Use of the Carlino Technique in Chronic Total Occlusion Percutaneous Coronary Intervention

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We examined the outcomes of the Carlino technique in chronic total occlusion (CTO) percutaneous coronary interventions (PCIs). We analyzed the baseline clinical and angiographic characteristics and outcomes of 128 CTO PCIs that included the Carlino technique at 22 US and no-US centers between 2016 and 2023. The Carlino technique was used in 128 (2.8%) of 4,508 cases that used anterograde dissection and reentry (78.9%) or the retrograde approach (21.1%) during the study period, and it increased steadily over time (from 0.0% in 2016 to 8.3% in 2023). The mean patient age was 65.6 ± 9.7 years, and 88.7% of the patients were men with high prevalence of hypertension (89.1%) and dyslipidemia (80.2%). The Carlino technique was more commonly used in cases with moderate to severe calcification (77.2% vs 55.5%, p <0.001) with higher J-CTO (3.3 ± 0.9 vs 3.0 ± 1.1, p = 0.007), Prospective Global Registry for the Study of Chronic Total Occlusion Intervention (PROGRESS-CTO) (1.7 ± 1.0 vs 1.4 ± 1.0, p = 0.001), PROGRESS-CTO Mortality (2.6 ± 0.9 vs 2.0 ± 0.9, p = 0.013) and PROGRESS-CTO Perforation (3.7 ± 1.1 vs 3.5 ± 1.0, p = 0.029) scores. Carlino cases had longer procedure and fluoroscopy time, and higher contrast volume and radiation dose. Carlino cases had lower technical (65.6% vs 78.5%, p <0.001) and procedural (63.3% vs 76.3%, p <0.001) success, similar major adverse cardiac events (6.2% vs 3.2%, p = 0.101) and higher incidence of pericardiocentesis (3.9% vs 1.3%, p = 0.042), perforation (18.0% vs 8.9%, p = 0.001) and contrast-induced acute kidney injury (2.3% vs 0.4%, p = 0.012). The Carlino technique was associated with higher procedural success when used for retrograde crossing (81.5% vs 58.4%, p = 0.047). The Carlino technique is increasingly being used in CTO PCI especially for higher complexity lesions. **(Am J Cardiol 2023;207:305−313)**

Keywords: anterograde dissection and reentry, Carlino, chronic total occlusion, percutaneous coronary intervention, retrograde wiring

Dissection and reentry techniques are key for the success of chronic total occlusions (CTOs) percutaneous coronary intervention (PCI).[1,2] The Carlino technique currently involves injection of a small amount of contrast (<0.5 ml) into the extraplaque space, to modify plaque compliance and facilitate guidewire and microcatheter advancement.[3−5] There are limited published data on the outcomes of this technique.[6−9] We analyzed a contemporary, multicenter CTO PCI registry to determine the frequency of use of the Carlino technique and the associated outcomes.

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See page 312 for Declaration of Competing Interest.

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Methods

We examined the baseline clinical and angiographic characteristics and procedural outcomes of 128 CTO PCIs that used the Carlino technique at 22 US and non-US centers between 2016 and 2023, of 11,231 CTO PCIs that included 4,508 ADR and retrograde cases. Data collection was recorded in a dedicated online database (Prospective Global Registry for the Study of Chronic Total Occlusion Intervention [PROGRESS-CTO]; *ClinicalTrials.gov* identifier: NCT02061436). Study data were collected and managed using Research Electronic Data Capture (REDCap) electronic data capture tools hosted at the Minneapolis Heart Institute Foundation.[10,11] The study was approved by the institutional review board of each center.

Coronary CTOs were defined as coronary lesions with thrombolysis in myocardial infarction (MI) grade 0 flow of at least 3-month duration. Estimation of the duration of occlusion was clinical, based on the first onset of angina, history of MI in the target-vessel territory, or comparison with a previous angiogram.

