Utility of CT Angiography to Guide Coronary Intervention of CTO*

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The procedural success rates of percutaneous intervention for chronic total coronary occlusions (CTOs) over the past decade have been increasing, driven by the development of specialized guidewires and microcatheters and the introduction of new technical strategies, including antegrade subintimal re-entry and the retrograde transcollateral approach. An ongoing challenge is to select the most promising strategy early to reduce total procedure time, to reduce radiation and contrast exposure, and to further improve complication-free procedural success rates. In this regard, procedural planning is typically based on the angiographic assessment of the occluded lesion, including features of the proximal cap, the extent of calcification, and the apparent length of the lesion (1). Pre-procedural coronary computed tomographic angiography (CTA) with modern high-resolution scanners may provide incremental information about the features of the coronary occlusion, which might enhance procedural planning and outcomes.

In early studies in which coronary CTA was used to visualize CTOs, the prominent features observed were the extent of calcification, occlusion length, and identification of the vessel course within a long occluded segment (2,3). In more recent studies with improved resolution computed tomography (CT) scanners, the degree and distribution of calcification has remained the most relevant predictor of CTO procedural success (4-6). However, it is well known that the success rate of percutaneous coronary intervention (PCI) is highly operator-dependent (7). Comparing features of successful versus failed cases is confounded by the capability of the expert operator to overcome the most hostile coronary anatomies. For complex CTO anatomies, advanced techniques, such as antegrade dissection and re-entry (with or without ultrasound guidance) and the retrograde transcollateral approach, are available, which allow ≥90% primary success rates. Nonetheless, selecting the optimal approach on the basis of angiographic characteristics is often more art than science, and high success rates are only achieved by readily switching when necessary (e.g., from a failed antegrade to a retrograde approach). Selecting the procedural strategy on the basis of coronary CTA-derived imaging might streamline the approach to CTOs, reduce contrast use and radiation exposure, and enhance procedural success.

The report by Luo et al. (8) in this issue of iJACC addresses the extent to which contemporary 256-slice high-resolution coronary CTA can provide incremental information to angiography in identifying baseline predictors of CTO procedural success versus failure with an initial antegrade approach (8). The new aspect of this study was to identify factors, derived both from coronary CTA and from diagnostic angiography, that would predict a successful antegrade procedure and, thus, to categorize cases beforehand that might alternatively benefit from an initial retrograde procedural approach. The size of the study is limited, but it is comparable to the numbers analyzed in previous reports. The major difference in this study compared with others is the relationship of outcomes to the procedural approach. An important finding was that pre-procedural coronary CTA contributed prognostic information beyond angiography alone. The independent coronary CTA features determining procedural failure of the antegrade approach were negative remodeling and lesion length.

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Although the present study suggested a slightly overall higher success rate in the group undergoing CT scanning as compared with those without pre-procedural coronary CTA, we cannot know with certainty that the lesions were of equal complexity. Moreover, in the “real world,” more complex CTOs might benefit from coronary CTA, but in the present study, we cannot be sure that the most complex lesions were not excluded (or otherwise not referred for CTO intervention). In addition, the information afforded by coronary CTA may be even more valuable when coregistered with angiography in the catheterization laboratory during the procedure, as was done in the study by Luo et al. (8). Similarly, Rolf et al. (10) used printouts from coronary CTA adapted to various angiographic gantry positions to help illustrate the vessel course within the CT body. Using this approach, the success rate was significantly higher than in a matched control group. Several companies are working on online coregistration systems that allow the actual simultaneous presentation of a volume-rendered coronary CTA image of the course of the occluded artery next to, or overlaid with, the angiographic image, thus providing a roadmap of the presumed wire course through the occlusion. The limitation of this approach will remain the synchronization with both the heart beat and respiration.

Which, if any, patients should currently undergo pre-procedural coronary CTA? In countries like Japan, the rate of patients undergoing such diagnostic imaging is extremely high, in some centers approaching 100%, despite a lack of objective evidence for benefit. In other countries like the United States and much of Europe, the number of these procedures is much lower due to a lack of reimbursement in the face of clinical equipoise. Is such an approach needed at all? In expert hands, the procedural success of PCI in CTOs with angiographic guidance alone has surpassed 90%, but it still involves considerable procedural investment in terms of time and equipment (and cost). The risk of procedural complications should also not be dismissed, and may be affected by strategic approach. It thus may be worthwhile to identify the features discriminating a CTO that might be treated with less complex approaches from those that might require more complex procedures or that should be referred to specialized centers to avoid unnecessary failed procedures with potential clinical hazards to the patient. The angiographically-based J-CTO score, which is a simple 5 point score based on the stump morphology, lesion length, calcification, lesion tortuosity and history of a previous attempt, may be used for this purpose (1), and the list of risk factors identified by Luo et al. (8) adds coronary CTA variables to further consider (although the lesion length cutoff of 32 mm requires prospective validation). A study of angiographic and coronary CTA features in a broader patient population (and at additional centers) is warranted to establish an improved discriminatory scoring system. In addition, the incremental cost, radiation, and contrast use of coronary CTA must be taken into consideration.
With early-generation multislice CT equipment the additional radiation exposure was considerable (11), but contemporary scanners and imaging protocols have markedly reduced the radiation dose (although no information in this regard is provided by the present study). Given the additional cost of pre-procedural coronary CTA, a selective strategy may be warranted. For example, patients with a J-CTO score $>1$ might be selected to undergo pre-procedural coronary CTA. Randomization is necessary to address the risk-benefit profile of pre-procedural coronary CTA for CTO interventional planning, and building on the present study by Luo et al. (8), we now have the essential information required to plan such a trial.

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