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Chronic total occlusion percutaneous coronary intervention: The Latin American experience

Chronic total occlusion percutaneous coronary intervention in Latin America

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Abstract

Objectives: To report clinical, angiographic characteristics, outcomes, and predictors of unsuccessful procedures in patients who underwent chronic total occlusion (CTO) percutaneous coronary interventions (PCI) in Latin America.

Background: CTO PCI has been increasingly performed worldwide, but there is a lack of information in this region.

Methods: An international multicenter registry was developed to collect data on CTO PCI performed in centers in Latin America. Patient, angiographic, procedural and outcome data were evaluated. Predictors of unsuccessful procedures were assessed by multivariable analysis.

Results: We have included data related to 1,040 CTO PCIs performed in seven countries in Latin America (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, and Puerto Rico). The mean age was 64 ± 10 years, and CTO PCI was performed mainly for

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angina control (81%) or treatment of a large ischemic area (30%). Overall technical success rate was 82.5%, and it was achieved with antegrade wire escalation in 81%, antegrade dissection/re-entry in 8% and with retrograde techniques in 11% of the successful procedures. Multivariable analysis identified moderate/severe calcification, a blunt proximal cap and a previous attempt as independent predictors of unsuccessful procedures. In-hospital major adverse cardiovascular events (MACE) occurred in 3.1% of the cases, death in 1% and cardiac tamponade in 0.9%

Conclusions: CTO PCI in Latin America has been performed mainly for ischemia relief. Procedures were associated with a success rate above 80% and low incidence of MACE. Predictors of unsuccessful procedures were similar to those previously reported in the literature.

KEYWORDS
chronic total occlusion, coronary artery disease, percutaneous coronary intervention

1 | INTRODUCTION

Chronic total occlusion (CTO) percutaneous coronary interventions (PCI) have been increasingly performed worldwide due to improvements in technique and new device development.[1–3] This growing interest in CTO PCI derives from the need to revascularize symptomatic patients refractory to medical therapy due to the presence of a CTO and who are not candidates to surgery, and when considering a complete revascularization

strategy in patients with more complex anatomies referred to a percutaneous approach. Indeed, two recent randomized clinical trials have demonstrated significant improvement in angina relief and quality of life in patients treated with CTO PCI when compared to optimal medical treatment.[4,5] Observational studies suggest that CTO PCI may also improve clinical outcomes and left ventricular function,[6–8] but randomized trials failed to demonstrate benefit.[9–11]

It is important to evaluate new and emerging therapies in diverse populations and in different regions of the world. Regional variations in patient characteristics and outcomes are common and relate to demographics, concomitant diseases, socioeconomic status, access to healthcare, treatment patterns and culture.[12,13] Europe and North America have several ongoing registries informing the current status of CTO PCI in these developed regions,[1,14–16] but there is a lack of information about CTO PCI in other regions. Within this perspective, the objective of the present study was to report clinical, angiographic characteristics, outcomes and predictors of unsuccessful procedures in patients who underwent CTO PCI in Latin America.

2 | METHODS

2.1 | Patients

The Brazilian Society of Interventional Cardiology developed and coordinated an ongoing international registry of CTO PCI (the LATAM CTO Registry), and centers in Latin America were invited and/or volunteered to participate. There was no specific requirement regarding CTO PCI volume for center acceptance. Patients considered for this study were treated in one of the participating centers. The inclusion criteria were age above 18 years and the presence of a CTO with PCI attempt, as indicated by the attending physician. The definition of a CTO was as a 100% lesion in a major coronary artery known or estimated to be at least 3-month duration. Local institutional review boards approved the study. The authors are solely responsible for the design and conduct of the study, statistical analysis, drafting and editing of the paper, and approval of its final contents.

2.2 | Data collection

Investigators inserted CTO PCI data in an online platform coordinated by the Brazilian Society of Interventional Cardiology and managed at the Instituto de Cardiologia do Rio Grande do Sul, Brazil. Access to the database was available via Research Electronic Data Capture (REDCap),[17] a secure and free-access web application developed by the Vanderbilt University and meeting the requirements of the National Agency for Sanitary Surveillance (ANVISA) in Brazil. REDCap provides an intuitive interface for standardized data entry, automated calculations and checks of discrepant/missing values, tools for controlling the quality and security of stored data and automated data export procedures for statistical packages. In addition, the software runs in computers, tablets or cell phones, offline or online, allowing the collection of data at the bedside or at any location inside the participating center.

