Failure to deliver stents and balloons past tortuous, calcific lesions because of inadequate support has long plagued interventional cardiologists. The mother–daughter technique using a GuideLiner Catheter (Vascular Solutions, Inc, Minneapolis, MN) is now commonly used to address these situations.1,2 Despite the improved support provided by the GuideLiner catheter, occasions arise in which a single GuideLiner is not adequate to facilitate the delivery of stents or balloons to target lesions. This is especially problematic when attempting percutaneous coronary intervention (PCI) on the retrograde limb of a bypassed coronary through a long saphenous vein graft (SVG). The double bend of the anastomosis into the retrograde coronary artery combined with the antegrade turn of the target branch is often uncrossable even with modern balloon and stent technology. We describe 2 cases of the mother–daughter–granddaughter double GuideLiner technique using a 6 Fr GuideLiner inside an 8 Fr GuideLiner to perform highly challenging PCI.

Case 1
Seventy-two-year-old man with a history of remote coronary artery bypass grafting with left internal mammary artery to left anterior descending and SVG to the first obtuse marginal (OM1) bypass, who later required left main, left anterior descending, and proximal left circumflex (LCX) complex bifurcation stenting, presented to his cardiologist with severe refractory chest pain. Subsequent angiography demonstrated that the left main, proximal LCX, and left anterior descending stents were totally occluded. The angiogram also showed a patent SVG to the OM1, with slow retrograde flow into a nearly occluded LCX and second obtuse marginal artery (OM2; Figure 2A and Data Supplement Movie I).

Description of the Procedure for Case 1
Given the complexity of the turns required to gain access to the LCX, the mother–daughter–granddaughter double GuideLiner approach was used. The mother–daughter–granddaughter system was assembled outside of the body (Figure 1), and the entire unit, including the microcatheter, was advanced into the coronary. The SVG bypass to the OM1 was wired, and the GuideLiner system was advanced so that the microcatheter was located in the OM2. The 6 Fr GuideLiner was placed proximal to the anastomosis of the SVG to OM1 (Figure 2B). After balloononing the ostial OM1 stenosis, the GuideLiner unit was further advanced into the LCX, allowing for the passage of equipment to the distal LCX (Figure 2C and Data Supplement Movie II). The vessel was ballooned and stented with excellent angiographic result (Figure 2D and Data Supplement Movie III).

Case 2
The patient is a 73-year-old man with a history of mitral valve replacement with bioprosthetic valve and severe coronary artery disease status after remote coronary artery bypass grafting, with known chronic total occlusion (CTO) of his LCX (Figure 3A and Data Supplement Movie IV). He presented with progressive shortness of breath and angina, despite maximal antianginal medications. A previous antegrade attempt at CTO PCI of the LCX was unsuccessful.

Description of the Procedure for Case 2
Given the complex nature of the turns needed to approach the LCX CTO, the mother–daughter–granddaughter double GuideLiner was again used. The GuideLiner system allowed for navigation of the SVG (Figure 3B and Data Supplement Movie V) followed by a sharp turn to wire back to the proximal ramus intermedius. The 6 Fr GuideLiner was positioned near the ostium of the LCX CTO, and a Turnpike catheter (Vascular Solutions, Inc) was used to facilitate wire escalation to cross the CTO from an antegrade approach (Figure 3C). The length of the lesion was then ballooned and stented with 2 drug eluting stents extending into the obtuse marginal branch (Figure 3D and Data Supplement Movie VI).

Discussion
GuideLiner-facilitated PCI is becoming increasingly common in clinical practice. A recent retrospective study by Waterbury...
et al\textsuperscript{3} described over 300 cases of GuideLiner-facilitated PCI and showed an 80% procedural success rate. Additionally, the mother–daughter approach using the GuideLiner has been demonstrated to aid in CTO and SVG PCI.\textsuperscript{4}

The presented cases are the first examples of utilization of a GuideLiner within a GuideLiner or the mother–daughter–granddaughter double GuideLiner technique. This technique allows navigation of tortuous saphenous grafts to enable wiring of the retrograde limb of the native circulation. This novel technique offers 2 advantages: (1) delivery of stents through the GuideLiner with unsheathing, rather than risky pushing of equipment through severe tortuosities; (2) improved guide length to approach distant targets, that is, via SVGs.

