## CLINICAL RESEARCH

### CORONARY

# A Clinical and Angiographic Scoring System to Predict the Probability of Successful First-Attempt Percutaneous Coronary Intervention in Patients With Total Chronic Coronary Occlusion

Giuseppe Alessandrino, MD, Bernard Chevalier, MD, Thierry Lefèvre, MD, Francesca Sanguineti, MD, Philippe Garot, MD, Thierry Unterseeh, MD, Thomas Hovasse, MD, Marie-Claude Morice, MD, Yves Louvard, MD

### ABSTRACT

**OBJECTIVES** This study sought to develop a scoring model predicting percutaneous coronary intervention (PCI) success in chronic total occlusions.

**BACKGROUND** Coronary chronic total occlusion is the lesion subtype in which angioplasty is most likely to fail. Chronic total occlusion for PCI (CTO-PCI) failure is associated with higher 1-year mortality and major adverse cardiac events compared with successful CTO-PCI. Although several independent predictors of final procedural success have been identified, no study has yet produced a model predicting final procedural outcome.

**METHODS** Data from 1,657 consecutive patients who underwent a first-attempt CTO-PCI were prospectively collected. The scoring model was developed in a derivation cohort of 1,143 patients (70%) using a multivariable stepwise analysis to identify independent predictors of CTO-PCI failure. The model was then validated in the remaining 514 (30%).

**RESULTS** The overall procedural success rate was 72.5%. Independent predictors of CTO-PCI failure were identified and included in the clinical and lesion-related score (CL-score) as follows: previous coronary artery bypass graft surgery +1.5 (odds ratio [OR]: 2.49, 95% confidence interval [CI]: 1.56 to 3.96), previous myocardial infarction +1 (OR: 1.6, 95% CI: 1.17 to 2.2), severe lesion calcification +2 (OR: 2.72, 95% CI :1.78 to 4.16), longer CTOs +1.5 (≥20 mm OR: 2.04, 95% CI: 1.54 to 2.7), non–left anterior descending coronary artery location +1 (OR: 1.56, 95% CI: 1.14 to 2.15), and blunt stump morphology +1 (OR: 1.39, 95% CI: 1.05 to 1.81). Score values of 0 to 1, >1 and <3, ≥3 and <5, and ≥5 identified subgroups at high, intermediate, low, and very low probability, respectively, of CTO-PCI success (derivation cohort: 84.9%, 74.9%, 58%, and 31.9%; p < 0,0001; validation cohort: 88.3%, 73.1%, 59.4%, and 46.2%; p < 0.0001).

**CONCLUSIONS** This clinical and angiographic score predicted the final CTO-PCI procedural outcome of our study population. (J Am Coll Cardiol Intv 2015;8:1540–8) © 2015 by the American College of Cardiology Foundation.

Several studies have shown that successful percutaneous coronary intervention (PCI) for coronary chronic total occlusion (CTO) is associated with a better outcome in terms of reduced mortality and 1-year major adverse cardiac events compared with CTO-PCI failure (1-5).

Although new dedicated devices and guidewires have had a favorable impact on procedural success (6,7), CTO remains the type of lesion in which angioplasty is most likely to fail. In a multicenter study, Morino et al. (8), developed an angiographic scoring system to stratify CTO-PCI complexity. Recently, Nombela-Franco et al. (9) confirmed that the Japanese chronic total occlusion (J-CTO) score is a useful tool for predicting successful guidewire crossing of the CTO within 30 min, but they failed to demonstrate the value of such a model in predicting final procedural success. Although the predictive value of angiographic parameters has been thoroughly investigated, it has been recently reported that even clinical characteristics may have a predictive role (10,11).

To obtain a scoring model able to predict final CTO-PCI success, we prospectively analyzed a cohort of patients who underwent CTO-PCI, taking into account both clinical and angiographic parameters.

## METHODS

We analyzed 1,671 consecutive patients with CTO treated by PCI from January 2004 to December 2013. All patients provided written informed consent. The study protocol was approved by the local ethics committee, and all procedures were performed according to current international guidelines (12,13).

We reviewed the database of the 1,671 patients who underwent CTO-PCI procedures at ICPS (Massy and Quincy hospitals, France).

**DEFINITIONS AND PATIENT SELECTION.** A CTO was defined by angiography as a coronary occlusion without antegrade filling of the distal vessel other than via collaterals. The duration of the occlusion had to be more than 3 months, as estimated from the onset of clinical events including myocardial infarction (MI), sudden onset or worsening of chest symptoms, or evidenced by angiography. When the duration of the occlusion was uncertain, and the investigators had no clear evidence that it was <3 months, the patient was included in the analysis.

Quantitative assessment was performed using the Quant-Cor QCA software package (CAAS II, V.5.0, Pie Medical Imaging, Maastricht, the Netherlands).

Previous MI was defined as an MI (non–ST-segment elevation MI or ST-segment elevation myocardial infarction) with a culprit lesion other than the CTO or an MI that had occurred at least 3 months before the CTO-PCI.

Previous coronary artery bypass surgery (CABG) was defined as a previous CABG of the CTO vessel carried out at least 3 months before the CTO-PCI procedure.

Blunt morphology of the lesion: the lesion was classified as a blunt morphology type if the occluded segment did not end in the shape of a funnel.

Calcified lesions: presence of calcification was classified according to 3 categories—mild, moderate, and severe.

The measurement of the degree of retrograde collateral supply was performed using a collateral grading system, according to the Rentrop classification (14).

Bending lesion: this was defined as any lesion with at least 1 bend of >45° assessed by angiography along the whole length of the occluded segment.

Length of occlusion: occlusion length was categorized as either <20 or ≥20 mm according to the EuroCTO Club consensus (15).

Successful procedure was defined as the achievement of <30% residual diameter stenosis as assessed by quantitative coronary angiography and associated with Thrombolysis In Myocardial Infarction flow grade 3.

To improve the accuracy of lesion analysis, all cases were reviewed by our core laboratory before and after the procedure.

**PATIENT SELECTION.** Patients in whom CTO-PCI was attempted in the setting of acute cardiogenic shock were excluded. In addition, to minimize confounders, only the first CTO-PCI attempts performed during the enrolling period were included in the analysis. If 2 or more CTO PCIs were attempted during the same procedure, the patient was excluded. If a single CTO lesion or 2 different CTO lesions were attempted in 2 or more separate procedures during the enrolling period, only the first procedure was considered as a first attempt and subsequently included in the analysis.

**DEFINITION OF COMPLICATIONS.** MI was defined as >3 times the upper limit of normal creatine phosphokinase release, in the absence of escalating creatine phosphokinase before PCI.

Ostial dissection and major pericardial effusion were defined, respectively, as angiographic evidence