All investigators received standardized instructions for the inclusion of data in REDCap, including an instructions' manual for completing electronic data collection sheets. The training focused on the purposes of registration, clarification of the data collection process and storage (computers, tablets and/or cell phones—according to the demand of each participating center). The centers received online support for questions regarding inclusion or completion of cases, and monthly feedbacks for missing data and discrepant values. We asked centers to address queries and internal audits were performed to maintain the quality of the database.

2.3 | Definitions

Moderate/large ischemia was defined as the presence of a perfusional defect by nuclear scan, stress echocardiography or magnetic resonance equal or greater than 10%. Moderate/severe calcification was defined as a > 50% involvement of the vessel by angiography, and moderate/severe tortuosity was the presence of at least two bends >70° or 1 bend >90° in the proximal vessel. Blunt stump was a lack of tapering at the proximal cap. Interventional collateral vessels were side branches considered amenable to crossing by a guidewire and a microcatheter by the operator. The J-CTO, PROGRESS, CL and ORA scores were calculated by the study investigators as previously described,[18–21] using the angiographic information reported by the centers. The Werner score and the presence or not of interventional collaterals were also reported.

The following strategies were generally considered for CTO PCI. Antegrade wire escalation consisted of the attempt to directly cross the occluded segment with the use of different guidewires, in a step-up fashion. Antegrade dissection re-entry was defined as an antegrade PCI during which the operator intentionally used the subadventitial space to partially or totally overcome the CTO segment with gears, reentering into the true lumen distally to the CTO. A retrograde procedure was defined as an attempt to cross the lesion through a collateral vessel supplying a segment distal to the target CTO. We defined technical success as successful CTO revascularization within the treated segment and restoration of TIMI antegrade flow grade 3. Procedural success was the achievement of technical success without major adverse cardiac events (MACE).

2.4 | Outcomes

In-hospital, MACE before hospital discharge included all-cause death, myocardial infarction (MI) and stroke. MI was defined using the universal definition of MI (type 4a MI).[22] Stroke was defined as a new focal neurological deficit of sudden onset of presumably cerebrovascular irreversible cause (or resulting in death) within 24 hr and not caused by any other easily identifiable cause.

Procedural complications included major bleeding, coronary perforation, cardiac tamponade and urgent revascularization with PCI or coronary artery bypass graft (CABG). Major bleeding was defined as any bleeding causing reduction in hemoglobin >3 g/dL or bleeding requiring transfusion or surgical intervention. Coronary perforation was defined as any contrast extravasation beyond artery wall. Cardiac tamponade was defined as hemodynamic compromise caused by acute accumulation of blood in the pericardial space.

2.5 | Statistical analysis

We presented continuous variables as mean ± standard deviation (*SD*), and categorical variables in absolute and relative frequencies. The *t*-test (continuous variables) or chi-square test (categorical) were used to compare normally distributed data, and the Mann–Whitney test for non-parametric data. A two-tailed $p < .05$ was considered statistically significant for all tests. All analyzes were performed using SPSS version 22.

Characteristics and outcomes of unsuccessful procedures were compared to those with procedural success. Multiple logistic regression with backward stepwise technique was used to evaluate independent predictors of unsuccessful procedures. Candidate predictors were chosen considering statistical significance in the univariate analysis and/or relevance according to previous reports and biological plausibility. Tapered stump and proximal cap ambiguity presented significant co-linearity, and two different models were constructed with each one of these and the other candidate predictors (gender, age, diabetes, previous attempt, previous CABG, PCI in the circumflex artery, moderate/severe calcification, tortuosity, dual injection, microcatheter and retrograde technique). The model including tapered stump showed a better calibration and was chosen as the final model. Calibration was assessed by the Hosmer and Lemeshow goodness-of-fit test.[23]

3 | RESULTS

We have included procedural data of 1,040 CTO PCIs performed in 35 centers from seven countries in Latin America between January 2015 and February 2019. Brazil included 610 patients (59% of the study population), Argentina included 243 cases (23% of the population), Puerto Rico contributed with 112 cases (11% of the total), Chile had 38 cases (4%), Colombia had 30 patients (3%), Ecuador four patients (0.4%) and Mexico three patients (0.3%).