In the presented cases, no complications occurred. Several steps by the operator can be used to prevent complications and achieve successful intervention with the double GuideLiner technique. First, injections through the system should generally be avoided to prevent hydraulic vessel dissection. Second, the operator must perform meticulous back-bleeding of the catheters to prevent air entrainment or thrombus embolization. Third, because the double GuideLiner system may occlude blood flow, the patient must be carefully monitored for the development of ischemia or hemodynamic instability. Patients with borderline preprocedural hemodynamics may not tolerate this technique. Finally, the operator should avoid advancing the system only over a coronary wire, but rather should use a microcatheter or a balloon for additional support to reduce the probability of iatrogenic dissection.\textsuperscript{3}

In conclusion, we report the first 2 described cases using the mother–daughter–granddaughter double GuideLiner technique to successfully perform highly complex PCI in situations that may have previously been considered technically unapproachable.

**Disclosures**

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**References**


**Key Words:** chronic total occlusion ■ coronary artery bypass ■ guide catheter ■ percutaneous coronary intervention ■ saphenous vein graft
Figure 1. Mother–daughter–granddaughter double GuideLiner system. The mother–daughter–granddaughter double GuideLiner technique requires a 0.014" guidewire (A), a Turnpike microcatheter (B), a 6 Fr GuideLiner (C), and an 8F GuideLiner (D). The left panel shows the devices before assembly and right panel shows the devices assembled. The dilator of the 8 Fr GuideLiner may be used to dilate into the proximal portion of the 6 Fr GuideLiner (C) to create an improved seal. The device is inserted into the body as a unit. A distal anchor may also be used to aid in deployment.
Figure 2. Angiography and intervention for case 1. A, Diagnostic angiography demonstrating SVG to OM1 with retrograde filling of the LCX and the OM2 (see also Data Supplement Movie I). B, The 6 Fr GuideLiner (inside the 8 Fr GuideLiner) is shown approaching the distal anastomosis of the SVG to OM1. The Turnpike microcatheter and guidewire is positioned in the distal OM2. C, The system has been advanced and a balloon is inflated in the distal LCX. The 6 Fr GuideLiner is positioned beyond the OM1/LCX bifurcation, and the 8F GuideLiner is just proximal to the distal anastomosis of the SVG to OM1 (see also Data Supplement Movie II). D, The final angiographic result after deploying stents to the distal LCX and proximal portion of the OM1 through the mother–daughter–granddaughter double GuideLiner system (see also Data Supplement Movie III). GL indicates GuideLiner; LCX, left circumflex; OM, obtuse marginal; SVG, saphenous vein graft; and TP, Turnpike catheter.

Figure 3. Angiography and intervention for case 2. A, Diagnostic angiography displaying SVG to RI with retrograde filling of the RI to the LCX, which is chronically occluded distally (see also Data Supplement Movie IV). B, A guidewire is positioned in the distal RI to allow for advancement of the mother–daughter–granddaughter double GuideLiner system. The 6 Fr GuideLiner is seen in mid portion of SVG and Turnpike in the distal RI (see also Data Supplement Movie V). C, The system has been advanced and a balloon is inflated in the distal LCX. The 6 Fr GuideLiner is positioned just proximal to the distal anastomosis of the SVG to RI anastomosis. The 8 Fr GuideLiner ending just before the SVG to RI anastomosis. The 6 Fr GuideLiner was used to facilitate wire escalation to cross the LCX CTO via an antegrade approach. D, Angiogram after stenting of the CTO LCX into the RI supplied by the SVG (see also Data Supplement Movie VI). CTO indicates chronic total occlusion; GL, GuideLiner; LCX, left circumflex; RI, ramus intermedius; SVG, saphenous vein graft; and TP, Turnpike catheter.
Mother–Daughter–Granddaughter Double GuideLiner Technique for Delivering Stents Past Multiple Extreme Angulations
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