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INTERMEDIATE

CASE REPORT: CLINICAL CASE

Use of Lithotripsy in a Calcified Saphenous Vein Graft

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ABSTRACT

Percutaneous coronary interventions in saphenous vein grafts can pose a variety of challenges, such as severely calcified lesions. If these lesions are nondilatable, lithotripsy can arguably be a proper tool for lesion preparation. We present a case in which a nondilatable, calcified saphenous vein graft was successfully treated using Shockwave lithotripsy. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2020;2:1891–4) © 2020 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

A 74-year-old man was admitted to the cardiology department with progressively worsening retrosternal chest pain for several weeks. He had now developed chest pain at rest that improved within 5 min after nitroglycerin administration. Physical examination was unremarkable and vital signs were normal (heart rate 52 beats/min, blood pressure 155/70 mm Hg after nitroglycerin).

LEARNING OBJECTIVES

- In degenerated SVGs, calcifications are predominantly found in the vessel wall instead of in the plaque, because of arterialization.
- Lithotripsy can be considered for lesion preparation in patients with calcified SVG stenoses.
- Intravascular imaging should be performed at a low threshold in severely calcified stenoses to optimize treatment selection.

MEDICAL HISTORY

The patient's medical history included non-insulin-dependent diabetes, hypertension, inferior wall myocardial infarction in 1980, coronary artery bypass grafting in 1985 (left internal mammary artery [LIMA] to left anterior descending coronary artery and a sequential saphenous vein graft [SVG] to a diagonal branch, an obtuse marginal branch, and the posterior descending artery), and sustained fast ventricular tachycardia followed by percutaneous coronary intervention (PCI) with drug-eluting stent (DES) implantation in the proximal SVG in 2014.

DIFFERENTIAL DIAGNOSIS

Clinical presentation and medical history were highly suggestive for a recurrent acute coronary syndrome. Theoretically, the patient could also have had hypertension or intermittent arrhythmias.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* author instructions page.

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ABBREVIATIONS AND ACRONYMS

DES = drug-eluting stent(s)

LIMA = left internal mammary artery

NC = noncompliant

PCI = percutaneous coronary intervention

SVG = saphenous vein graft

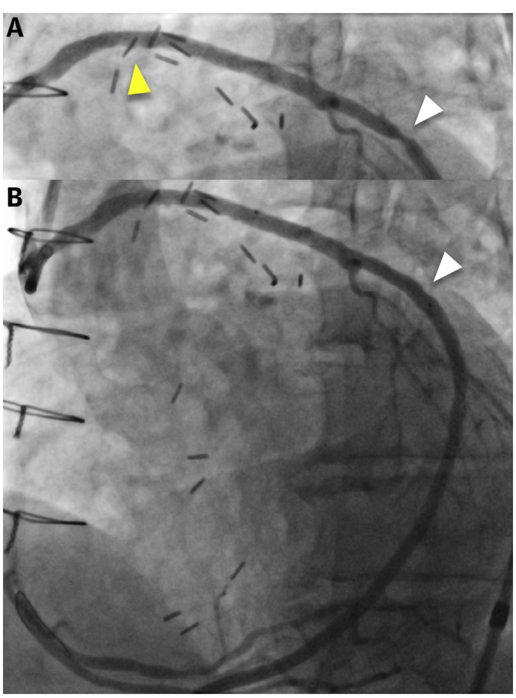
INVESTIGATIONS

The electrocardiogram was unchanged from previous outpatient electrocardiograms (sinus rhythm, heart rate 54 beats/min, negative T waves in the inferior leads). Serial high-sensitivity troponin and creatine kinase measurements were successfully used to rule out an acute myocardial infarction. Cardiac ultrasound showed known mildly impaired systolic left ventricular function without significant valvular disease. Because the diagnosis was unstable angina, coronary angiography was scheduled and revealed occlusion of all 3 native vessels. LIMA function was normal. The proximal SVG contained an in-stent restenosis. In addition, a short calcified stenosis was seen in the segment between the anastomoses with the diagonal and the obtuse marginal branches (**Figure 1A**, Video 1).

MANAGEMENT

The patient was discussed by the heart team and accepted for PCI of the SVG. PCI of the native vessels and redo coronary artery bypass graft surgery (considering the normal LIMA function) were considered inferior options.