Table 1 shows the overall baseline clinical characteristics and according to CTO PCI success. The mean age was 64 ± 10 years, most patients had a diagnosis of hypertension, diabetes mellitus was

TABLE 1 Clinical characteristics in study patients and according to success or not of the CTO PCI procedure

	All cases (*n* = 1,040)	Successful procedures (*n* = 858)	Unsuccessful procedures (*n* = 182)	*p*
Age, years	64.48 ± 10.70	64.30 ± 10.68	65.35 ± 10.74	.228
Male	826 (78%)	684 (80%)	142 (78%)	.607
White race	700 (73%)	575 (72%)	125 (77%)	.360
Hypertension	917 (90%)	758 (90%)	159 (89%)	.695
Dyslipidemia	716 (70%)	596 (71%)	120 (67%)	.343
Smoker	174 (17%)	144 (17%)	30 (17%)	.927
Diabetes mellitus	375 (37%)	308 (36%)	67 (37%)	.845
Medical history				
MI	326 (41%)	267 (41%)	59 (40%)	.838
PCI	456 (58%)	370 (57%)	86 (59%)	.719
Previous attempt of CTO PCI	145 (14%)	107 (13%)	38 (21%)	.003
CABG	151 (19%)	115 (18%)	36 (25%)	.058
Stroke	33 (4%)	24 (4%)	9 (6%)	.181
Peripheral vascular disease	64 (8%)	50 (8%)	14 (10%)	.459
Chronic renal failure	71 (9%)	60 (9%)	11 (8%)	.503
Ejection fraction, %	54.94 ± 11.45	55.16 ± 11.25	53.88 ± 12.39	.193
Procedural indication				
Angina control	846 (81%)	705 (82%)	141 (78%)	.140
Moderate/large ischemia	314 (30%)	260 (30%)	54 (30%)	.866
Chronic heart failure	89 (9%)	72 (8%)	17 (9%)	.678
Others	35 (3%)	28 (3%)	7 (4%)	.692

Note: Categorical data are *n* (%). Values are mean ± *SD*.

Abbreviations: CABG, coronary artery bypass grafting; CTO, chronic total occlusion; MI, myocardial infarction; PCI, percutaneous coronary intervention.

TABLE 2 Angiographic characteristics in study patients and according to success or not of the CTO PCI procedure

	All cases (*n* = 1,040)	Successful procedures (*n* = 858)	Unsuccessful procedures (*n* = 182)	*p*
Target vessel				
Left anterior descending artery	355 (34%)	308 (36%)	47 (26%)	.009
Right coronary artery	438 (42%)	354 (41%)	84 (46%)	.229
Left circumflex artery	229 (22%)	180 (21%)	49 (27%)	.080
Left main	9 (0.9%)	7 (0.8%)	2 (1%)	.709
Vein graft	8 (0.8%)	8 (0.9%)	0	.191
CTO length, mm	26.1 ± 15.6	25.7 ± 15.7	28.4 ± 14.7	.054
Proximal cap ambiguity	327 (32%)	230 (27%)	97 (55%)	<.001
Tapered stump	508 (50%)	458 (54%)	50 (29%)	<.001
Moderate/severe calcification	475 (47%)	376 (44%)	99 (57%)	.002
Moderate/severe tortuosity	235 (23%)	185 (22%)	50 (29%)	.039
Distal cap at bifurcation	289 (34%)	237 (34%)	52 (35%)	.849
Lack of interventional collaterals	255 (25%)	212 (25%)	43 (25%)	.827
Werner score				.38
0	255 (25%)	212 (25%)	43 (25%)	
1	509 (50%)	87 (47%)	427 (51%)	
2	247 (24%)	50 (29%)	197 (23%)	
In-stent restenosis	127 (12%)	110 (13%)	17 (10%)	.232
Prediction scores				
J-CTO score[18] (*n* = 910)	2.13 ± 1.23	2.00 ± 1.22	2.80 ± 1.09	<.001
PROGRESS CTO score[19] (*n* = 839)	1.03 ± 0.87	0.97 ± 0.86	1.34 ± 0.88	<.001
CL score[20] (*n* = 710)	3.13 ± 1.59	2.99 ± 1.57	3.87 ± 1.55	<.001
ORA score[21] (*n* = 1.010)	1.12 ± 0.71	1.13 ± 0.72	1.07 ± 0.69	.274

