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The predictive Value of the New PROGRESS-CTO Complication Score

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Abstract

Background: Coronary chronic total occlusion percutaneous coronary interventions (CTO PCI) are regarded as more expensive and complex procedures, and they may be linked to a greater incidence of peri-procedural complications. In this environment, there is currently no specific instrument available to predict the risk of peri-procedural complications. In the PROGRESS CTO trial, which is part of the Prospective Global Registry for the Study of Chronic Total Occlusion Intervention, the researchers found that the hybrid method was both safe and effective for recanalizing CTOs. The PROGRESS CTO score was devised as a prediction model for estimating technical success utilizing this technique. In order to evaluate the new complications associated with PROGRESS CTO, we initiated this investigation.

Methods: This prospective cohort investigation was conducted on 60 patients who had CTO. The patients were separated into two groups; the first group included patients who developed major in-hospital adverse cardiovascular event (MACE group) and the other group included patients who didn't develop major in-hospital adverse cardiovascular event.

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Results: PROGRESS-CTO score for MACE is a significant predictor of occurrence of MACE in CTO patients undergoing PCI (AUC =0.919, p <0.001). At a cut off value of >3 it can predict the occurrence of MACE with a sensitivity of 71.4% and specificity of 88.7%.

Conclusions: For the purpose of assessing the potential for problems in patients undergoing CTO PCI, the New PROGRESS-CTO complication scores may be useful, as they are easy to calculate, calibrated, and exhibit good discriminative performance.

Keywords: Percutaneous coronary interventions, Progress-CTO Complication Score, Coronary chronic total occlusion.

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Introduction:

Among the most challenging cases in interventional cardiology is coronary chronic total occlusion (CTO). Complete blockage of a coronary artery for at least three months is a hallmark of this condition, which is accompanied by thrombolysis in myocardial infarction (TIMI) grade 0 flow **[1]**. Percutaneous coronary interventions (PCIs) for CTO represent less than 4% of all percutaneous revascularization procedures, even though CTO occurs in 18-46% of patients with stable coronary artery disease (CAD) who undergo coronary angiography. CTO PCI's success rates are consistently improved as new techniques and instruments are created to resolve the specific difficulties of CTO PCI. The risk-benefit analysis is continuously impacted by the 3.1% rate of periprocedural complications that was observed in a large contemporary meta-analysis **[2]**.

In comparison to continuous lesions angioplasty, CTO PCI strategies are regarded as more expensive and complex methods, and they may be linked to a greater incidence of peri-procedural complications. In CTO PCI, the importance of patients' selection has been emphasized in various reports [3]. There is presently no method for predicting the risk of periprocedural complications in CTO PCI, despite the fact that scores like the Prospective Global Registry for the Study of Chronic Total Occlusion Intervention [PROGRESS CTO] score, the Japanese Chronic Total Occlusion [J-CTO] score, and the Clinical and Lesion-related [CL] score have been produced to predict procedural and technical outcomes **[4]**.

In reality, interventional cardiologists are discouraged from embracing this procedure due to a high incidence of failures and complications associated with CTO revascularization, as well as the absence of supportive data from randomized clinical trials. In order to achieve the most favorable immediate and long-term outcome, it may be imperative to establish scores that accurately predict the success of CTO recanalization and identify suitable candidates for a percutaneous approach among CTO patients, as a result of these factors **[5]**.

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The hybrid approach in CTO recanalization was both safe and effective, as reported by the investigators in the PROGRESS CTO. Using this methodology, a prediction model (PROGRESS CTO score) was developed to evaluate technical success. Four angiographic variables comprised the model: the absence of "interventional" collaterals (1 point), moderate/severe tortuosity (1 point), circumflex artery CTO (1 point), and proximal cap ambiguity (1 point) **[6]**.

Therefore, the objective of this investigation was to assess the potential of the PROGRESS CTO complications score to estimate the major adverse cardiovascular events (MACE) in patients who experienced CTO PCI.

Patients and Methods:

This prospective cohort study was performed on 60 consecutive patients with CTO admitted to national heart institute (NHI), Egypt. The patients were separated into two groups; MACE group involved patients who developed major adverse cardiovascular events and no MACE group which included patients who didn't develop MACE. Exclusion criteria included patients with severe left ventricular dysfunction (LVEF< 30%), baseline renal impairment, age less than 18 years old, and those who refused to take part in the study.

