Coronary CTO Intervention

Practice development and economic effects.

BY WILLIAM L. LOMBARDI, MD, FACC, FSCAI, AND NOAH J. JONES, MD

Chronic total coronary occlusions (CTOs) remain one of the most challenging lesion subsets for the interventional cardiologist. Successful CTO revascularization can have a beneficial effect on long-term survival and relief of angina, and use of drug-eluting stents has significantly reduced target lesion revascularization.[1-5] However, procedural and nonprocedural factors often dissuade interventionists from fully adopting CTO cases into their practice. These factors include high reocclusion rates, high complication rates, low procedural success, suboptimal reimbursement, and prolonged procedure times.

To our knowledge, there has been no published economic analysis of CTO interventions. The goal of this article is to provide a framework that will help the interested interventionist develop a successful CTO program. Considerations will be given to the economic impact that a dedicated CTO program may have on the hospital and individual practice.

BACKGROUND

The authors are part of a 13-member private practice group working at a high-volume institution (North Cascade Cardiology, Saint Josephs Hospital, Bellingham, WA). The structure of the group is much like that of most university-based or large private practices, with dedicated subspecialists performing high-volume coronary, endovascular, structural, electrophysiologic, and noninvasive imaging procedures. In 2005, our group encouraged the author (W. L. L.) to train as a CTO interventionist, which prompted a trip to Japan for education and training. Taking into consideration the financial constraints of our institution, it was decided to adopt a low overhead approach to CTO interventions using a range of coronary wires and relying on evolving techniques rather than new expensive technologies. Since January 2005, the author (W. L. L.) has performed 230 CTO coronary interventions, including 17 retrograde procedures. The current procedural success rate for 2007 has been 80%, with an average occlusion length of 27.8 mm. The techniques used in our practice include

TABLE 1. CLASSIFICATION OF CTOs

Level 1	• Well-defined entry point • Nontortuous left anterior descending or right coronary artery • Short (<10 mm) zone of occlusion • Absence of diffuse disease • Distal vessel diameter visualized • No major bridging collaterals
Level 2	• Left circumflex occlusion • Moderate tortuosity • Moderate (10 mm to 20 mm) zone of occlusion • Moderate calcification • Bridging collaterals • Intracoronary collaterals (neovascular channels) • In-stent CTO >20 mm
Level 3	• Ostial occlusions • Entry point not visualized • Occlusion at takeoff of side branch • Long (>20 mm) zone of occlusion • Occlusion in bend >60% or two bends of >45% • Severe calcification • Distal vessel course barely visible • Tandem occlusions • Previous failed attempt

TABLE 2. CTO LESION CLASSIFICATION AND PROCEDURE TIME		
CTO Classification	**Procedure Time (min) 2005 to 2006**	**Procedure Time (min) 2007 to Present**
Level 1	76.3	66.4
Level 2	95.2	82.5
Level 3	98.2	118.8

TABLE 3. COMPARISON OF INTRAPROCEDURAL VARIABLES FOR CTO AND NON-CTO CORONARY INTERVENTIONS			
	CTO (N=132)	**Non-CTO (N=439)**	***P* Value**
Mean procedure time (mins)	93.6	47.6	<.005
Mean fluoroscopic time (mins)	38.3	14.9	<.005
Mean contrast dose (mL)	341	185	<.005

employing dual catheters (left main trunk and right coronary artery intubation) for visualization of the collateral circulation, stiff steerable guidewires, parallel-wire technique, IVUS-guided wiring, retrograde technique (including controlled antegrade and retrograde subintimal tracking [CART]), and a modification of the subintimal tracking and re-entry technique (STAR).[6-11]

DISCUSSION

Procedural duration is one of the difficult challenges encountered with CTO intervention and is often cited as having a negative impact on physician reimbursement and productivity. We currently use a CTO classification system that is based on levels of CTO lesion complexity (Table 1). The classification system can be used to identify patients who may have shorter procedural times and higher success rates and has allowed for better scheduling and more efficient case preparation. For example, we generally schedule two less-complex cases and two level-3 cases in a single day. We have found it beneficial to use the same approach with CTO interventions as we do with our endovascular caseload. Dedicated catheterization laboratory days are given for both endovascular and CTOs, which has improved the educational experience and knowledge base of the catheterization laboratory staff.

When developing a CTO program, it must be realized that most CTO interventions are level 3, resulting in longer procedure times and equipment usage. Among the CTO interventions at our institution, 16.7% are level 1, 32.6% are level 2, and 50.7% are level 3. The average procedural time from vascular access to case completion has been approximately 94.9 minutes. Table 2 demonstrates the correlation between procedural time and lesion classification and suggests that there exists a learning curve with procedural duration. We have observed that retrograde procedures, in particular, have the longest procedure times at 145.1 minutes per case (17 cases, 13 successfully revascularized). The last five retrograde procedures at our institution were performed at an average of 118.6 minutes. As experience continues to improve with the retrograde approach, procedure times should decrease accordingly. Furthermore, as the operator's wire and catheter skills become more adept with CTO intervention, these skills will carry over and improve the efficiency in non-CTO cases.