Note: Categorical data are *n* (%). Values are mean ± *SD*.
Abbreviations: CTO, chronic total occlusion; PCI, percutaneous coronary intervention.

TABLE 3 Procedural characteristics in study patients and according to success or not of the CTO PCI procedure

	All cases (*n* = 1,040)	Successful Procedures (*n* = 858)	Unsuccessful Procedures (*n* = 182)	*p*
Radial access	522 (50%)	432 (50%)	90 (50%)	.803
Femoral access	754 (73%)	620 (72%)	134 (74%)	.742
Dual injection	551 (53%)	444 (52%)	107 (60%)	.058
Use of microcatheter	714 (69%)	579 (68%)	135 (75%)	.052
Type of microcatheter				
Corsair	211 (20%)	166 (20%)	45 (25%)	.091
Finecross	318 (31%)	253 (30%)	65 (36%)	.087
Turnpike LP	78 (8%)	67 (8%)	11 (6%)	.420
Fluoroscopy time, min	39.32 ± 28.11	37.02 ± 27.92	50.56 ± 26.38	<.001
Contrast volume, ml	242.94 ± 115.72	238.47 ± 114.37	264.49 ± 120.09	.010
Radiation, mGy	3,074 ± 2,390	2,928 ± 2,355	3,785 ± 2,439	<.001

Note: Categorical data are *n* (%).
Abbreviations: CTO, chronic total occlusion; PCI, percutaneous coronary intervention.

present in one-third of individuals and almost half had already undergone a previous revascularization procedure. Left ventricular systolic function was generally preserved. CTO PCI was carried out mainly for angina control or treatment of a large ischemic area. The only significant difference when comparing clinical characteristics of patients who experienced or not a successful procedure was a previous

TABLE 4 Multiple logistic regression model of candidate variables associated with unsuccessful CTO PCI procedures

Variables in the equation	*B*	Odds ratio	95% CI		*p*
			Lower	Upper	
Blunt proximal cap	0.95	2.59	1.80	3.73	<.001
Moderate/severe calcification	0.42	1.52	1.08	2.15	.02
Previous attempt	0.57	1.77	1.15	2.73	<.01
Constant	−3.43	0.03			<.001

Note: Hosmer and Lemeshow test: chi-square 0.95, $p = .97$.
Abbreviations: CI, confidence interval; CTO, chronic total occlusion; PCI, percutaneous coronary intervention.

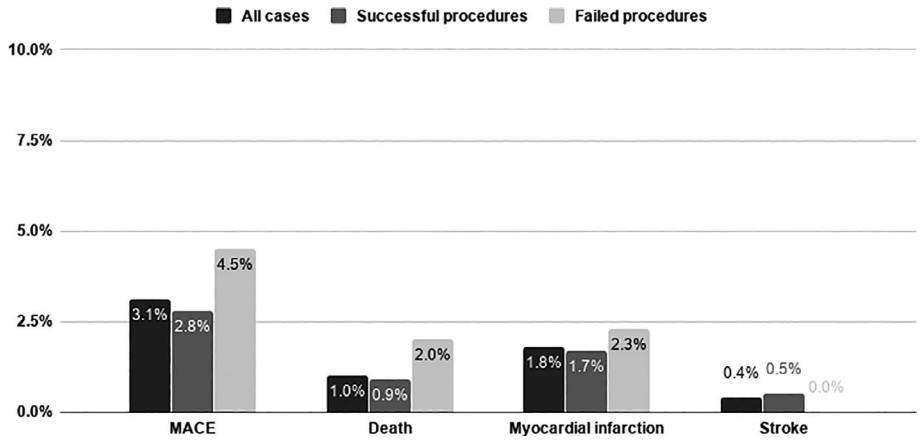

FIGURE 1 Thirty-day clinical event rates in the study population and according to the success or not of the CTO PCI procedure. CTO, chronic total occlusion; MACE, major adverse cardiovascular event; PCI, percutaneous coronary intervention