Calcification was assessed by angiography and classified as mild (spots), moderate (involving ≤50% of the reference lesion diameter), or severe (>50%).[12,13] CTOs were defined according to the definition of the CTO Academic Research Consortium, as absence of anterograde flow through the lesion with a presumed or documented duration of ≥3 months.[14] Technical success was defined as successful CTO revascularization with achievement of <30% residual diameter stenosis within the treated segment and restoration of thrombolysis in MI grade 3 anterograde flow. Procedural success was defined as the achievement of technical success without any in-hospital major adverse cardiac events (MACEs). In-hospital MACE included any of the after adverse events before hospital discharge: death, MI, recurrent symptoms requiring urgent repeat target-vessel revascularization with PCI or coronary artery bypass graft surgery, tamponade requiring either pericardiocentesis or surgery, and stroke. MI was defined using the Third Universal Definition of MI (Type 4a MI).[15] The Japanese CTO (J-CTO) score was calculated as described by Morino et al,[16] the PROGRESS-CTO score as described by Christopoulos et al,[17] the new PROGRESS-CTO complication scores (acute MI, MACE, mortality, and pericardiocentesis) as described by Simsek et al,[18] and the PROGRESS-CTO perforation score as described by Kostantinis et al.[19] The Modification of Diet in Renal Disease 4-variable equation was used to calculate the estimated glomerular filtration rate (estimated glomerular filtration rate = 175 × $\text{SerumCreatinine}^{-1.154}$ × $\text{age}^{-0.203}$ × 1.212 [if African-American] × 0.742 [if female]).[20]

The Carlino technique has been extensively described elsewhere.[3–9] Briefly, a small amount (<0.5 ml) of contrast media is gently injected by way of a microcatheter to either obtain information on gear location (main CTO vessel vs

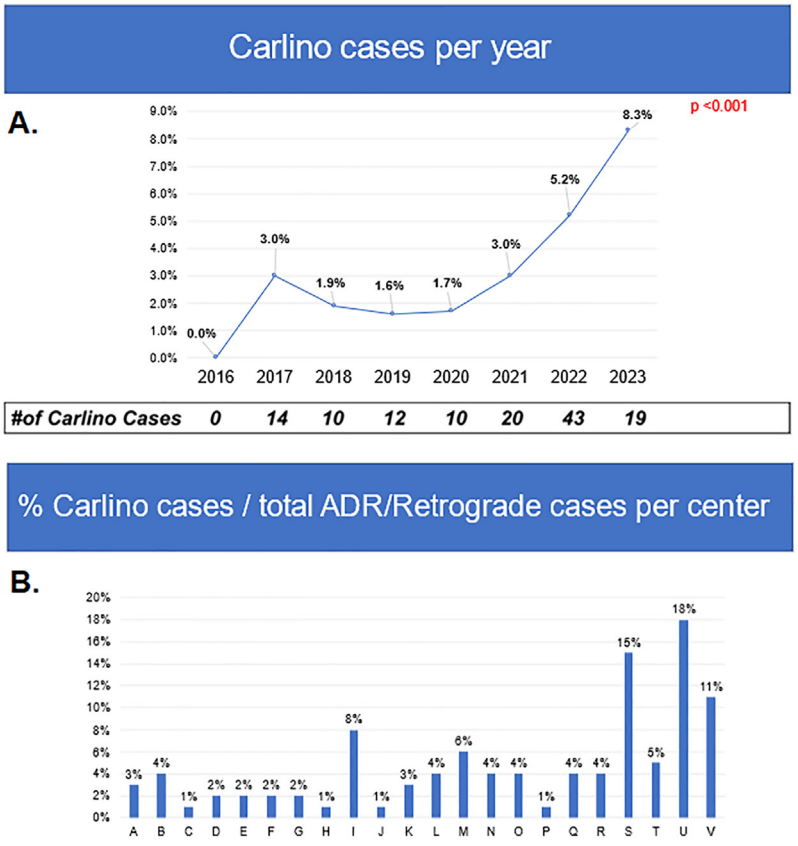

Figure 1. *(A)* Utilization of the Carlino technique in ADR/retrograde cases over time; *(B)* Proportion of the total ADR/retrograde cases per center that used the Carlino technique.

side branch), modify a resistant plaque/cap, or better define an ambiguous proximal cap.

Categorical variables were expressed as percentages and were compared using the Pearson's chi-square test. Continuous variables are presented as mean ± SD or as median (interquartile range) unless otherwise specified and were compared using the independent-samples *t* test for normally distributed variables and the Mann−Whitney *U* test for nonparametric variables, as appropriate. Temporal trends were tested for significance with the Mann-Kendall test. All statistical analyses were performed using R Statistical Software, version 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria). A p <0.05 was considered statistically significant.