All the studied patients were exposed to clinical examination, full history taking, laboratory investigation, trans-thoracic echocardiography and electrocardiography to assess left ventricular systolic function. The PROGRESS CTO complication score was calculated according to the invasive coronary angiography (ICA) findings following criteria of the scoring sheet. The term "MACE" was identified as a combination of mortality, MI, stroke, and urgent repeat revascularization. Achieving a residual stenosis of lower than 30% and restoring TIMI grade 3 antegrade flow were the criteria for technical success in CTO revascularization. It was determined that procedural success was achieved when technical success was combined with the absence of in-hospital complications. After the Ethical

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Committee's approval, the investigation was implemented. All patients who participated in the investigation provided written informed consent.

Statistical analysis

In order to carry out the statistical analysis, SPSS v27 (Chicago, IBM©, USA, IL) was utilized. We utilized histograms and the Shapiro-Wilks test to determine if the data was normally distributed. The quantitative parametric data, presented as mean and SD, were analyzed by employing an ANOVA (F) test with a Tukey post hoc test. Median and interquartile range (IQR) were used to display quantitative non-parametric data. Kruskal-Walli's test with Mann-Whitney U test was utilized to examine the data. Use of the Chi-square test was implemented to analyze qualitative variables in the form of frequency and percentage (%). Statistically significant two-tailed P values were defined by values that were less than 0.05.

Results:

This study involved 60 patients with CTO PCI and their age ranged between 50–74 years with the mean of 64.41±3.12 years. MACE occurred in 7 patients (11.67%). Patients who developed MACE were significantly older (70.3 ± 9.5 vs. 58.2 ± 7.9 years, $p < 0.001$), more likely to be females ($p = 0.044$) and smokers ($p = 0.021$). History of atrial fibrillation ($p = 0.009$), heart failure ($p = 0.016$), and chronic lung disease ($p = 0.043$) were more prevalent in patients who developed MACE. Baseline criteria are illustrated in **table 1.**

There was an insignificantly statistical different in LVEF and CTO target vessel between both studied groups. Regarding successful crossing strategy, the number of the study participants who had antegrade wiring (AW) was significantly lower in MACE group, but retrograde wiring was significantly higher in MACE group compared to no MACE group. There was an insignificant difference in the number of study participants who had ADR or didn’t have successful crossing. Blunt stump and moderate or severe calcification were significantly higher in MACE group compared to no MACE group. The

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number of study participants who had technical angiographic success was significantly lower in MACE group (42.9% vs. 81.1%, p = 0.045). PROGRESS-CTO score for MACE was significantly higher in the MACE group compared to no MACE group **(Table 2)**.

Multivariate regression analysis revealed that the PROGRESS-CTO score for MACE is a significant predictor of occurrence of MACE with an OR of 2.72 (1.42 – 5.19) and p < 0.01. According to the results of the ROC curve study, the PROGRESS-CTO score for MACE is a strong indicator of whether MACE will occur in CTO patients who are having PCI (AUC = 0.919, p <0.001). When the cutoff value is more than 3, it has a sensitivity of 71.4% and a specificity of 88.7% in predicting MACE occurrence **(Figure 1)**.

Discussion:

For coronary interventionists, CTO lesions continue to be an important problem and frequently lead to recommendations for coronary artery bypass graft surgery (CABG). Specialized centers achieve greater success rates of PCI compliance for CTOs, which range from 55% to 80% **[7]**. After a successful CTO PCI, the MACE rate is nearly 2 to 2.5%. Conversely, a failed PCI is associated with a greater MACE rate of nearly 5.6%**[8]**.

A variety of scoring systems has been created to evaluate the prospective efficacy of CTO PCI procedures **[9-11]**. The numerical evaluation of success and complications, which is facilitated by these scoring systems, serves a multitude of purposes, including the enhancement of case selection based on objective assessments of clinical and anatomical complexity. The purpose of developing the PROGRESS-CTO complications score was to facilitate the assessment of probable adverse events before hospital discharge **[11]**.

