

EDITORIAL COMMENT

Percutaneous Treatment of Chronic Total Coronary Occlusions

The Light That Came From Japan*

Javier Escaned, MD, PhD



Around 25% of patients with coronary artery disease undergoing angiography have a chronic total occlusion (CTO) in an epicardial vessel, yet only 8% of all CTOs undergo percutaneous coronary intervention (PCI) (1). Why are so few CTOs treated in clinical practice? There is not a single answer to this obvious question, but beyond considerations related to procedural costs and prognostic benefit of revascularization, I suspect that important reasons are technical challenge, low procedural success rates, and the resulting operator's dismay. Let us remember that the procedural success rate in CTOs in the high-volume PCI centers participating in the SYNTAX (Synergy Between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery) trial was lower than 50% (2).

As a matter of fact, the low success rate in CTOs is as long as the history of PCI, and has inflicted a narcissistic wound to generations of interventional cardiologists. Over the years, there were brave attempts of individual operators to address CTO lesions, but it was in Japan where a collective and comprehensive effort facing the challenges of CTO revascularization emerged in the late 90s and, ultimately, made a dramatic breakthrough in improving procedural success. Japanese interventionalists pioneered a systematic approach to CTO PCI, with the development of specific skills and tools required to successfully tackle CTOs. The latter included microcatheters, over-the-wire balloons, dedicated

CTO guidewires, and channel dilators that were frequently designed in partnership with Japanese biomedical industries, sensitive to the unmet needs of local CTO operators (3,4).

After working regularly with Japanese colleagues for over a decade, I became convinced that these achievements were facilitated by their cultural background. The ethical code that permeates the Japanese society gives harmonious teamwork and uncomplaining perseverance a central role in active life. As a Westerner educated in methodological skepticism— which, to a degree, dismisses the value of individual experience in favor of consolidated evidence—I was impressed on many occasions by the speed of adoption by the Japanese interventional community of a new skill or technique proposed by a peer colleague, based on a pragmatic “try and see” attitude. This collegial spirit was key in their accomplishment of consolidating interventional treatment for patients with CTOs. The development of the retrograde CTO PCI approach through collateral channels constitutes the perfect example of their success in integrating procedural systematization, hardware development, and operator skills (5).

SEE PAGE 2144

In this issue of *JACC: Cardiovascular Interventions*, Suzuki et al. (6) report the procedural outcomes of CTO PCI procedures performed over 2 years (2014 to 2015) by 41 highly experienced operators, all accredited by the Japanese Board of CTO Interventional Specialists. The interventions were performed within the framework of a prospective registry, providing a realistic view of the state-of-the art PCI in CTO lesions in Japan. The overall technical success rate of CTO PCI procedures was very high: virtually 90%, a figure moderately better than recent European series (7). This figure

*Editorials published in *JACC: Cardiovascular Interventions* reflect the views of the authors and do not necessarily represent the views of *JACC: Cardiovascular Interventions* or the American College of Cardiology.

From the Hospital Clinico San Carlos IDISSC and Complutense University of Madrid, Madrid, Spain. Dr. Escaned has reported that he has no relationships relevant to the contents of this paper to disclose.

supports the concept that CTOs can be treated successfully if adequate training is obtained and a systematic approach is followed. The report provides valuable information on this and other relevant topics such as choosing which is the best primary approach, procedural strategies used during rescue procedures, and determinants of procedural failure.

Contemporary CTO PCI is usually performed with bilateral guiding catheters to facilitate switching between the antegrade and retrograde approach during the same procedure. However, this does not reduce the need to carefully select the primary approach: a failed initial strategy may modify the anatomy with dissections and subintimal hematoma; decrease distal vessel opacification; increase procedural time, radiation dose, and contrast administration; and cause operator fatigue. All this contributes to a lower success rate of bailout strategies (6-8). The current report shows that Japanese operators more frequently use an initial retrograde approach (27%) than their Western counterparts (around 18%) (7,8). Some of the factors favoring their choice were the existence of better collateral support, a previous failed PCI attempt, long and tortuous occluded segments, and absence of a proximal stump. As a result, primary retrograde interventions addressed technically more challenging CTOs (J-CTO score 2.4) than primary antegrade procedures (J-CTO score 1.9), and therefore, the success rate of the former was slightly lower (87% vs. 91% in the primary retrograde and antegrade strategies, respectively) (6).

They also had a lower threshold to opt for the retrograde approach than Western CTO operators, who reserve a primary retrograde approach for more complex lesions (J-CTO score ≥ 3.0) (7,8). Either due to higher proficiency in the retrograde approach or to better patient selection, the procedural success of the primary retrograde approach by our Japanese colleagues was markedly higher (87%) than in recent Western series (ranging from 50% to 70%) although the aforementioned differences in complexity have to be taken into account (7,8). It has to be kept in mind that the retrograde approach was associated with more periprocedural myocardial infarction, cardiac tamponade, and contrast-induced nephropathy than the primary antegrade strategy; however, the figures were relatively low (2%, 0.9%, and 3.1%, respectively) and are commensurate with differences in procedural risk profile. As expected, the success rate of retrograde procedures was lower when used as a secondary approach (68%).