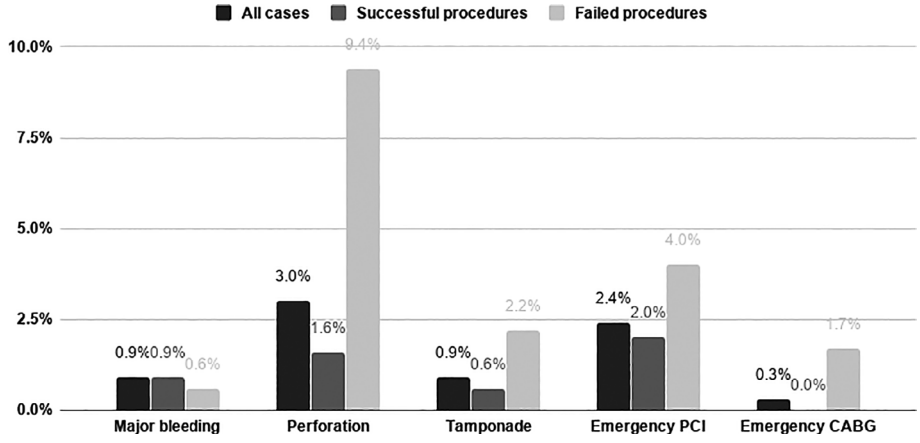

FIGURE 2 In-hospital complication rates in the study population and according to the success or not of the CTO PCI procedure. CABG, coronary artery bypass surgery; CTO, chronic total occlusion; PCI, percutaneous coronary intervention

attempt, which was more common in those with unsuccessful procedures.

Table 2 shows the baseline angiographic characteristics of all the study patients and in patients with successful and unsuccessful procedures. The frequency of multivessel disease was 57%, and the mean CTO length was 26 ± 15 mm. A tapered stump and moderate/severe calcification were present in half of the patients. Patients with unsuccessful procedures had more frequently proximal cap ambiguity, a blunt stump, moderate/severe calcification and significant tortuosity. Characteristics of the collateral circulation and the Werner score were not statistically different between patients with or without procedural success.

Overall, technical success rate of the CTO PCI in this registry was 82.5%, and it ranged from 65 to 100% among centers. Success rates also varied amongst countries: Brazil had a mean success rate of 84%, Argentina had a success rate of 79%, Puerto Rico 85%, Chile 87%, Colombia 63%, Ecuador 100% and Mexico 100%. Procedural success was achieved with antegrade wire escalation (AWE) in 644 patients

TABLE 5 Recent registry reports of CTO PCI data

Study	*n*	Procedural success	JCTO score	Retrograde approach	Cardiac tamponade	MACE	Death
National Registries							
NCDR[26]	22,365	59%	NR	NR	0.3%	1.6%	0.4%
British[27] (2014)Cardiovascular	28,050	67%	NR	NR	0.24%	0.73%	0.2%
CTO Registries							
OPEN CTO[14]	1,000	90%	2.3	35%	2.8%	7%	0.9%
PROGRESS[15]	3,055	87%	2.43	39%	0.85%	3%	0.85%
EURO CTO[1]	4,314	88%	2.17	30%	NR	0.5%	0.1%
RECHARGE [16]	1,253	89%	2.2	34%	1.3%	2.6%	0.2%
Japanese[28]	3,229	88%	1.5	32%	0.34%	0.53%	0.2%
LATAM	1,040	81%	2.13	11%	0.9%	3%	1%

Abbreviations: CTO, chronic total occlusion; MACE, major adverse cardiovascular events; PCI, percutaneous coronary intervention.

