

CASE REPORT

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Guide-Extension Carlino: A novel technique for crossing a microcatheter uncrossable proximal cap during chronic total occlusion interventions

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Abstract

Balloon and microcatheter uncrossable chronic total occlusions can be challenging to treat. We present a novel technique for treating such lesions through contrast injection via a guide catheter extension wedged against the proximal cap. We named this technique “guide-extension Carlino.”

KEYWORDS

atherosclerosis, chronic total occlusion, coronary circulation, percutaneous coronary intervention

1 | INTRODUCTION

Balloon and microcatheter uncrossable lesions are commonly encountered during chronic total occlusions (CTO) percutaneous coronary intervention (PCI), especially in heavily calcified lesions.¹ Use of small balloons, grenadoplasty² and stronger guide support are usually used first in balloon uncrossable lesions.³ Additional treatment options include laser, atherectomy^{4,5} and extraplaque techniques that either modify the lesion through extraplaque balloon inflation or through stenting of the more compliant extraplaque space.^{6,7} We report a novel treatment technique for balloon uncrossable lesions that achieves proximal cap modification through contrast injection via a deeply seated guide catheter extension. We named this technique “guide-extension Carlino.”

2 | CASE REPORT

A 79-year-old-man with hypertension, hyperlipidemia and prior tobacco use presented with angina. He had undergone coronary artery bypass graft surgery 25 years prior and had multiple prior PCIs of the left anterior descending artery. Myocardial perfusion study revealed moderate ischemia in the right coronary artery (RCA) territory. Coronary angiography revealed a patent saphenous vein bypass graft to the obtuse marginal, occluded left internal mammary

artery bypass graft to the left anterior descending coronary artery, patent stents in the left anterior descending coronary artery, chronic occlusion of a saphenous vein bypass graft to the right posterior descending coronary artery and a proximal RCA CTO. The distal RCA filled via left to right collaterals. Despite maximally tolerated doses of metoprolol, amlodipine, isosorbide, and ranolazine the patient continued to require sublingual nitroglycerin two or three times per day and was referred for PCI of the RCA CTO.

Bilateral femoral arterial access was obtained. The RCA was engaged with an 8 French AL1 guide and the left main with a 7 French EBU4 guide. Dual injection revealed a proximal RCA CTO with clear tapered proximal cap with heavy calcification, long occlusion length, diffusely diseased distal vessel and no interventional collaterals. (Figure 1A and Video S1). Antegrade wiring was attempted with a Gladius Mongo (Asahi Intecc) guidewire through a Turnpike Spiral microcatheter (Teleflex). The guidewire partially advanced through the lesion but the microcatheter would not cross despite using an 8 French Trapliner guide extension (Teleflex). A right anterior oblique view demonstrated an anomalous anterior origin of the RCA followed by a 180-degree hairpin turn that likely contributed to the difficulties we encountered with the antegrade approach (Figure 1B and Video S2). Retrograde septal crossing attempts failed. A 1.0 × 15 mm Sapphire balloon (OrbusNeich) failed to cross. It was subsequently inflated until it ruptured (grenadoplasty), but the antegrade microcatheter still could not cross.

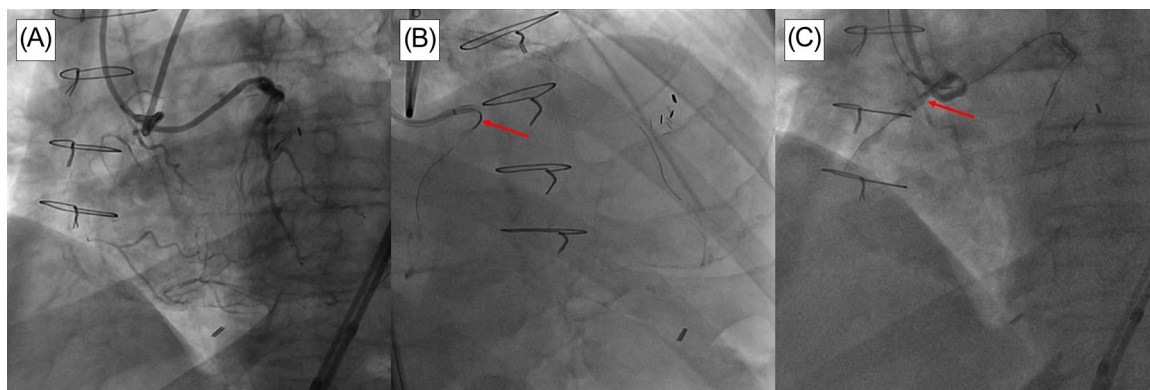


FIGURE 1 (A) Dual guide catheter coronary angiography of the native right and left coronary arteries demonstrating a right coronary artery CTO. (B) Right anterior oblique projection showing an anomalous anterior origin of the right coronary artery followed by a 180-degree hairpin turn (arrow) that likely contributed to the difficulties encountered with antegrade crossing attempts. (C) Contrast injected into the right coronary artery while the Trapliner guide extension was wedged to intentionally induce a dissection plane around the proximal cap of the CTO (arrow). CTO, chronic total occlusion [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/ccd.30207)]