FIGURE 1 Saphenous Vein Graft Angiography



Angiography before **(A)** and after **(B)** treatment of the new stenosis (indicated by a **white arrow in both panels**). The **yellow arrow in A** indicates the location of the successfully treated in-stent stenosis during the index procedure. See Videos 1 and 4.

During a transradial procedure, the in-stent restenosis in the proximal segment of the saphenous graft was successfully treated with a DES. Because this was a tight stenosis, it had to be treated before balloons with diameter >3 mm could be advanced toward the new stenosis. An attempt to treat this new stenosis was unsuccessful; the calcified lesion was resistant to high pressure (24 atm) dilation with noncompliant (NC) balloons up to 3.5 mm.

After team discussion, the patient was scheduled for a second attempt, with anticipated rotational atherectomy or lithotripsy. Transfemoral access was obtained to allow the use of an 8-F left Amplatz 1.0 guiding catheter.

Optical coherence tomography was performed to guide further treatment selection and confirmed the anticipated presence of excessive calcification; circumferential calcium (360°) was found over the entire length of the graft but in particular at the site of the stenosis (**Figures 2A, 2B, and 2E**, Video 2). Lithotripsy was considered the most appropriate method to prepare the lesion.

Optical coherence tomographic evaluation revealed a crack in the calcification (**Figure 2C**, Video 3) after application of 8 cycles of 10 pulses using a 3.5 × 12 mm Shockwave lithotripsy balloon (Shockwave Medical, Santa Clara, California). Pre-dilation was successfully performed using a 3.75-mm NC balloon, followed by implantation of a 3.5 × 13 mm DES. A 4.0-mm NC balloon was used to perform post-dilation. The final angiographic result can be appreciated in **Figure 1B** and Video 4. Normal coronary blood flow was present during this injection (TIMI [Thrombolysis In Myocardial Infarction] flow grade 3).

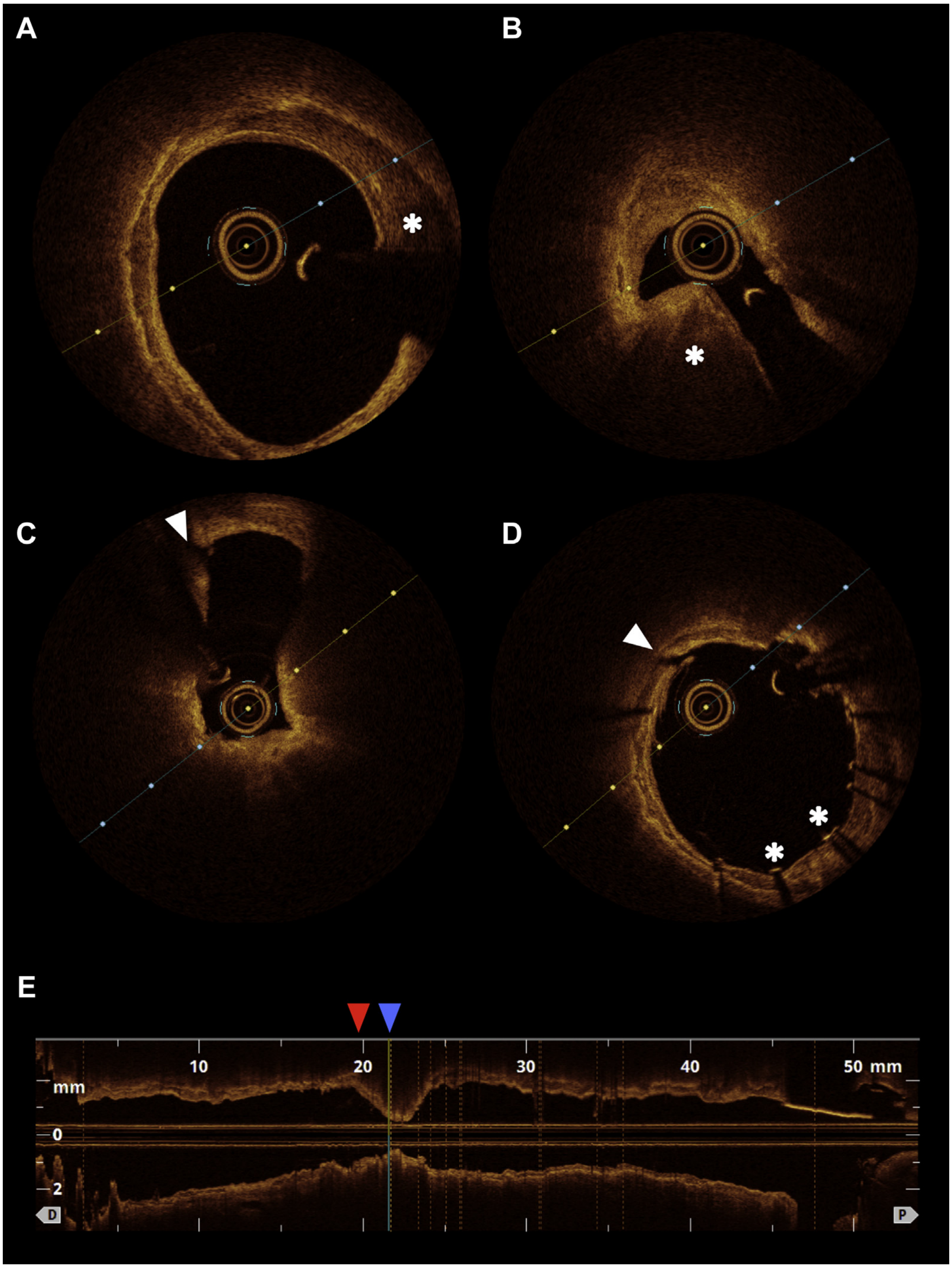
Optimal stent apposition and expansion were confirmed during the final optical coherence tomographic run (**Figure 2D**, Video 5).