Results

Between 2016 and 2023, the Carlino technique was used in 128 of 4,508 CTO PCIs (2.8%) performed using ADR or the retrograde approach at 22 US and non-US centers, with increasing frequency over time and variability in its use between centers (Figure 1). Table 1 summarizes the baseline clinical and angiographic characteristics of the included patients. The mean age was 65.6 ± 9.7 years, 88.7% of the patients were men and the prevalence of hypertension (89.1%) and dyslipidemia (80.2%) was high.

Table 2 presents the angiographic characteristics of the study lesions. The Carlino technique was less commonly used in cases with interventional collaterals (50.9% vs 72.1%, p <0.001) and more commonly used in cases with moderate to severe calcification (77.2% vs 55.5%, p <0.001) and higher J-CTO (3.3 ± 0.9 vs 3.0 ± 1.1, p = 0.007), PROGRESS-CTO (1.7 ± 1.0 vs 1.4 ± 1.0, p = 0.001), PROGRESS-CTO Mortality (2.6 ± 0.9 vs 2.4 ± 0.9, p = 0.013) and PROGRESS-CTO Perforation (3.7 ± 1.1 vs 3.5 ± 1.0, p = 0.029) scores. Balloon uncrossable and balloon undilatable CTO lesions were similar in both ADR/retrograde cases that used the Carlino technique and the rest of the ADR/retrograde cases (Table 3).

The procedural characteristics and outcomes of 101 CTO PCIs that used the Carlino technique of 2,140 ADR cases, are shown in Table 4: 15.1% of the CTOs were balloon uncrossable and 6% were balloon undilatable. The successful crossing strategy was ADR in most cases (43.6%), whereas ADR was the first crossing strategy in only 15.8% of the cases. When Carlino was used, antegrade wiring and retrograde wiring had been used in 77.2% and 64.4% of the cases, respectively. The successful dissection technique in these patients was most commonly a knuckled wire (47.5%), followed by the Carlino technique (34.7%). The ADR technique used was most commonly subintimal tracking and reentry (35.6%), followed by the Stingray system (20.8%).

The procedural characteristics and outcomes of 27 retrograde CTO PCIs that used the Carlino technique, of 3,327 retrograde CTO PCIs, are shown in Table 5. Successful

Table 1
Comparison of baseline clinical characteristics of patients in which the Carlino technique was used vs the rest of the ADR/Retrograde cases

Variables	Carlino use (n = 128)	No Carlino use (n=4380)	P-value
Age (years)	65.62 ± 9.67	64.61 ± 10.27	0.288
Gender, male	88.7% (110)	83.1% (3419)	0.130
Body mass index (kg/m^2)	30.16 ± 6.00	30.60 ± 6.18	0.459
Diabetes mellitus	44.2% (53)	42.8% (1661)	0.834
Hypertension	89.1% (106)	89.8% (3561)	0.927
Dyslipidemia	80.2% (97)	88.1% (3489)	**0.012**
Smoking, current	23.1% (27)	27.6% (1050)	0.328
Anemia	22.4% (26)	20.4% (733)	0.689
Atrial fibrillation	4.4% (5)	13.6% (460)	**0.007**
Left ventricular ejection fraction (%)	49.73 ± 11.96	50.13 ± 12.58	0.747
Family history of CAD	33.6% (37)	33.4% (1121)	1
Heart failure	30.5% (36)	28.7% (1094)	0.737
Prior PCI	77.7% (94)	67.0% (2691)	**0.018**
Prior MI	46.6% (54)	46.9% (1750)	1
Cerebrovascular disease	8.4% (10)	10.3% (396)	0.602
Peripheral arterial disease	16.7% (20)	15.9% (608)	0.914
CAD presentation			
Stable Angina	64.7% (77)	69.8% (2742)	0.101
Unstable Angina	16.8% (20)	15.8% (620)	
NSTEMI	5.0% (6)	6.7% (262)	
STEMI	1.7% (2)	0.9% (37)	
Nonischemic symptoms	0.8% (1)	1.6% (63)	
No symptoms	10.9% (13)	5.2% (203)	
Baseline creatinine (mg/dL)	1.00 [0.86, 1.30]	1.01 [0.87, 1.20]	0.436
eGFR (mL/min/1.73m2)	72.65 [54.05, 90.41]	72.08 [58.19, 86.01]	0.977

ADR = antegrade dissection and reentry; CAD = coronary artery disease; eGFR = estimated glomerular filtration rate; MI = myocardial infarction; NSTEMI = non-ST segment elevation myocardial infarction; PCI = percutaneous coronary intervention; STEMI = ST segment elevation myocardial infarction.