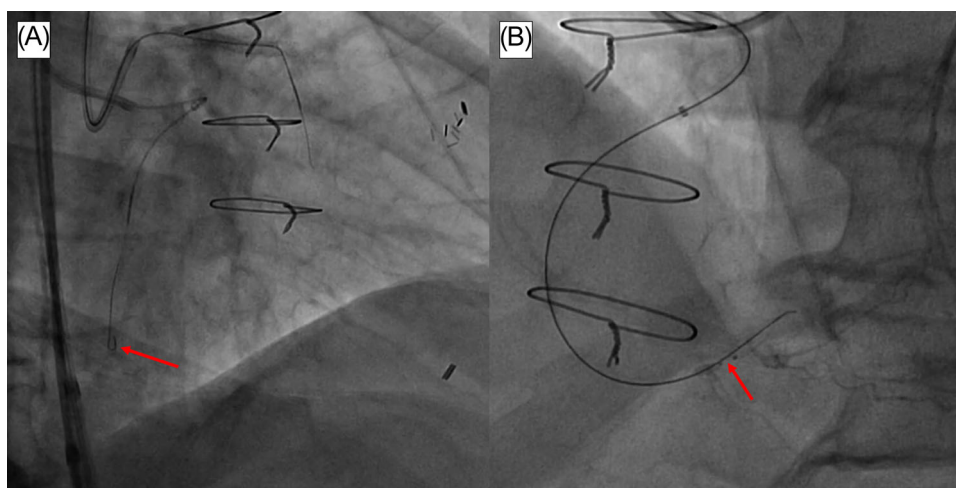


FIGURE 2 (A) A knuckled guidewire easily progressed through the mid segment of the right coronary artery within the extraplaque space (arrow). (B) Distal true lumen reentry was achieved using the stick and drive technique with an Astato 20 guidewire and a Stingray balloon (arrow) [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/ccd.30207)]

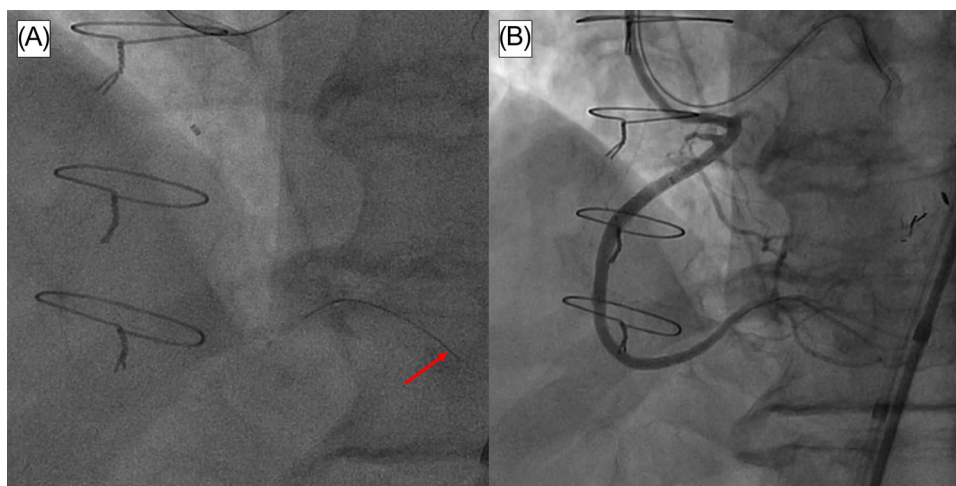


FIGURE 3 (A) A workhorse wire was easily advanced distally through an over-the-wire balloon confirming distal true lumen wire position (arrow). (B) Final angiography showing successful recanalization of the right coronary artery [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/ccd.30207)]

TABLE 1 Studies using the contrast guided subintimal tracking and re-entry "Carlino" technique

