Use of the Frontrunner Catheter to Cross a Chronic Total Occlusion of the Left Subclavian Artery

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Crossing a subclavian artery chronic total occlusion may be challenging. We report the treatment of such an occlusion in a patient with a patent left internal mammary graft to the left anterior descending artery, who presented with progressive angina. Several attempts to cross the occlusion, both antegrade and retrograde, with various guidewires failed. The lesion was successfully crossed antegradely using the Frontrunner catheter and was successfully stented with resolution of the patient’s angina.

Chronic total occlusions (CTOs) of the subclavian artery (SA) are challenging to treat, mainly because they are difficult to cross.\(^1\) The Frontrunner blunt microdissection catheter has been successfully used to recanalize CTOs of the lower extremity,\(^2\) but there is no report of its use in the SA. We present a case in which a proximal left SA CTO was successfully crossed using the Frontrunner catheter, after conventional crossing attempts failed.

Case presentation

A 50-year-old woman with diabetes, hypertension and dyslipidemia, who was a current smoker, presented with progressive angina pectoris for 6 weeks. Eighteen months prior to admission she had undergone coronary artery bypass grafting (CABG) with a left internal mammary artery (LIMA) graft to the left anterior descending artery and a saphenous venous graft (SVG) to the first obtuse marginal branch. Following CABG she was angina-free until her recent admission, when she presented with progressively worsening chest pain, shortness of pain and diaphoresis. The troponin and CK-MB levels were 0.03 ng/ml and 3.9 ng/ml, respectively. Electrocardiography showed ST-segment depression in the inferolateral leads.

Coronary angiography showed 2-vessel coronary artery disease involving the first obtuse marginal branch and the mid right coronary artery (Figures 1A, 1C). The SVG to the first obtuse marginal branch was occluded. The LIMA to the mid left anterior descending artery graft filled retrogradely (Figures 1C, 1D, 1F). Aortic arch angiography demonstrated a totally occluded left subclavian artery at its origin (Figure 1E). The first obtuse marginal branch was predilated with a \(2 \times 10\) mm Sprinter balloon (Medtronic Vascular, Inc., Santa Rosa CA, USA) and was successfully stented with a \(2.5 \times 14\) mm Endeavor drug-eluting stent (Medtronic Vascular) (Figure 1D). The mid right coronary artery was predilated with a \(2 \times 10\) mm Sprinter balloon (Medtronic Vascular) at 10 atmospheres and stented with a \(2.5 \times 14\) mm Endeavor stent (Medtronic Vascular) (Figure 1B).

The patient continued to have ex-
Figure 1. Right coronary angiography in the right anterior oblique projection showing a mid vessel stenosis (arrow, panel A), that resolved after stenting (arrow, panel B). Left coronary angiography in the right anterior oblique caudal projection showing a significant first obtuse marginal lesion (arrow, panel C) that resolved after stenting (arrow, panel D). Aortic arch angiography in the left anterior oblique projection showing a chronic total occlusion of the proximal left subclavian artery (arrow, panel E). Left coronary angiography demonstrating an ostial left main lesion (arrowhead), a severe lesion in the first obtuse marginal branch (single arrow, panel F), and retrograde filling of the left internal mammary graft (multiple arrows, panel F).
Figure 2. Bilateral injection via a brachial artery catheter and a femoral artery sheath demonstrating complete occlusion of the proximal left subclavian artery and extraluminal position of the Frontrunner catheter (arrow, panel A). Subclavian angiography via a left brachial artery catheter showing intraluminal location of the tip of the Frontrunner catheter (arrow, panel B) that was advanced antegrade via the left femoral artery sheath. Balloon predilatation of the proximal left subclavian artery was performed (arrow, panel C). Left subclavian artery angiography after stenting (arrow, panel D) showing no residual left subclavian artery stenosis.
ertional angina and was subsequently referred for angioplasty of the left subclavian CTO. Angioplasty was attempted antegradely using a 90 cm long 7 French sheath (Cordis, Warren NJ, USA) and several guidewires, including a 0.035 inch Glidewire (Terumo, Sommerset NJ, USA), 0.014 Miracle Bro 3, 6, and 9 Wires, (Asahi, Abbott Vascular, Santa Clara CA, USA), the Cross it 100 (Abbott Vascular) and the Regatta HS Guidewire (Cordis). However all attempts to cross failed.