DISCUSSION

In contrast to native artery calcification, the process of calcification within an SVG is not limited to the plaque but occurs predominantly in the vessel wall. This is considered to be the result of arterialization: fibrous thickening, medial hypertrophy, and lipid deposition caused by the hemodynamic stress on the graft (1).

The resulting calcifications of this process can clearly be seen in the presented case (**Figure 2**). The combination of these circumferential wall calcifications and an eccentric, severely calcified plaque caused the difficult lesion in this case. Proper lesion

FIGURE 2 **Optical Coherence Tomographic Findings Before and After Lithotripsy**



Imaging performed before lithotripsy reveals circular calcifications (marked by an **asterisk in A**; a distal reference close to the focal tight lesion). At the site of maximal stenosis, a large amount of superficial eccentric calcification can be seen in addition to the deep calcification (marked by an **asterisk in B**). Following lithotripsy, disruption of the arc of calcification can be seen at 11 o'clock (marked by an **arrow in C**). Proper expansion and apposition of the stent after post-dilation are shown in **D** (several stent struts are marked by an **asterisk**). A longitudinal view **(E)** reveals calcifications covering the entire length of the venous graft. **A and B** are cross-sectional views at the level of the **red and blue arrows**, respectively. See Videos 2, 4, and 5.

preparation using rotational atherectomy or lithotripsy, a technique in which calcium is cracked by sonic pressure waves, was therefore required.

Given the amount and depth of the calcium revealed by optical coherence tomography, scoring (or cutting) balloon lesion preparation was not considered sufficient and therefore not attempted. Contemporary imaging-supported decision algorithms, although not specifically designed for SVG lesions, support this assumption (2–4). However, an attempt to crack the calcium with a scoring balloon could have been performed during the index procedure.

Although rotational atherectomy using a Rotablator (Boston Scientific, Marlborough, Massachusetts) has not been approved for use in an SVG, successful rotational atherectomy has been described in degenerated grafts (5). This approach was therefore considered in this patient as well but eventually appeared to be a less suitable lesion preparation tool than lithotripsy in this case because of the eccentric, circular, thick, and deep calcifications. Furthermore, we hoped to minimize risk for distal embolization in a vessel prone to embolization in combination with a technique prone to distal embolization.

Although lithotripsy has proved to be an effective tool to prepare severely circumferential calcified stenoses in native coronary arteries (6), its use within venous grafts has not been described previously.

In this case, lesion preparation by lithotripsy allowed straightforward successful treatment of a calcified lesion in a 34-year-old SVG that was resistant to high-pressure NC balloon inflations.

FOLLOW-UP

Six months after the procedure, the patient is still free from angina.

CONCLUSIONS

In selected cases, lithotripsy appears to be a feasible option for severely calcified SVG stenoses that are resistant to NC balloon dilation.

AUTHOR RELATIONSHIP WITH INDUSTRY

The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS coronary artery bypass, percutaneous coronary intervention, stenosis, stents

APPENDIX For supplemental videos, please see the online version of this paper.