(81% of the successful procedures), with antegrade dissection/re-entry (ADR) in 62 patients (8%) and with retrograde techniques in 85 patients (11%). The following guidewires successfully crossed the CTO lesion (percent of cases each wire was successful): PT2 (14%), Whisper (13%), Fielder XT (12%), Runthrough NS (7%), Fielder FC (6%), Confianza Pro 12 (5%), Pilot 200 (5%), Progress 80 (5%) and other wires (33%).

Table 3 shows the overall procedural aspects of the study patients and in those with successful procedures or not. Radial access, dual injection and a microcatheter were used in approximately half of the cases. There was a trend towards a higher use of microcatheters and dual injections in those who experienced failures. However, a microcatheter was used in more angiographically complex procedures (J-CTO score: 2.36 ± 1.22 vs JCTO = 1.84 ± 1.18, respectively; $p < .001$). Procedures that used dual injections were also significantly more complex than those without this technique (J-CTO score: 2.41 ± 1.18 vs 1.50 ± 1.09, respectively; $p < .001$). Unsuccessful procedures presented significantly higher fluoroscopy time, contrast use and radiation exposure. Table 4 shows the multivariate analysis model with the best calibration to this population. Predictors of unsuccessful procedures were moderate/severe calcification, a blunt proximal cap and a previous attempt.

Figure 1 shows MACE and its individual components rates in all patients and in those with successful procedures or not. Overall, the rates of events were low, with no significant differences between those with unsuccessful procedures or not. Figure 2 shows procedural complications, which were also generally low. However, coronary perforation, cardiac tamponade and emergent CABG were significantly more frequent in patients who experienced an unsuccessful procedure.

4 | DISCUSSION

In this study, we report for the first time comprehensive data of CTO PCI performed in Latin America, including clinical, angiographic, procedural characteristics, outcomes and predictors of unsuccessful procedures. CTO PCI procedures data from North America, Western Europe and Japan have been extensively reported,[1,14–16,24] but there is a paucity of real-world data from other regions. We found encouraging results of CTO PCI, with success rates above 80%, generally low rates of complications and adverse outcomes and frequent use of recommended CTO PCI approaches.

The present analysis is relevant because equipment and resources are generally more limited in Latin America, mainly due to financial restraints and fragmented regulatory issues.[25] Registry data from very experienced CTO centers report success rates of approximately 90%, higher than found in our report. In Table 5, we compare characteristics of the present registry with contemporary registries in the literature, which we have categorized as National Registries (CTO PCI extracted from large national general PCI registries)[26,27] and CTO Registries (CTO PCI data from dedicated CTO centers in the United States, Europe and Japan).[1,14–16,28] Data from the most recent year was chosen when a registry had been collecting data over a long period (more than 5 years). In general, the success rates were higher in the LATAM CTO Registry when compared to those reported in the National Registries, but lower than in those reported in the dedicated CTO Registries. Anatomy complexity in our registry, as assessed by the J-CTO score, was similar to other CTO Registries, but information from the National Registries was not available. Complication and MACE rates were also generally similar between the LATAM CTO Registry and CTO Registries, but higher than in the National Registries.

As mentioned above, our lower success rates could be related to more limited resources and because many centers and operators are in different phases of the learning curve for CTO PCI.[25] This is exemplified by the variability of success rates and number of patients included amongst participating centers and countries in this report. On the other hand, LATAM CTO Registry success rates were higher than found in "National Registries" of CTO PCI, probably demonstrating some level of proficiency and experience in the participating centers of our registry. Differently from other dedicated CTO registries,[1,14] we did not establish a minimum number of cases per

operator or center to participate. We aimed at showing a picture of clinical practice in CTO PCI in Latin America, and every center willing to participate was included. Our results may, therefore, be more generalizable and represent the global reality of most interventional cardiology services with CTO interest.

The use of microcatheters and, especially, dual injections are considered best practice in several documents.[3,15,16,27] The fact that only half of the procedures in our study were performed using dual injections and only two-thirds used microcatheters reinforces the notion of a learning curve in our region. While a lower use of microcatheters than recommended could be related to reimbursement and financial issues, there is no such issue regarding dual injections other than operator decision. The trends towards higher use of microcatheter and dual injection in unsuccessful procedures are probably due to their higher use in more complex cases. These observations highlight the importance of proper education, proctoring and training for all those who intend to perform CTO PCI.