The report also highlights the excellent success rate of primary antegrade approach (91%). Again, this is partly a result of adequate patient selection.

Understandably, the procedural success rate was markedly lower (78%) when the antegrade approach was used as a rescue strategy. The higher procedural complexity of the rescue antegrade approach gets reflected in a more frequent use of parallel wire technique and intravascular ultrasound guidance, used in many cases to guide wire re-entry into the vessel lumen from a subintimal location. Overall, the availability of the antegrade and retrograde approaches increases the ability to circumvent specific anatomic challenges. Yet, as shown in the multivariate analysis, tortuosity and calcification of the CTO lesion remain major challenges in CTO revascularization.

In translating the Japanese experience to other regions of the world, several differences should be taken into account. In terms of patient profile, higher rates of post-coronary artery bypass graft surgery patients in Western countries may increase the difficulty, risks, and failure rate of PCI in CTOs (8). Obesity and high body mass index, more frequent in Western patients, increase patient radiation dose and limit procedural duration. From a technical standpoint, Japanese operators favor the use of large bore (7- to 8-F) catheters and the femoral route, are more proficient in procedural intravascular ultrasound guidance, and prefer contrast tip injections for collateral navigation. They invest more time in CTO procedures (mean 160 min) but use less contrast medium (mean 230 ml) than in the West (median 90 min and 250 ml, respectively) (6,7). On the other hand, Western operators use more frequently dedicated antegrade dissection and re-entry devices as part of the hybrid algorithm for CTO revascularization (7).

A major accomplishment of the Japanese school is that they managed to successfully spread their knowledge all over the world by active publishing, lecturing, and proctoring on how to treat CTOs. Western operators followed their successful cooperative model and organized themselves into expert CTO groups and associations. New devices to facilitate antegrade dissection and re-entry were designed in the West and merged with the Japanese wire-based antegrade and retrograde strategies, yielding quite competitive procedural outcomes to those reported in this article (7). Like this article by Suzuki et al. (6), every new report on CTO revascularization from Japan has nowadays the 2-fold interest of tracking the evolution of the pioneers in this complex PCI field and benchmarking the more recent Western initiatives.

ADDRESS FOR CORRESPONDENCE: Prof. Javier Escaned, Interventional Cardiology Unit, Hospital Clinico San Carlos, Prof Martin Lagos s/n, 28040 Madrid, Spain. E-mail: escaned@secardiologia.es.

REFERENCES

1. Tsai TT, Stanislawski MA, Shunk KA, et al. Contemporary incidence, management, and long-term outcomes of percutaneous coronary interventions for chronic coronary artery total occlusions: insights from the VA CART program. *J Am Coll Cardiol Intv* 2017;10:866–75.
2. Farooq V, Serruys PW, Garcia-Garcia HM, et al. The negative impact of incomplete angiographic revascularization on clinical outcomes and its association with total occlusions: the SYNTAX (Synergy Between Percutaneous Coronary Intervention with Taxus and Cardiac Surgery) trial. *J Am Coll Cardiol* 2013;61:282–94.
3. Saito S, Tanaka S, Hiroe Y, et al. Angioplasty for chronic total occlusion by using tapered-tip guide-wires. *Catheter Cardiovasc Interv* 2003;59:305–11.
4. Tsuchikane E, Katoh O, Kimura M, et al. The first clinical experience with a novel catheter for collateral channel tracking in retrograde approach for chronic coronary total occlusions. *J Am Coll Cardiol Intv* 2010;3:165–71.
5. Surmely JF, Katoh O, Tsuchikane E, et al. Coronary septal collaterals as an access for the retrograde approach in the percutaneous treatment of coronary chronic total occlusions. *Catheter Cardiovasc Interv* 2007;69:826–32.
6. Suzuki Y, Tsuchikane E, Katoh O, et al. Outcomes of percutaneous coronary interventions for chronic total occlusion performed by highly experienced Japanese specialists: the first report from the Japanese CTO-PCI Expert registry. *J Am Coll Cardiol Intv* 2017;10:2144–54.
7. Maeremans J, Dens J, Spratt JC, et al. Antegrade dissection and reentry as part of the hybrid chronic total occlusion revascularization strategy: a subanalysis of the RECHARGE Registry (Registry of CrossBoss and Hybrid Procedures in France, the Netherlands, Belgium and United Kingdom). *Circ Cardiovasc Interv* 2017;10:e004791.
8. Karpaliotis D, Karatasakis A, Alaswad K, et al. Occlusion interventions in a contemporary multi-center US registry. *Circ Cardiovasc Interv* 2016;9:e003434.

KEY WORDS chronic total occlusions, coronary angioplasty, stable coronary artery disease