Study	Year	Number of patients	Groups of comparison	Procedural success	Cardiac survival	Stent thrombosis	Restenosis	Target vessel MI
Carlino et al. ⁹	2008	32	Microchannel technique	78%	NA	NA	NA	NA
Carlino et al. ¹⁰	2008	68	Contrast guided STAR	62%	100% (30-day follow-up)	0%	NA	0%
Godino et al. ⁸	2012	355	Contrast guided STAR versus conventional antegrade CTO recanalization	100% (only successful cases were followed (overall success 72%))	97.2% vs. 97.5%, $p = 0.912$	2.8% vs. 1.8%, $p = 0.610$	54% vs. 30%, $p < 0.0001$	
Amsawelu et al. ¹² (case reports, no follow-up)	2016	2	Carlino technique	100%	NA	NA	NA	NA
Carlino et al. ¹¹	2016	59	Modified contrast microinjection (Carlino)	81%	NA	NA	NA	NA
Azzalini et al. ¹³	2017	924	Old DR techniques (STAR, mini-STAR, contrast-guided STAR, LAST, CART) versus Modern DR (Stingray, CrossBoss, reverse CART) versus True to true lumen crossing	100% (only successful cases were followed (overall success 87%))	96.8% vs. 98.8% vs. 98.1%, $p < 0.001$		18.1% vs. 7.0% vs. 6.0%, $p < 0.001$ (ischemia driven TVR)	5.3% vs. 1.9% vs. 1.9%, $p = 0.11$
Azzalini et al. ¹⁴ (review)	2019		STAR, contrast guided STAR, microchannel technique, Carlino technique,	NA	NA	NA	NA	NA

Abbreviations: CART, controlled antegrade and retrograde tracking; DR, dissection/re-entry; LAST, limited antegrade subintimal tracking; MI, myocardial infarction; STAR, subintimal tracking and re-entry; TVR: target vessel revascularization.

We advanced the Trapliner guide extension as far as possible into the proximal cap until a dampened waveform was observed. We then injected 2 cc of contrast through the antegrade guide catheter inducing a dissection around the proximal cap of the CTO (Figure 1C and Video S3). The Mongo guidewire was withdrawn into the tip of the Trapliner and quickly readvanced knuckling into the extraplaque space (Figure 2A and Video S4). The Turnpike Spiral microcatheter was then easily advanced through the CTO proximal cap into the distal false lumen of the CTO, followed by successful reentry using the stick and drive technique with an Astato 20 guidewire (Figure 2B and Video S5). The Astato 20 guidewire was then exchanged for a workhorse wire (Figure 3A and Video S6). Intravascular ultrasound confirmed distal true lumen wire position. After predilation and stenting with four drug-eluting stents an excellent final result was achieved (Figure 3B and Video S7). The patient's angina resolved.

3 | DISCUSSION

We present a novel technique for proximal cap modification of balloon uncrossable lesions by gentle contrast injection through a guide catheter extension wedged against the proximal cap. We named this technique "guide-extension Carlino."

Approximately 9% of CTO lesions are balloon uncrossable.¹ Treating such lesions can be challenging and has been associated with lower success and higher complication rates. Use of an algorithmic step-by-step approach can significantly facilitate treatment.³

In our patient we could not advance a Turnpike Spiral microcatheter through the proximal cap of a RCA CTO despite using an 8 French guide extension. Retrograde crossing attempts failed. Contrast injection through a wedged Trapliner created a dissection that enabled microcatheter crossing through the proximal cap, followed by successful reentry and completion of the case.

Contrast injection through a microcatheter was developed by Mauro Carlino to facilitate crossing of CTOs, by overcoming resistance to wire advancement and helping resolve ambiguity in the vessel course (Table 1). Initially contrast injection was aggressive with potential risk of complications,⁸⁻¹⁰ but in its current form a small amount (1-2 cc) of contrast is injected gently.^{11,12} Similarly, in the "guide-extension Carlino" technique we recommend injection of a small amount of contrast (2-3 cc) through a distally advanced guide extension with dampened pressure waveform under fluoroscopy. Creation of a dissection may facilitate subsequent equipment delivery attempts. Injection of large contrast volume should be avoided, as it could lead to perforation or extensive extraplaque hematoma, possibly causing compression of the distal true lumen. A single successful case does not establish the safety of this technique, hence it should be used with caution until further data becomes available.

4 | CONCLUSION

In summary, the "guide-extension Carlino" is a novel and easy-to-use technique for proximal cap modification that could be used to facilitate crossing of balloon uncrossable CTOs and possibly wire impenetrable proximal caps.

CONFLICTS OF INTEREST

Dr. Brilakis: consulting/speaker honoraria from Abbott Vascular, American Heart Association (associate editor Circulation), Amgen, Asahi Intecc, Biotronik, Boston Scientific, Cardiovascular Innovations Foundation (Board of Directors), ControlRad, CSI, Elsevier, GE Healthcare, IMDS, InfraRedx, Medtronic, Medtronic, Opsens, Siemens, and Teleflex; research support: Boston Scientific, GE Healthcare; owner, Hippocrates LLC; shareholder: MHI Ventures, Cleerly Health, Stallion Medical. All the other authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Karacsonyi J, Brilakis ES, Chandwaney RH. Guide-Extension Carlino: A novel technique for crossing a microcatheter uncrossable proximal cap during chronic total occlusion interventions. *Catheter Cardiovasc Interv*. 2022;99:2038-2042. doi:10.1002/ccd.30207