are available regarding the possible consequences of a rare spontaneous retrograde dissection of a partially absorbed MgBRS.

In the absence of evidence-based randomized trials to analyze the outcomes of different strategies, the optimal treatment for spontaneous coronary artery dissection remains unknown. Several recent strategies have refined the outcome of spontaneous coronary artery dissection, including traditional DESs, BRSs, and drug eluting balloons. Similarly, due to the lack of conventional data, expert consensus has recommended the use of biodegradable polymer sirolimus-eluting stents (Orsiro; Biotronik, Bulach, Switzerland) because its coating does not interfere with the residual magnesium alloy.
CONCLUSION

To achieve the therapeutic intention of “leave nothing behind” BRs have been materialized to conquer the limitations of metallic drug-eluting stents. We reported a rare case, the first in Taiwan, which demonstrated successful treatment of rare spontaneous retrograde dissection of a partially absorbed MgBRS with bailout stenting of the SES. This rare case report provides new information on MgBRS gathered from previous clinical experience, review of current data, anticipation, advice, and recommendations for interventional cardiologist. It also hints the possible future perspectives on MgBRS.

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REFERENCES

1. Neumann FJ, Sousa-Uva M, Ahlsson A, Alfonso F, Banning AP, Benedetto U, Byrne RA, Collet JP, Falk V, Head SJ, Jini P, Kastrati A, Kollier A, Kristensen SD, Niebauer J, Richter DJ, Sefirovic' PM, Sibbing D, Stefanini GG, Windecker S, Yadav R, Zembala MO. [2018 ESC/EACTS Guidelines on myocardial revascularization. The Task Force on myocardial revascularization of the European Society of Cardiology (ESC) and European Association for Cardio-Thoracic Surgery (EACTS)]. G Ital Cardiol (Rome) 2019; 20: 1S-61S [PMID: 31379378 DOI: 10.1714/3203.31801]

2. Iqbal J, Serruya PW, Silber S, Kelbaek H, Richardt G, Morel MA, Negota M, Buszman PE, Windecker S. Comparison of zotarolimus- and everolimus-eluting coronary stents: final 5-year report of the RESOLUTE all-comers trial. Circ Cardiovasc Interv 2015; 8: e002230 [PMID: 26047993 DOI: 10.1161/CIRCINTERVENTIONS.114.002230]

3. Schmidt T, Abbott JD. Coronary Stents: History, Design, and Construction. J Clin Med 2018; 7 [PMID: 29843465 DOI: 10.3390/jcm7060126]

4. Forrestal B, Case BC, Yerasi C, Musallam A, Chezar-Azerrad C, Waksman R. Bioresorbable Scaffolds: Current Technology and Future Perspectives. Ramham Maimonides Med J 2020; 11: 32374257 DOI: 10.5041/RMMJ.10402

5. Rapetto C, Leoc mini M. Magmaris: a new generation metallic sirolimus-eluting fully bioresorbable scaffold: present status and future perspectives. J Thorac Dis 2017; 9: S903-S913 [PMID: 28894596 DOI: 10.21037/jtd.2017.06.34]

6. Regazzoli D, Leone PP, Colombo A, Latib A. New generation bioresorbable scaffold technologies: an update on novel devices and clinical results. J Thorac Dis 2017; 9: S979-S985 [PMID: 28894604 DOI: 10.21037/jtd.2017.07.104]

7. Włodarczak A, Garcia LAI, Karjalainen PN, Komósci A, Pisano F, Richter S, Lanocha M, Rumoroso JR, Leung KF. Magnesium 2000 postmarket evaluation: Guideline adherence and intraprocedural performance of a sirolimus-eluting resorbable magnesium scaffold. Cardiovasc Revasc Med 2019; 20: 1140-1145 [PMID: 30833209 DOI: 10.1016/j.carrev.2019.02.003]

8. Fajadet J, Haude M, Joner M, Koo len J, Lee M, Tögl R, Waksman R. Magmaris preliminary recommendation upon commercial launch: a consensus from the expert panel on 14 April 2016. EuroIntervention 2016; 12: 828-833 [PMID: 27639734 DOI: 10.4244/EIJV12I17A137]