Regardless of a particular lesion's degree of difficulty, fluoroscopic time and contrast load will usually limit procedural times (Table 3). We try to limit cases to less than 60 minutes of fluoroscopy, and we calculate the maximum radiographic contrast dose (MRCD) for each patient as MRCD = 5 mL X body weight (kg)/serum creatinine (mg/dL), to minimize the risk of radiation skin burns and contrast-induced nephropathy. Employing these limits still allows us to perform four CTO cases in a single day.

Unfortunately, there is a lack of published data on the economic impact of CTO interventions. An analysis of

TABLE 4. COST AND REIMBURSEMENT COMPARISONS OF CTO VERSUS NON-CTO INTERVENTIONS FOR A SINGLE OPERATOR		
	CTO (N=149)	**Non-CTO (N=468)**
Direct costs	$9,191	$10,513
Indirect costs	$3,808	$4,215
Reimbursement	$14,448	$17,055
Profit per case	$1,447	$2,326

CTO reimbursement patterns at our institution was performed. Direct costs, including equipment such as catheters, wires, and stents, and indirect costs, including operational overhead, ancillary staff, and administrative cost to the institution, were also compared. Table 4 shows the economic impact of CTO versus non-CTO interventions. CTO interventions were not as profitable as non-CTO interventions but still maintained favorable reimbursement. Although CTO procedures are approximately 37% less profitable within our institution, in our experience, the addition of a CTO program will ultimately add 10% to 15% more cases to the overall coronary interventional volume. The additional volume will ultimately lead to an increase in physician and institution reimbursement.

To build a CTO practice, it is important to educate colleagues and referring physicians, often with the use of case reviews and didactic sessions. In so doing, lesions once considered not amenable for intervention will be considered within the realm of the CTO interventionist, and referral patterns and case volumes will improve. To perform CTO coronary interventions at a high level requires volume. It takes approximately 300 career CTO interventions to become a true expert (Osamu Katoh, personal communication, July 2005). With that in mind, it is a serious commitment of both time and personal education to achieve a high-level CTO program.

CONCLUSION

Benefits of a successful CTO revascularization include improved long-term survival and relief of angina. Lack of skill or reduced profit should not be a reason to exclude a therapy that could be beneficial to patients. A motivated operator can become a highly successful CTO interventionist. In our experience, adding a CTO program to a practice with a dedicated staff and institutional support can have a beneficial economic impact for both the individual practice and institution. The technical challenges of learning CTO intervention, or a perceived negative impact on physician finances, should not dissuade the interventionist from adopting CTO intervention. ■

William L. Lombardi, MD, FACC, FSCAI, is from North Cascade Cardiology, Bellingham, Washington. He has disclosed that he is a paid consultant to Boston Scientific and Bridge Point Medical, is on the speakers' bureau for Medtronic, and is on the advisory board to Abbott Vascular. Dr. Lombardi may be reached at (360) 734-2700; wllombardi@hinet.org.

Noah J. Jones, MD, is from North Cascade Cardiology, Bellingham, Washington. He has disclosed that he holds no financial interest in any product or manufacturer mentioned herein. Dr. Jones may be reached at (360) 734-2700; njjones@hinet.org.

1. Suero JA, Marso SP, Jones PG, et al. Procedural outcomes and long-term survival among patients undergoing percutaneous coronary intervention of a chronic total occlusion in native coronary arteries: a 20-year experience. J Am Coll Cardiol. 2001;38:409-414.
2. Aziz S, Stables RH, Grayson AD, et al. Percutaneous coronary intervention for chronic total occlusions: improved survival for patients with successful revascularization compared to a failed procedure. Cathet Cardiovasc Interv. 2007;70:15-20.
3. Ramanathan K, Gao M, Nogareda GJ, et al. Successful percutaneous recanalization of a non-acute occluded coronary artery predicts clinical outcomes and survival [abstract]. Circulation. 2001;104:II-415.
4. Nakamura S, Muthusamy TS, Bae JH, et al. Impact of sirolimus-eluting stents on the outcome of patients with chronic total occlusions: multicenter registry in Asia [abstract]. J Am Coll Cardiol. 2004;43:35A.
5. Hoye A, Tanabe K, Lemos PA, et al. Significant reduction in restenosis after the use of sirolimus-eluting stents in the treatment of chronic total occlusions. J Am Coll Cardiol. 2004;43:1954-1958.
6. Colombo A, Mikhail GW, Michev I, et al. Treating chronic total occlusions using subintimal tracking and reentry: the STAR technique. Catheter Cardiovasc Interv. 2005;64:407-411.
7. Ito S, Suzuki T, Ito T, et al. Novel technique using intravascular ultrasound-guided guidewire cross in coronary intervention for uncrossable chronic total occlusions. Circ J. 2004;68:1088-1092.
8. Kimura BJ, Tsmikas S, Bhargava V, et al. Subintimal wire position during angioplasty of a chronic total coronary occlusion: detection and subsequent procedural guidance by intravascular ultrasound. Cathet Cardiovasc Diagn. 1995;35:262-265.
9. Matsubara T, Murata A, Kanyama H, et al. IVUS-guided wiring technique: promising approach for the chronic total occlusion. Cathet Cardiovasc Interv. 2004;61:381-386.
10. 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. Cathet Cardiovasc Interv. 2007;69:826-832.
11. Surmely JF, Tsuchikane E, Katoh O, et al. New concept for CTO recanalization using the controlled antegrade and retrograde subintimal tracking: the CART technique. J Invas Cardiol. 2006;18:334-338.