



THE COMPARISON OF HYBRID APPROACH VERSUS SINGLE CROSSING STRATEGIES TO CORONARY CTO-PCI

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ABSTRACT

BACKGROUND: Most attempts to intervene on coronary chronic total occlusions fail because the wire cannot cross the occlusion. Three main strategies can be used to cross a CTO: antegrade wire escalation, antegrade dissection/re-entry and retrograde. The basic underlying principle of the hybrid approach (HA) is that no single procedural crossing strategy should be pursued to exhaustion, but an alternative strategy should be attempted if a given crossing strategy does not progress.

METHODS: The success rates, complication rates, procedural characteristics and clinical outcomes of 72 consecutive CTO-PCIs with single crossing strategy (control group) were compared to 34 cases of hybrid approach to CTO-PCI (study group). In the study group, successful crossing strategy was assessed. The SYNTAX and J-CTO scores were assessed to evaluate the potential severity of the procedure. The complications included MACCE and the procedural complications. At 6-month follow-up, clinical outcomes including target vessel revascularization (TVR), target lesions revascularization (TLR) and major adverse cardiac events (MACE) were evaluated.

RESULTS: Procedural success was achieved in 91.2% cases in HA group and was significantly higher than cases in control group (86.1% respectively). The final successful CTO crossing strategy in HA group was antegrade in 48.4%, retrograde in 29%, and antegrade dissection/reentry in 22.6%. The retrograde approach in control group was used in 45.8% cases with 87.9% procedural success. Major procedural complications occurred 2.9% and 2.8% respectively, with no statistically significant difference.

CONCLUSION: Use of the hybrid approach to CTO-PCI is associated with higher success and similar complication rates compared to other CTOs crossing strategies. High success rates for CTO interventions can be achieved without incurring more complications.

Keywords: CTO-PCI, hybrid approach

INTRODUCTION

Coronary chronic total occlusions (CTO) are identified in 20-30% patients undergoing diagnostic coronary angiography [1], with the incidence increasing with age. [2] Successful recanalization of a CTO is associated with a reduction of need for coronary artery bypass graft surgery [3], improvement in angina symptoms [4] and left ventricular function and segment wall thickening [5], as well as long-term survival. [6, 7]. Moreover, success rates for treating CTOs with conventional techniques have remained unchanged over time [6-10] averaging 65-70%. Selecting the optimal technique for each CTO lesion can be challenging, but this process has recently been changed by the introduction of a hybrid CTO crossing algorithm. [11] The term hybrid refers to (1) sequential use of CTO crossing techniques if the initially attempted technique fails and (2) unification of all 3 currently available CTO crossing techniques (antegrade wire escalation, antegrade dissection/re-entry and retrograde) during same procedure. [11-18] The aim of this study was to examine the difference in success and complication rates, procedural characteristics and clinical outcomes of single CTO crossing strategies versus hybrid approach to coronary CTO-PCI.

METHODS

We collected the clinical and angiographic characteristics and procedural outcomes of 34 patients undergoing hybrid CTO PCI (study group) and compared with data from 72 consecutive CTO with single crossing strategy procedures (control group). The success and complication rates, procedural characteristics and clinical outcomes were compared. In the study group, successful crossing strategy was assessed. Procedural characteristics were evaluated by numbers of stents, wires, micro catheters, amount of dye used, total fluoroscopy time, air kerma radiation dose and total procedural time. Complications included: 1) Major adverse cardiac and cerebrovascular events (MACCE) - death, myocardial infarction, emergent coronary bypass surgery, repeat PCI, stroke; and 2) Procedural complications: acute or sub-acute occlusion, distal embolization, coronary dissection, coronary perforation. At 6-month follow-up, clinical outcomes were evaluated: target vessel revascularization (TVR), target lesions revascularization (TLR), major adverse cardiac events (MACE). All procedures were performed by operators with mid-expertise in CTO PCI using the "hybrid" approach. CTOs were defined as coronary obstructions with TIMI flow grade 0 of at least 3 months' duration, which was based on first onset of angina symptoms, prior history of myocardial infarction in the target vessel, or comparison with a prior angiogram views. Technical success was defined as angiographic evidence of <30% residual stenosis with restoration of TIMI 3 antegrade flow in the CTO target vessel. [19] Procedural success was defined as technical success with no procedural MACE.