Table 2
Comparison of angiographic characteristics of cases in which the Carlino technique was used vs the rest of the ADR/Retrograde cases

Variables	Carlino use (n = 128)	No Carlino use (n=4380)	P-value
CTO target vessel			0.422
Right coronary artery	69.5% (89)	62.4% (2642)	
Left anterior descending	16.4% (21)	19.4% (820)	
Left circumflex artery	12.5% (16)	16.2% (685)	
Other	1.6% (2)	2.1% (90)	
Interventional collaterals	50.9% (56)	72.1% (2670)	**<0.001**
Lesion diameter (mm)	3.02 ±0.50	2.97 ±0.53	0.281
Lesion length (mm)	41.72 ± 27.99	37.85 ±22.76	0.064
Proximal cap ambiguity	59.0% (72)	54.2% (2122)	0.341
Side branch at the proximal cap	66.1% (74)	63.1% (2331)	0.593
Blunt/no stump	73.2% (90)	71.9% (2961)	0.843
Moderate/severe calcification	77.2% (95)	55.5% (2283)	**<0.001**
Moderate/severe proximal tortuosity	45.5% (56)	38.0% (1562)	0.109
In-stent restenosis	16.5% (20)	13.0% (522)	0.321
J-CTO score	3.28 ±0.94	3.01 ±1.08	**0.007**
PROGRESS-CTO score	1.69 ±1.02	1.39 ±0.98	**0.001**
PROGRESS-CTO Acute MI score	1.19 ±0.73	1.23 ±0.77	0.603
PROGRESS-CTO MACE score	3.98 ±1.36	3.87 ±1.28	0.382
PROGRESS-CTO Mortality score	2.64 ±0.85	2.40 ±0.94	**0.013**
PROGRESS-CTO Pericardiocentesis score	3.12 ±1.01	2.98 ±0.98	0.143
PROGRESS-CTO Perforation score	3.74 ±1.11	3.53 ±1.03	**0.029**

ADR = antegrade dissection and reentry; CTO = chronic total occlusion; J-CTO; Japan chronic total occlusion; MACE = major adverse cardiac events; MI = myocardial infarction; PROGRESS-CTO = Prospective Global Registry for the Study of Chronic Total Occlusion Intervention chronic total occlusion.

retrograde CTO crossing was achieved in 20 cases (74.1%). The first crossing strategy was retrograde wiring in most cases (59.3%), followed by antegrade wiring (40.7%). The retrograde approach was the successful crossing strategy in most cases (70.4%) and 4.8% of lesions were balloon uncrossable or undilatable. In cases where the retrograde Carlino was used and retrograde CTO crossing was successful, the most commonly used were retrograde true luminal puncture (55%), knuckle wire (50%) and just marker (true-to-true anterograde crossing) (35%), while the final/successful strategy was most commonly conventional reverse controlled antegrade and retrograde tracking (9 cases, 28.1%), true-to-true retrograde crossing (6 cases, 18.8%) and guide extension reverse controlled antegrade and retrograde tracking (6 cases, 18.8%).

Table 3
Procedural techniques and characteristics of cases in which the Carlino technique was used vs the rest of the ADR/Retrograde cases

Variables	Carlino use (n = 128)	No Carlino use (n=4380)	P-value
First crossing strategy			**0.015**
Antegrade wiring	60.9% (78)	65.4% (2863)	
Antegrade dissection and reentry	12.5% (16)	5.8% (252)	
Retrograde	26.6% (34)	28.9% (1265)	
Successful crossing strategy			**<0.001**
Antegrade wiring	3.1% (4)	9.7% (424)	
Antegrade dissection and reentry	36.7% (47)	27.8% (1218)	
Retrograde	29.7% (38)	43.5% (1905)	
None	30.5% (39)	19.0% (833)	
Balloon uncrossable CTO lesion	12.8% (12)	8.7% (299)	0.235
Balloon undilatable CTO lesion	5.7% (5)	8.2% (263)	0.508

ADR = antegrade dissection and reentry; CTO = chronic total occlusion.