In spite of the limited availability of resources and the operator variability in CTO PCI expertise in our region, one important finding was that the main predictors of unsuccessful procedures in the LATAM CTO Registry were generally similar to previous reports.[18,19,29–31] Angiographic characteristics more common in unsuccessful procedures were long lesions, proximal cap ambiguity, a tapered stump, calcification and tortuosity. Regarding procedural aspects, there were no characteristics significantly associated with unsuccessful procedures. By multivariable analysis, a previous attempt, a blunt proximal cap and calcification were independent predictors of unsuccessful procedures.

Procedural time, contrast volume and radiation dose were significantly higher in patients with unsuccessful procedures, as well the incidence of coronary perforation and cardiac tamponade. The rates of hard endpoints were numerically higher in patients with unsuccessful procedures, albeit not significantly different from those with successful procedures. It is important to highlight the almost four times higher incidence of perforations in patients with unsuccessful procedures, which demonstrate the potential inherent risks of CTO PCI.[32] The lower incidence of dual injection (thus limiting the assessment of guidewire position) and mixed expertise of the operators could also play a role here.

The indications to perform CTO PCI have recently been questioned by randomized clinical trials failing to show benefit of these procedures in lowering cardiovascular events or improving ventricular function.[9–11] On the other hand, CTO PCI improved symptoms and quality of life when compared to optimal medical therapy in two recent randomized trials.[4,5] In this context, it is reassuring that 82.5% of the procedures in the LATAM CTO registry were performed to relieve symptoms and 30% to treat a large ischemic area. Overall, only 6% of the patients in this registry underwent CTO PCI for a clinical indication that was not angina relief or large ischemic area. According to the most recent guidelines,[33,34] these are appropriate indications for percutaneous revascularization in patients with stable CAD, whether the lesion is a CTO or not.

5 | LIMITATIONS

This is the first registry aiming to assess characteristics of patients submitted to CTO PCI in Latin America, including 35 centers from seven countries in this region. However, data included were reported by the centers, with no on-site auditing or monitoring. A detailed instructions manual was sent to centers to standardize inclusion and collection and minimize variability. Also, we periodically checked the database for outliers, spurious values and asymmetries in an effort to improve data quality. The inclusion of patients by each center was not necessarily consecutive, which could have introduced a selection bias. Angiographic and procedural characteristics were not independently evaluated by a core lab, which can also be considered a limitation. The assessment of scoring systems depends on whether dual angiography was performed, and its use in only half of the cases could have overestimated the scores. Clinical outcomes were not centrally adjudicated by a central events committee, but standardized definitions were provided to the centers in the study manual. Long-term outcomes were not reported in this paper, and we plan to report these in future analysis.

6 | CONCLUSION

CTO PCI in Latin America has been performed mainly for angina relief and to treat moderate/large ischemic burden, with success in over 80% of the cases and low rates of major adverse cardiac events. Previous attempt, a blunt proximal cap, and moderate/severe calcification were independent predictors of failure. These results show the effectiveness and feasibility of CTO PCI in a real-world scenario of middle-income and developing countries, but also highlight the need for further promotion and improvement of these procedures in our region.

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CONFLICT OF INTEREST

Alexandre Quadros has received educational support from Boston, Asahi, Biotronik and Terumo, research grants from Boston and Terumo, and was a speaker for Boston. João Tinoco is a speaker and works as proctor for Boston. Ricardo Santiago is a Proctor/Speaker/Consultant for Boston Scientific, Abbott Vascular,Teleflex and also is a Speaker/Consultant for Abiomed. Breno Falcão is a speaker and works as proctor for Boston. Marco Alcantara is a speaker and works

as proctor for Boston. Lucio Padilla is a speaker and works as proctor for Boston and Terumo. Daniel Weillenmann is a speaker/proctor for Boston and proctor for Terumo. The other authors report no conflict of interest.

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