The patient returned 3 weeks later for another attempt at angioplasty of the left subclavian artery CTO. Arterial access was obtained via the right femoral and the left brachial artery. Subclavian angiography, through a catheter inserted via the brachial artery, revealed reconstitution of the subclavian artery proximal to the vertebral artery with no distal disease. Multiple attempts to cross the occlusion retrogradely with a Glidewire (Terumo) inserted via a Tempo Aqua catheter (Cordis), with a Runthrough wire (Terumo) inserted via a Venture catheter (St. Jude Medical, Minnetonka MN, USA), and with a Frontrunner catheter (Cordis) failed (Figure 2A).

The Frontrunner catheter was subsequently introduced over a 7 French 90 cm Pinnacle destination sheath (Terumo) that engaged the left subclavian artery stump and successfully crossed the CTO. The intraluminal location of the Frontrunner catheter tip was confirmed with contrast injection through a left brachial artery multipurpose catheter (Figure 2B). The Frontrunner catheter delivery sheath was advanced over the catheter and a Glidewire (Terumo) was inserted antegradely into the left subclavian artery. The subclavian artery was sequentially predilated with 4 × 40 mm and 4 x 60 mm Powerflex balloons (Cordis) (Figure 2C). An 8 x 27 mm Express stent (Boston Scientific Natik MA, USA) was deployed, with an excellent final angiographic result (Figure 2D). Following the procedure the patient reported complete angina resolution.

Discussion

Our case illustrates the use of the Frontrunner catheter to successfully cross an ostial left subclavian CTO, in a patient with coronary-subclavian steal.

Coronary-subclavian steal is increasingly recognized as a cause of angina after CABG, which is why it is currently recommended to perform subclavian angiography in all prior CABG patients in whom the LIMA or right internal mammary artery have been used as bypass conduits. The time of presentation of coronary-subclavian steal varies. The average interval from CABG to coronary-subclavian steal symptoms was 6.9 years in a study by Elian et al., with more than half the patients presenting 9 or more years after CABG. Westerband et al reported that coronary steal occurred between 2 and 31 (mean 14) years after CABG.

Percutaneous angioplasty and stenting is increasingly being considered as the therapy of choice for subtotal SA stenosis, because it carries a lower risk of complications compared to surgery. The success rate for endovascular therapy of totally occluded SA lesions is low (46-83%, Table 1). Schillinger et al reported that complete occlusion and long lesions (> 2cm) were correlated with a lower success rate, and that success rates were higher via the brachial approach (in 10 of 14 patients, 71%) compared to the transfemoral route (in 3 of 13 patients, 23%, p=0.02). Obtaining both antegrade and retrograde access may facilitate intervention in total SA occlusions, as in our patient.

The Frontrunner catheter uses controlled blunt microdissection to separate atherosclerotic plaque and create a channel through a CTO, thereby en-

<table>
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<th>Author</th>
<th>Year</th>
<th>Overall (Overall)</th>
<th>Subtotal occlusions (Subtotal)</th>
<th>Complete occlusions (Complete)</th>
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<tr>
<td>Henry</td>
<td>2007</td>
<td>94% (223/237)</td>
<td>100% (192/192)</td>
<td>69% (31/45)</td>
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<td>Schillinger</td>
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<td>100% (98/98)</td>
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<td>100% (39/39)</td>
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</tr>
<tr>
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<td>100% (76/76)</td>
<td>54% (7/13)</td>
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<tr>
<td>Motarjeme</td>
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<td>100% (67/67)</td>
<td>46% (6/13)</td>
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<tr>
<td>Mathias</td>
<td>1993</td>
<td>83% (38/46)</td>
<td>*</td>
<td>83% (38/46)</td>
</tr>
<tr>
<td>Hebrang</td>
<td>1991</td>
<td>86.6% (45/52)</td>
<td>93% (40/43)</td>
<td>56% (5/9)</td>
</tr>
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* Mathias et al reported only reported outcomes in complete subclavian occlusions.
abling wire placement and subsequent angioplasty and stenting. Blunt dissection takes advantage of the differential elastance between intraluminal plaque and adventitia to preferentially disrupt the atherosclerotic plaque while maintaining the integrity of the outer arterial wall layer. The Frontrunner catheter has been successfully used for treating lower extremity arterial CTOs. Our case shows that it can also facilitate crossing of subclavian CTOs. Special care should be taken to confirm the endoluminal position of the Frontrunner by contralateral injections after crossing, so as to minimize the risk of perforation.

In summary, coronary-subclavian steal should be included in the differential diagnosis of angina after CAGB. Use of the Frontrunner blunt microdissection catheter may allow crossing of chronic total subclavian artery occlusions once conventional crossing techniques have failed.

References

9. White CJ. The times they are a-changin’... J Am Coll Cardiol. 1999; 33: 1246-1247.