In-hospital outcomes are presented in Figures 2 and 3. CTO PCIs that used the Carlino technique required longer procedure and fluoroscopy time and more contrast volume and air kerma radiation dose. Technical (65.5% vs 78.5%, p <0.001) and procedural success (63.3% vs 76.5%, p <0.001) were lower in cases that used the Carlino technique, compared with the rest of the ADR/retrograde cases. The cases that used the retrograde Carlino technique had higher procedural success (81.5% vs 58.4%, p = 0.047) (Figure 4). Carlino cases had higher rates of pericardiocentesis (3.9% vs 1.3%, p = 0.042), perforation (18.0% vs 8.9%, p = 0.001), and contrast-induced acute kidney injury (2.3% vs 0.4%, p = 0.012) (Figure 5). Only 5 of the 23 perforations in Carlino cases were related to the use of the Carlino technique (Table 6). The perforation type was more commonly Ellis class 2 (52.4%), followed by Ellis class 3 (19%) and Ellis class 1 (19%). The perforation vessel was more commonly the CTO target vessel (73.9%).

Discussion

To the best of our knowledge, this is the largest study of the Carlino technique in CTO PCI. The major findings are that the Carlino technique: (1) is infrequently used (2.8% of ADR/retrograde cases), but its use has been increasing over time; (2) is often used in cases with long occlusion length, high J-CTO score, and complex angiographic characteristics; (3) is associated with lower CTO PCI success rate.

Table 4
Procedural techniques used in cases in which the Carlino technique was used for ADR

Variables	Carlino use (n = 101)
First crossing strategy	
Antegrade wiring	66.3% (67)
Antegrade dissection and reentry	15.8% (16)
Retrograde	17.8% (18)
Successful crossing strategy	
Antegrade wiring	2.0% (2)
Antegrade dissection and reentry	43.6% (44)
Retrograde	18.8% (19)
None	35.6% (36)
Other strategies used	
Antegrade wiring	77.2% (78)
Retrograde wiring	64.4% (65)
Balloon uncrossable CTO lesion	15.1% (11)
Balloon undilatable CTO lesion	6.0% (4)
Successful dissection technique	
BASE	7.9% (8)
Carlino	34.7% (35)
CrossBoss	2.0% (2)
Knuckle Wire	47.5% (48)
Scratch and go	9.9% (10)
Side-BASE	0.0% (0)
Other	3.0% (3)
Antegrade reentry technique	
STAR	35.6% (36)
Contrast-Guided STAR	7.9% (8)
LAST	11.9% (12)
Stringray Balloon and Wire	20.8% (21)
ReCross	1.0% (1)
Other	7.9% (8)
Successful dissection crossing	
No	26.0% (25)
Yes − Sub-intimal crossing	64.6% (62)
Yes − True lumen crossing	9.4% (9)
Dissection techniques used when Carlino was the only successful dissection technique *(14 cases)*	
BASE	7.1% (1)
CrossBoss	0% (0)
Knuckle Wire	28.6% (4)
Scratch and go	21.4% (3)
Side-BASE	0% (0)
Other	0% (0)

ADR = antegrade dissection and reentry; CTO = chronic total occlusion.

Table 5
Procedural techniques used in cases in which the retrograde Carlino technique was used

Variables	Carlino use (n = 27)
First crossing strategy	
Antegrade wiring	40.7% (11)
Antegrade dissection and reentry	0.0% (0)
Retrograde	59.3% (16)
Successful crossing strategy	
Antegrade wiring	7.4% (2)
Antegrade dissection and reentry	11.1% (3)
Retrograde	70.4% (19)
None	11.1% (3)
Reason of Primary Retrograde	*(12 cases)*
Ostial Occlusion	25.9% (7)
Side Branch at Proximal Cap	14.8% (4)
Long Occlusion	14.8% (4)
Tortuosity	11.1% (3)
Poor Target Vessel at Distal Cap	3.7% (1)
Bifurcation at Distal Cap	3.7% (1)
"Last remaining conduit"	3.7% (1)
Proximal cap ambiguity	0.0% (0)
Other	29.6% (8)
Other strategies used	
Antegrade wiring	40.7% (11)
Antegrade dissection and reentry	14.8% (4)
Balloon uncrossable CTO lesion	4.8% (1)
Balloon undilatable CTO lesion	4.8% (1)
Successful retrograde lesion crossing	
No	25.9% (7)
Yes	74.1% (20)
Techniques used when retrograde Carlino was used, and the retrograde CTO lesion crossing was successful	*(20 cases)*
Retrograde True Lumen Puncture	55% (11)
Kissing Wire	20% (4)
Just Marker (Antregrade Wire Crossed)	35% (7)
Knuckle Wire	50% (10)
CART	10% (2)
Conventional reverse CART	30% (6)
Guideliner reverse CART	30% (6)
Contemporary ("directed") reverse CART	15% (3)
Extended reverse CART	15% (3)
E-CART	5% (1)
If retrograde failed, reason for failure	
Failed collateral wire crossing	66.7% (4)
Failed re-entry to proximal true lumen	33.3% (2)