9. Serruya PW, On uma Y, Dudek D, Smits PC, Koo len J, Chevalier B, de Bruyne B, Thuesen L, McClear D, van Geuns RJ, Windecker S, Whitbourn R, Meredith I, Dorange C, Veldholf S, Hebert KM, Sudhir K, Garcia-García HM, Ormiston JA. Evaluation of the second generation of a bioresorbable everolimus-eluting vascular scaffold for the treatment of de novo coronary artery stenosis: 12-month clinical and imaging outcomes. J Am Coll Cardiol 2011; 58: 1578-1588 [PMID: 21958884 DOI: 10.1016/j.jacc.2011.05.050]

10. Zhang YJ, Iqbal J, Nakatani S, Bourantas CV, Campos CM, Ishibashi Y, Cho YK, Veldholf S, Wang J, Onuma Y, Garcia-García HM, Dudek D, van Geuns RJ, Serruya PW; ABSORB Cohort B Study Investigators. Scaffold and edge vascular response following implantation of everolimus-eluting bioresorbable vascular scaffold: a 3-year serial optical coherence tomography study. JACC Cardiovasc Interv 2014; 7: 1361-1369 [PMID: 25457053 DOI: 10.1016/j.jcin.2014.06.025]

11. Gogas BD, Bourantas CV, Garcia-García HM, Onuma Y, Muramatsu T, Farooq V, Diletti R, van Geuns RJ, De Bruyne B, Chevalier B, Thuesen L, Smits PC, Dudek D, Koo len J, Windecker S, Whitbourn R, McClear D, Dorange C, Miquel-Hebert K, Veldholf S, Rapoza R, Ormiston JA, Serruya PW. The edge vascular response following implantation of the Absorb everolimus-eluting bioresorbable vascular scaffold and the XIENCE V metallic everolimus-eluting stent. First serial follow-up assessment at six months and two years: insights from the first-in-man ABSORB Cohort B and SPIRIT II trials. EuroIntervention 2013; 9: 709-720 [PMID: 23628499 DOI: 10.4244/EIJV9I7A137]
Tateishi H, Suwannasom P, Sotomi Y, Nakatani S, Ishibashi Y, Tenekcioglu E, Abdelghani M, Cavalcante R, Zeng Y, Grundeken MJ, Albuquerque FN, Veldhof S, Onuma Y, Serruys PW; investigators of the ABSORB Cohort B study. Edge Vascular Response After Resorption of the Everolimus-Eluting Biodegradable Vascular Scaffold - A 5-Year Serial Optical Coherence Tomography Study. *Circ J* 2016; 80: 1131-1141 [PMID: 26936236 DOI: 10.1253/circj.CJ-15-1325]

Hideo-Kajita A, Garcia-Garcia HM, Haude M, Joner M, Koolen J, Ince H, Abizaid A, Toelg R, Lemos PA, von Birgelen C, Christiansen EH, Wijns W, Neumann FI, Kaiser C, Eeckhout E, Teik LS, Escaned J, Azizi V, Kuku KO, Ozaki Y, Dan K, Waksman R. First Report of Edge Vascular Response at 12 Months of Magmaris, A Second-Generation Drug-Eluting Resorbable Magnesium Scaffolds, Assessed by Grayscale Intravascular Ultrasound, Virtual Histology, and Optical Coherence Tomography. A Biosolve-II Trial Sub-Study. *Cardiovasc Revasc Med* 2019; 20: 392-398 [PMID: 31079817 DOI: 10.1016/j.carrev.2019.02.019]

Rogers JH, Lasala JM. Coronary artery dissection and perforation complicating percutaneous coronary intervention. *J Invasive Cardiol* 2004; 16: 493-499 [PMID: 15353832]

Yang C, Alfadhel M, Saw J. Spontaneous Coronary Artery Dissection: Latest Developments and New Frontiers. *Curr Atheroscler Rep* 2020; 22: 49 [PMID: 32734349 DOI: 10.1007/s11883-020-00866-4]