In order to assess the novel PROGRESS-CTO complication risk score for the prediction of in-hospital MACE, our investigation was conducted on 60 consecutive CTO patients who underwent PCI. MACE group patients were significantly older, more likely to be females. Similarly, Simsek et al., **[12]**

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reported that patients who had MACE were older ($P < 0.001$) and more likely to be women (27% vs. 19%; $P = 0.004$).

In terms of successful crossing strategy, the number of individuals experiencing retrograde was significantly higher in the MACE group compared to the no MACE group, while the number of people experiencing AW was significantly lower in the MACE group. There was an insignificant difference in the number of study participants who had ADR or didn't have successful crossing. Similarly, Simsek et al., [12] discovered that MACE was associated with ADR and retrograde strategy. There was no correlation between the use of ADR or retrograde methods and a greater risk of MACE compared to AW, according to their data. Although the success rate of CTO PCI was greatly improved with the retrograde technique, it is important to recognize that this strategy is linked to an elevated complication rates.

We also found that Blunt stump and moderate or severe calcifications were significantly higher in MACE group compared to no MACE group. Simsek et al., [12] discovered that moderate-severe proximal vessel tortuosity and moderate-severe calcification were correlated with MACE. They also discovered an independent association between the risk of MACE and a blunt amputation. Blunt stumps were linked to a 63% increased incidence of MACE in their respective analyses. Guidewires with a higher penetration force or retrograde crossing are frequently required for blunt stump lesions, which may be associated with elevated complication rates [13].

The number of study participants who had technical angiographic success was significantly lower in MACE group.

In line with us, Simsek et al., [14] In an additional study that aimed to externally demonstrate the PROGRESS-CTO complication risk scores, 4569 patients who had CTO PCI were included. The results indicated that patients with MACE had a decreased rate of technical success (59% vs. 86%, $p < 0.001\%$).

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The results showed that the MACE group had a significantly greater PROGRESS-CTO score. In coherence with the previous finding, Azzalini et al., [15] investigated CTO PCIs carried out at 12 experienced US centers for validation of the new PROGRESS-CTO complication risk scores. According to their findings, the PROGRESS-CTO MACE score was considerably greater in the MACE group. They discovered that higher PROGRESS-CTO MACE scores were linked to greater MACE rates, with increases of 0.5% (score 0−1), 2.4% (score 2), 3.7% (score 3), 4.5% (scoring 4), 7.8% (score 5), and 13.0% (score 6−7).

Moreover, we discovered that the PROGRESS-CTO score for MACE is a highly predictive factor for the occurrence of MACE in CTO patients who are undergoing PCI (AUC =0.919, p <0.001). At a cut-off value of >3, it is capable of predicting the occurrence of MACE with a specificity of 88.7% and a sensitivity of 71.4%. In agreement with us, Simsek et al., [12] Using the ROC curve, he found that the PROGRESS-CTO MACE score performed satisfactorily (AUC:0.74; 95% CI:0.70-0.78). Similarly, Azzalini et al., [15] reported that The AUC for PROGRESS-CTO MACE score was 0.72 (95% CI: 0.66−0.78).

Logistic regression of new PROGRESS-CTO score in our study showed that PROGRESS-CTO score for MACE is a significant predictor of occurrence of MACE with an OR of 2.72 (1.42 – 5.19) and p value 0.003. In agreement with us, Simsek et al., [12] reported that the PROGRESS-CTO MACE score showed on Logistic regression a significant prediction of occurrence of MACE with a P value <0.10.

Conclusions:

Because of their superior discriminative calibration, performance, and simplicity of calculation, the New PROGRESS-CTO complication scores may be advantageous for evaluating the risk of complications in patients undergoing CTO PCI.

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Conflict of Interest: Nil

References:

1. Hafeez Y, Varghese V. Chronic Total Occlusion of the Coronary Artery. 2023 Jul 24. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan–. PMID: 32809342.
2. Muraca I, Carrabba N, Virgili G, Bruscoli F, Migliorini A, Pennesi M, et al. Chronic total occlusion revascularization: A complex piece to "complete" the puzzle. World J Cardiol. 2022; 14:13-28.
3. Boukhris M, Mashayekhi K, Elhadj ZI, Galassi AR. Predictive scores in chronic total occlusions percutaneous recanalization: only fashionable or really useful? J Thorac Dis. 2016; 8:1037-41.
4. Kalnins A, Strele I, and Lejnieks A. Comparison among Different Scoring Systems in Predicting Procedural Success and Long-Term Outcomes after Percutaneous Coronary Intervention in Patients with Chronic Total Coronary Artery Occlusions. Medicina (Kaunas). 2019 Aug 16; 55(8):494. doi: 10.3390/medicina55080494.
5. Ybarra LF, Rinfret S, Brilakis ES, Karmpaliotis D, Azzalini L, Grantham JA, et al. Definitions and Clinical Trial Design Principles for Coronary Artery Chronic Total Occlusion Therapies: CTO-ARC Consensus Recommendations. Circulation 2021; 143:479-500.
6. Tajti P, Karmpaliotis D, Alaswad K, Jaffer FA, Yeh RW, Patel M, et al. The Hybrid Approach to Chronic Total Occlusion Percutaneous Coronary Intervention: Update from the PROGRESS CTO Registry. JACC Cardiovasc Interv. 2018; 11:1325-35.
7. Werner GS, Martin-Yuste V, Hildick-Smith D, Boudou N, Sianos G, Gelev V, et al. A randomized multicentre trial to compare revascularization with optimal medical therapy for the treatment of chronic total coronary occlusions. Eur Heart J. 2018; 39:2484-93.
8. Neumann FJ, Sousa-Uva M, Ahlsson A, Alfonso F, Banning AP, Benedetto U, et al. 2018 ESC/EACTS Guidelines on myocardial revascularization. Eur Heart J. 2019; 40:87-165.

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9. Christopoulos G, Kandzari DE, Yeh RW, Jaffer FA, Karmpaliotis D, Wyman MR, et al. Development and Validation of a Novel Scoring System for Predicting Technical Success of Chronic Total Occlusion Percutaneous Coronary Interventions: The PROGRESS CTO (Prospective Global Registry for the Study of Chronic Total Occlusion Intervention) Score. JACC Cardiovasc Interv. 2016; 9:1-9.
10. Alessandrino G, Chevalier B, Lefèvre T, Sanguineti F, Garot P, Unterseeh T, et al. A Clinical and Angiographic Scoring System to Predict the Probability of Successful First-Attempt Percutaneous Coronary Intervention in Patients With Total Chronic Coronary Occlusion. JACC Cardiovasc Interv. 2015; 8:1540-8.
11. Galassi AR, Boukhris M, Azzarelli S, Castaing M, Marzà F, Tomasello SD. Percutaneous Coronary Revascularization for Chronic Total Occlusions. JACC: Cardiovascular Interventions. 2016; 9:911-22.
12. Simsek B, Kostantinis S, Karacsonyi J, Alaswad K, Krestyaninov O, Khelimskii D, et al. Predicting Periprocedural Complications in Chronic Total Occlusion Percutaneous Coronary Intervention: The PROGRESS-CTO Complication Scores. JACC: Cardiovascular Interventions. 2022; 15:1413-22.
13. Brilakis ES, Mashayekhi K, Tsuchikane E, Abi Rafeh N, Alaswad K, Araya M, et al. Guiding principles for chronic total occlusion percutaneous coronary intervention: a global expert consensus document. Circulation 2019; 140:420-33.
14. Simsek B, Tajti P, Carlino M, Ojeda S, Pan M, Rinfret S, et al. External validation of the PROGRESS-CTO complication risk scores: Individual patient data pooled analysis of 3 registries. International journal of cardiology 2023; 375:14-20.

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15. Azzalini L, Hirai T, Salisbury A, Gosch K, Sapontis J, Nicholson WJ, et al. Validation of the new PROGRESS-CTO complication risk scores in the OPEN-CTO registry. Catheterization and Cardiovascular Interventions 2023; 101:536-42.