CART = controlled antegrade and retrograde tracking; CTO = chronic total occlusion.

Mauro Carlino published the contrast-guided subintimal tracking and reentry technique in 2008[21] using 3 to 4 ml of contrast, then subsequently modified it by injecting smaller amounts of contrast.[9,22] Injection of <0.5 ml of contrast is currently recommended to increase the procedure's safety and limit the risk of complications.[4–6] The Carlino technique is used to modify plaque compliance, to resolve proximal or distal cap ambiguity and to clarify the location of the microcatheter.[3,5,23]

Our study shows a significant increase in the use of the Carlino technique in recent years, which is likely at least in part because of expanding overall CTO PCI experience, especially in treating complex lesions. The high variability in its use likely suggests various levels of comfort with the technique: injecting contrast in the extraplaque (or intraplaque) space is against the rules of standard PCI, hence some operators are reluctant to use it. However, the Carlino technique can often provide a solution when all other treatment options are exhausted. Proctoring and especially injection of a small amount of contrast are critical for reducing the risk of complications.

In our study the Carlino technique was used in highly complex CTO lesions (mean J-CTO score 3.3 ± 0.9), which likely accounts for the lower success rate. However, cases that used the retrograde Carlino had high success rate (81.5%). In a study of 43 patients by Azzalini et al[7] that

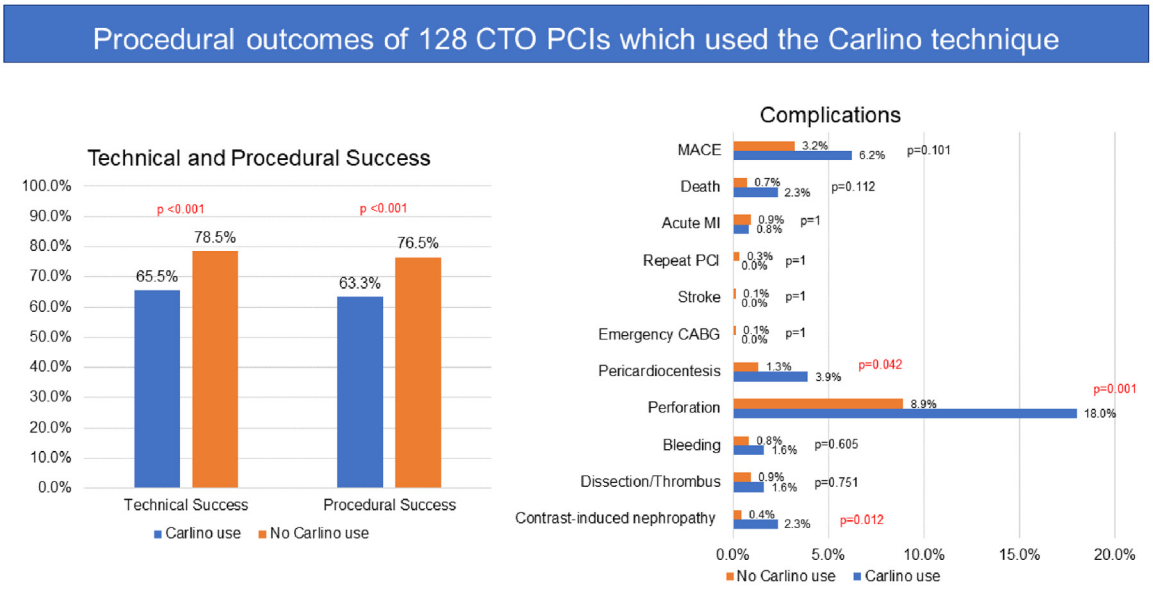

Figure 2. Procedural outcomes of cases in which the Carlino technique compared with the remaining ADR/retrograde cases. CABG = coronary artery bypass graft.