STATISTICAL ANALYSIS

Continuous data were summarized as mean \pm standard deviation (normally distributed data) or median and interquartile range (non-normally distributed data) and compared using t-test or Wilcoxon rank-sum test, as appropriate. Categorical data were presented as frequencies or percentages and compared using chi square or Fisher's exact test, as appropriate. A two-sided p value of <0.05 was considered statistically significant.

RESULTS

Clinical and angiographic characteristics

Mean age in study and control groups were 67.8 ± 8.2 and 69.2 ± 7.6 years, respectively, and most (82% and 78%) of patients were men with high frequency of diabetes mellitus (35% and 31%), prior myocardial infarction (28% and 24%) and prior CABG (26% and 22%). All CTO target vessels were in a native coronary vessel. A prior CTO PCI attempt was performed in 15% of cases in hybrid approach group to compare with 10% cases of control group. The target CTO vessel was the right coronary artery in 63% of patients in study group to compare of 61% in control group, followed by the left descending (22% and 24%) and left circumflex artery (11% and 14%). The median visually estimated CTO occlusion length in study group was 30 (interquartile range 22 to 55) mm and CTO reference vessel diameter was 2.8 ± 0.5 mm, to compare with control group occlusion length 27 (interquartile range 19 to 47) mm and diameter 3.0 ± 0.5 mm. There were no statistically significant differences in all the characteristics to compare in control group with hybrid approach group.

Procedural techniques and outcomes

Technical success and procedural success were achieved 90.5% and 91.2%, respectively in study group, to compare with 87.5% and 86.1%, respectively in control group, with statistically significant difference. The final successful CTO crossing strategy in study group was antegrade in 48.4%, retrograde in 29% and antegrade dissection/re-

entry in 22.6%. The retrograde approach in control group was used in 44% of cases with 86% technical and 85% procedural success and 3.2% incidence of MACE. Median contrast volume and fluoroscopy time in study group were 260 (195-377) ml and 41 (26-67) min, respectively with a statistically significant difference to compare with control group (see Table 1). Only acute myocardial infarction as MACCE in study group occurred in 2 patients to compare with 1 patient in control group. No patient experienced a stroke or death, urgent target vessel revascularization with PCI, and no patient required emergency CABG. Perforation was the most common procedural adverse effect (3.2% in study group, and 2.9% in control group, $p>0.05$), dissection (2.4% and 2.1% respectively, $p>0.05$) and vascular access complications (1.6% and 1.2%, $p>0.05$). There were no statistically significant differences in target vessel revascularization, target lesion revascularization and MACE at 6-month follow-up in both groups. The most common MACE at early 6-month outcomes was the need of CABG in both groups.

CONCLUSION

The main finding of our study is that the "hybrid" approach to CTO PCI is associated with significantly higher success and similar complication rates to comparison with single crossing strategies for coronary CTO. Present study has important limitations. It was observational without independent review of the coronary angiograms. Furthermore, operator experience can significantly increase success rates of CTO PCI. Finally, long-term clinical or angiographic follow-up was not performed. Our findings suggest that the efficacy of CTO PCI is significantly improved, and they demonstrate that high success can be achieved without incurring more complications. All authors have no financial conflicts of interest to disclose concerning the manuscript.

REFERECES

1. Kahn JK, Hartzler GO. Retrograde coronary angioplasty of isolated arterial segments through saphenous vein bypass grafts. *Cathet Cardiovasc Diagn* 1990;20(2):88-93.
2. Cutlip DE, Windecker S, Mehran R, Boam A, Cohen DJ, van Es GA, Steg PG, Morel MA, Mauri L, Vranckx P and others. Clinical end points in coronary stent trials: a case for standardized definitions. *Circulation* 2007;115(17):2344-51.
3. Warren RJ, Black AJ, Valentine PA, Manolas EG, Hunt D. Coronary angioplasty for chronic total occlusion reduces the need for subsequent coronary bypass surgery. *Am Heart J* 1990;120(2):270-4.