Table 1: Baseline characteristics of the studied patients

	MACE group (n=7)	**No MACE group (n=53)**	**P value**
Age, years	70.3 ± 9.5	58.2 ± 7.9	< 0.001
Male gender	4 (57.14%)	48 (90.57%)	0.044
HTN	6 (85.7%)	41 (77.4%)	1.0
DM	3 (42.9%)	19 (35.8%)	0.699
Smoking	5 (71.4%)	13 (24.5%)	0.021
Dyslipidemia	6 (85.7%)	39 (73.6%)	0.411
Atrial fibrillation	3 (42.9%)	2 (3.8%)	0.009
Heart failure	5 (71.4%)	12 (22.6%)	0.016
MI	3 (42.9%)	28 (52.8%)	0.702
Prior PCI	4 (57.1%)	27 (50.9%)	1.0
Cerebrovascular disease	1 (14.3%)	5 (9.4%)	0.541
Chronic lung disease	3 (42.9%)	5 (9.4%)	0.021
SBP (mmHg)	163.5± 24.9	146.5 ± 20.7	0.050*
DBP (mmHg)	93 ± 9.2	87.5 ± 11.5	0.026*
Heart rate (bpm)	96.9 ± 18.7	86.5 ± 11.6	<0.001*
BMI (Kg/m^2)	30 ± 6.6	31.7 ± 7.2	0.554
LVEF (%)	52.4 ± 15.1	58.6 ± 15.2	0.318

SBP: systolic blood pressure, MI: myocardial infarction, BMI: body mass index, HTN: hypertension, MACE: major adverse cardiovascular events, DM: diabetes mellitus, DBP: diastolic blood pressure, LVEF: left ventricular ejection fraction, PCI: percutaneous coronary intervention.

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Table 2: Angiographic characteristics of the studied patients			
	MACE group (n=7)	**No MACE group (n=53)**	**P value**
CTO target vessel			
LAD	2 (28.6%)	17 (32.1%)	0.953
LCX	4 (57.1%)	27 (50.9%)	
RCA	1 (14.3%)	9 (17%)	
Moderate or severe calcification	6 (85.7%)	21 (39.6%)	0.039
Blunt stup	5 (71.4%)	14 (26.4%)	0.411
Successful crossing strategy			
AW	1 (14.3%)	35 (66%)	0.013
ADR	1 (14.3%)	6 (11.3%)	
Retrograde	4 (57.1%)	8 (15.1%)	
None	1 (14.3%)	4 (7.5%)	
Technical angiographic success	3 (42.9%)	43 (81.1%)	0.021
PROGRESS-CTO score, median (IQR)	5 (3.5 – 5)	1 (0 – 2)	< 0.001

MACE: major adverse cardiovascular events; AW: antegrade wiring; CTO: chronic total occlusion; ADR: antegrade dissection and re-entry; LCX: left circumflex artery; RCA: right coronary artery; LAD: left anterior descending artery, PROGRESS-CTO: Prospective Global Registry for the Study of Chronic Total Occlusion Intervention.

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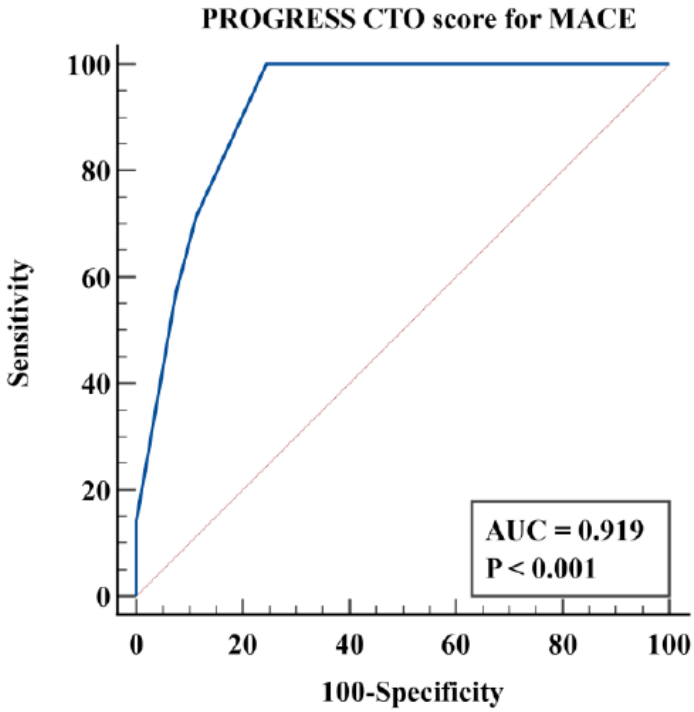

Figure 1: ROC curve analysis of the new PROGRESS-CTO score for MACE for the prediction of MACE in CTO patients undergoing PCI.