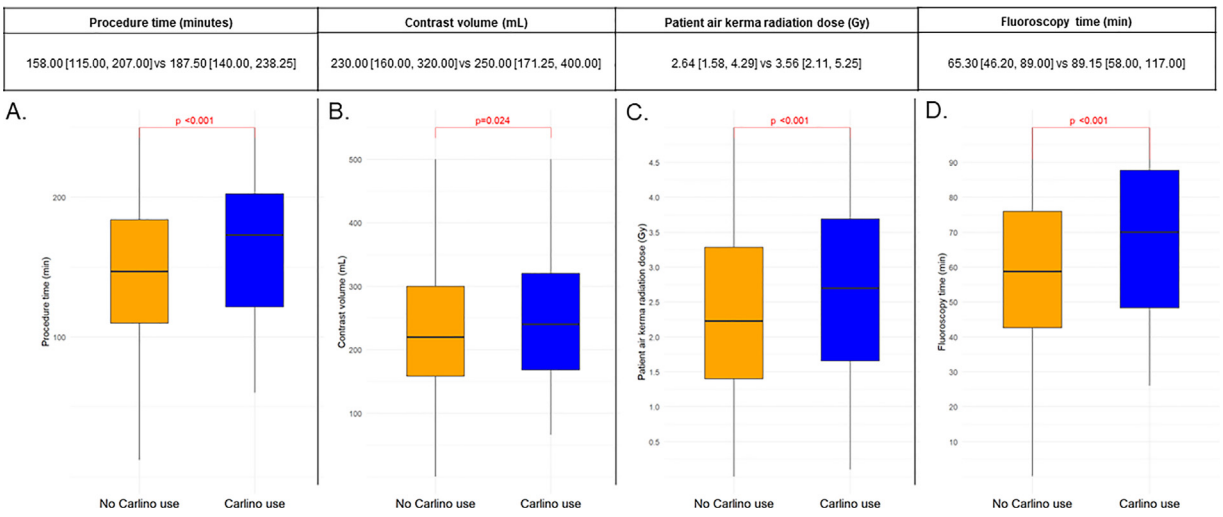

Figure 3. *(A)* Procedure time, *(B)* contrast volume, *(C)* patient air kerma radiation dose, *(D)* fluoroscopy time in cases in which the Carlino technique was used vs the rest of the ADR/retrograde cases.

used the Carlino technique during retrograde CTO PCI with mean J-CTO score 3.3 ± 0.8, and overall technical and procedural success was 86%, similar to our data.

A perforation occurred in 1 of 5 of the Carlino cases but pericardiocentesis was needed only in 3.9% (5 cases).[24–26] When the Carlino technique was first introduced in 2016, one of the important limitations mentioned by the authors was the risk of perforation, that was kept low by decreasing the amount of contrast injected.[6] Of the 23 cases that used Carlino and reported perforation as a complication, only 5 were related to use of the Carlino technique in our registry.

Our study has limitations. The PROGRESS-CTO is an observational registry with all inherent limitations. There was no independent adjudication of clinical events. The procedures reported in the registry were performed at centers with experienced CTO PCI operators, potentially limiting the generalizability of the results to centers with limited CTO PCI experience. The decision to use the Carlino technique was at the discretion of the operator.

In conclusion, the Carlino technique is increasingly being used in CTO PCI for cases with higher complexity and is associated with lower success rates.