4. IvanhoeRJ, WeintraubWS, DouglasJS,Jr., LemboNJ, FurmanM, Gershony G, Cohen CL, King SB, 3rd. Percutaneous transluminal coronary angioplasty of chronic total occlusions. Primary success, restenosis, and long-term clinical follow-up. *Circulation* 1992;85(1):106-15.
5. Werner GS, Surber R, Kuethe F, Emig U, Schwarz G, Bahrmann P, Figulla HR. Collaterals and the recovery of left ventricular function after recanalization of a chronic total coronary occlusion. *Am Heart J* 2005;149(1):129-37.
6. Suero JA, Marso SP, Jones PG, Laster SB, Huber KC, Giorgi LV, Johnson WL, Rutherford BD. 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(2):409-14.
7. Hoyer A, van Domburg RT, Sonnenschein K, Serruys PW. Percutaneous coronary intervention for chronic total occlusions: the Thoraxcenter experience 1992-2002. *Eur Heart J* 2005;26(24):2630-6.
8. Puma JA, Sketch MH, Jr., Tchong JE, Harrington RA, Phillips HR, Stack RS, Califf RM. Percutaneous revascularization of chronic coronary occlusions: an overview. *J Am Coll Cardiol* 1995;26(1):1-11.
9. KinoshitaI, KatohO, NariyamaJ, OtsujiS, TateyamaH, KobayashiT, Shibata N, Ishihara T, Ohsawa N. Coronary angioplasty of chronic total occlusions with bridging collateral vessels: immediate and follow-up out- come from a large single-center experience. *J Am Coll Cardiol* 1995;26(2):409-15.
10. Lefevre T, Louvard Y, Loubeyre C, Dumas P, Piechaud JF, Krol M, Benslimane A, Premchand RK, Morice MC. A randomized study comparing two guidewire strategies for angioplasty of chronic total coronary occlusion. *Am J Cardiol* 2000;85(9):1144-7, A9.
11. E.S.Brillakis, J.A.Grantham, S.Rinfret,etal., A percutaneous treatment algorithm for crossing coronary chronic total occlusions, *JACC Cardiovasc. Interv.* 5 (2012) 367–379.
12. A.Pershad, M.Eddin, S.Girotra, R.Cotugno, D.Daniels, W.Lombardi, Validation and incremental value of the hybrid algorithm for CTO PCI, *Catheter. Cardiovasc. Interv.* 84 (2014) 654–659.
13. C.A.Thompson, The hybrid approach for percutaneous revascularization of coronary chronic total occlusions, *Interv. Cardiol. Clin.* 1 (2012) 349–353.
14. S. Garcia, S. Abdullah, S. Banerjee, E.S. Brillakis, Chronic total occlusions: patient selection and overview of advanced techniques, *Curr. Cardiol. Rep.* 15 (2013) 334.
15. E.S. Brillakis, Manual of coronary chronic total occlusion interventions. A step-by-step approach, Elsevier, Waltham, MA, 2013.
16. A.El Sabbagh, S.Banerjee, E.S.Brillakis, Illustration of the ‘hybrid’ approach to chronic total occlusion crossing, *Interv. Cardiol.* 4 (2012) 639–643.
17. L.Nombela-Franco, M.Urena,M.Jerez-Valero,etal.,Validation of the J-chronic total occlusion score for chronic total occlusion percutaneous coronary intervention in an independent contemporary cohort, *Circ. Cardiovasc. Interv.* 6 (2013) 635–643.
18. T.T. Michael, O. Mogabgab, E. Fuh, et al., Application of the “hybrid approach” to chronic total occlusion interventions: a detailed procedural analysis, *J. Interv. Cardiol.* 27 (2014) 36–43.
19. D. Karpaliotis, T.T. Michael, E.S. Brillakis, et al., Retrograde coronary chronic total occlusion revascularization: procedural and in-hospital outcomes from a multicenter registry in the United States, *JACC Cardiovasc. Interv.* 5 (2012) 1273–1279.