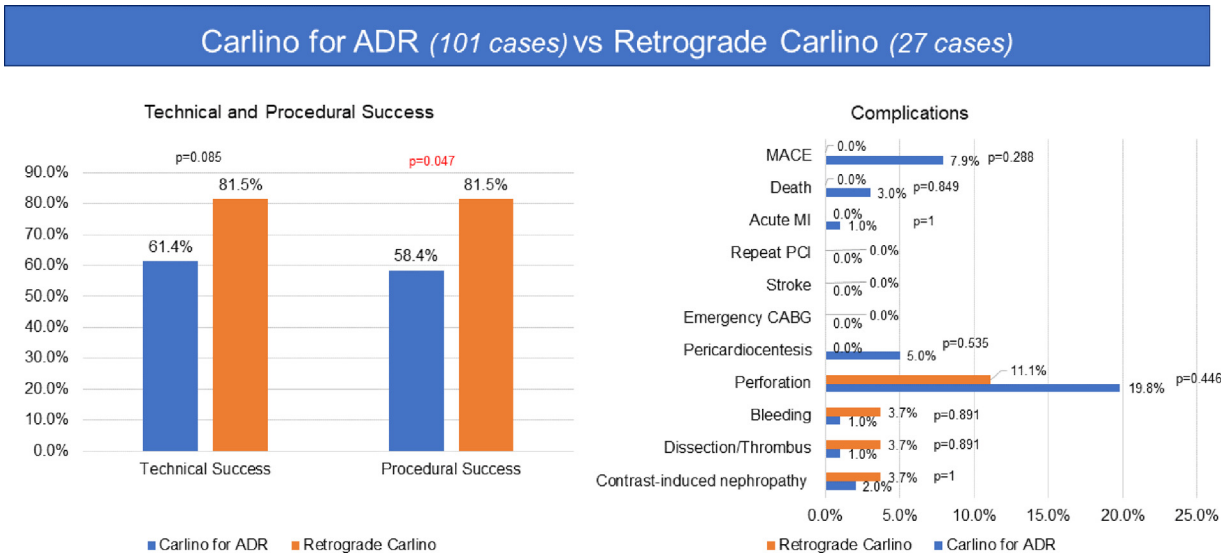

Figure 4. Procedural outcomes of cases in which the Carlino technique was used for ADR versus retrograde. CABG = coronary artery bypass graft.

Case	CarlinoUse	Emergency Surgery	Death	Acute MI	Pericardiocentesis	Perforation	Dissection/Thrombus	Bleeding	Contrast induced nephropathy
1	Retrograde	0	0	0	0	0	0	1	1
2	Retrograde	0	0	0	0	0	1	0	0
3	Retrograde	0	0	0	0	1	0	0	0
4	Retrograde	0	0	0	0	1	0	0	0
5	Retrograde	0	0	0	0	1	0	0	0
6	ADR	0	1	0	0	1	0	0	1
7	ADR	0	1	0	0	0	0	0	1
8	ADR	1	1	0	1	1	0	1	0
9	ADR	0	0	0	0	0	0	0	0
10	ADR	0	0	0	1	1	1	0	0
11	ADR	0	0	0	1	1	0	0	0
12	ADR	0	0	0	1	1	0	0	0
13	ADR	0	0	0	1	1	0	0	0
14	ADR	0	0	1	0	1	0	0	0
15	ADR	0	0	0	0	1	0	0	0
16	ADR	0	0	0	0	1	0	0	0
17	ADR	0	0	0	0	1	0	0	0
18	ADR	0	0	0	0	1	0	0	0
19	ADR	0	0	0	0	1	0	0	0
20	ADR	0	0	0	0	1	0	0	0
21	ADR	0	0	0	0	1	0	0	0
22	ADR	0	0	0	0	1	0	0	0
23	ADR	0	0	0	0	1	0	0	0
24	ADR	0	0	0	0	1	0	0	0
25	ADR	0	0	0	0	1	0	0	0
26	ADR	0	0	0	0	1	0	0	0
27	ADR	0	0	0	0	1	0	0	0

Figure 5. Complications of cases that used the Carlino technique.

Table 6
Perforations in cases that utilized the Carlino technique

Variables	Cases (n=23)
Perforation Vessel	
CTO Target Vessel	73.9% (17)
Septal Collateral	4.3% (1)
Epicardial Collateral	0% (0)
Other	8.7% (2)
Perforation Technique	
Antegrade Wiring	21.7% (5)
Antegrade dissection and reentry	52.2% (12)
Retrograde Wiring	13.0% (3)
Perforation Type	
Ellis Class 1	19.0% (4)
Ellis Class 2	52.4% (11)
Ellis Class 3	19.0% (4)
Ellis Class 3 - Cavity Spilling	9.5% (2)
Mechanism of Perforation	
Wire	50% (10)
CrossBoss	0% (0)
Rotablator	0% (0)
Microcatheter	17.4% (4)
Balloon	30.4% (7)
Stent	8.7% (2)
Unknown	8.7% (2)
Other	4.3% (1)

CTO = chronic total occlusion.

Declaration of Competing Interest

The authors have no competing interests to declare.

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