Cardiovascular Revascularization Medicine xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Cardiovascular Revascularization Medicine

Outcomes of the retrograde approach through epicardial versus non-epicardial collaterals in chronic total occlusion percutaneous coronary intervention☆,☆☆

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ARTICLE INFO

Article history:
Received 12 January 2017
Received in revised form 9 March 2017
Accepted 9 March 2017
Available online xxxx

Keywords:
Chronic total occlusion
Retrograde
Collateral
Epicardial

ABSTRACT

Background: The retrograde approach through epicardial collaterals (EC) for chronic total occlusion (CTO) percutaneous coronary intervention (PCI) is a challenging procedure. Our study aim was to evaluate the outcomes of patients undergoing CTO PCI using a retrograde approach through epicardial versus non-epicardial collaterals (NEC).
Methods: We collected data from our single-center registry of consecutive patients undergoing retrograde CTO PCI, performed by an experienced operator through EC and NEC (septals and bypass grafts). Clinical, angiographic and procedural data were recorded. The primary endpoint (major adverse cardiac events, MACE) was a composite of cardiac death, target-vessel myocardial infarction (MI) and target-vessel revascularization (TVR) on follow-up.
Results: During the study period, 318 CTO PCIs were performed. Of these, 81 procedures (25%) were performed retrogradely in 75 patients (38 using NEC [31 septals, 7 bypass grafts], 37 through EC [34 contralateral, 3 ipsilateral]). Clinical characteristics were balanced between EC and NEC. J-CTO score was 2.1±1.1 and 2.2±1.2, respectively ($p=0.92$). Collateral tortuosity was more marked in EC. Technical and procedural success was lower in EC (35% vs. 76%, $p<0.001$; 30% vs. 76%, $p<0.001$; respectively). There were two perforations (5%) with need for intervention in EC, and none in NEC ($p=0.15$). After a median follow-up of 443 (331–744) days, MACE were observed in 12.9% (n=4) of EC vs. 5.4% (n=2) in NEC patients ($p=0.28$).
Conclusions: In our experience, retrograde CTO PCI through EC was associated with lower success rate, and a numerically higher rate of perforation, as compared with NEC. Clinical outcomes on follow-up were similar.

1. Introduction

In the past few years, the retrograde approach has allowed an increase in success rates for chronic total occlusion (CTO) percutaneous coronary intervention (PCI) [1]. However, despite the recent advances in procedural techniques as well as guidewire and microcatheter technology, such approach is still associated with a non-negligible risk for complications, specifically linked to collateral manipulation. Indeed, perforation has been reported in 2.0–3.4% and collateral channel injury in 2.0–9.5% of all-comer patients included in multicenter registries [2–4].

Epicardial collaterals (EC) are particularly prone to damage, as they are friable and often extremely tortuous. These features hamper safe and effective wire and microcatheter manipulation, and thus might decrease procedural safety and efficiency. Therefore, even in experienced hands, epicardial collaterals are often avoided, and non-epicardial collaterals (NEC: septals and bypass grafts) are preferred choices for the retrograde approach [2–4].

However, in selected cases, EC might represent the only feasible or most likely successful retrograde option. Little published data exist on the outcomes of retrograde CTO PCI according to the type of collateral used [5]. The aim of our study was therefore to compare the procedural and long-term outcomes of retrograde CTO PCI using EC vs. NEC.

2. Methods

2.1. Patient population

Consecutive patients referred to our CTO PCI program, between November 2012 and July 2016, were considered for inclusion. All procedures were performed by an expert CTO PCI operator (>80% success rate in all-comers [6]). CTO PCI was indicated based on the presence of angina, ischemia or both [1]. CTO revascularization was performed electively (ad hoc PCI was discouraged) according to the Hybrid Algorithm:

☆ Funding sources: none.
☆☆ Conflict of interest: none.
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http://dx.doi.org/10.1016/j.carrev.2017.03.013
1553-8389/

a retrograde approach was chosen in case of presence of interventional collaterals, ambiguous proximal cap and/or poor distal landing zone [7]. The choice of EC vs. NEC was left at the operator discretion. Clinical, angiographic, and procedural data were collected. In case of multiple procedures, only the first procedure was considered for analyses. Follow-up was performed by means of telephone calls, outpatient visits or review of hospital records. Informed consent was obtained from each patient and the study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki, as reflected in a priori approval by the institution human research committee.

2.2. Definitions

CTO was defined as a 100% stenosis with antegrade Thrombolysis In Myocardial Infarction (TIMI) 0 flow for at least 3 months [8]. The J-CTO score [9] was calculated for all lesions.

Retrograde CTO PCI was defined as any attempt at CTO revascularization with wiring of collateral channels. A case was considered a retrograde EC attempt if the operator chose to attempt to utilize that channel, either as primary choice or as bailout after failed NEC attempt. EC-to-NEC crossover cases were considered in the EC group. NEC cases were represented by procedures in which septal collaterals or bypass grafts were used to try to access the occlusion in a retrograde fashion, and no EC attempt was made. Collateral tortuosity was classified in none/mild, moderate and severe ("corkscrew" anatomy) [10,11].

Technical success was defined as a residual stenosis <30% with antegrade TIMI 3 flow in the CTO target vessel [8]. Procedural success was defined as technical success plus the absence of in-hospital adverse events: all-cause death, Q-wave myocardial infarction (MI), stroke, target-vessel revascularization (TVR), and tamponade requiring pericardiocentesis or surgery [8].

Major adverse cardiac events (MACE) on follow-up were the primary endpoint of the study and were defined as the composite of cardiac death, target-vessel MI (Q-wave and non-Q-wave) and ischemia-driven TVR. MACE on follow-up were assessed only in patients who did not suffer any adverse event prior to hospital discharge.

2.3. Statistical analysis

Continuous variables are presented as mean ± standard deviation and t-test was used for comparisons. Categorical variables are presented as frequency (percentages), and compared using chi-square test. Kaplan–Meier curves of survival free from MACE according to the type of collateral channels used were plotted and compared using the log-rank test. For all tests, a $p < 0.05$ was considered significant. Statistical analysis was performed using SPSS 24 (IBM Corp., Armonk, NY).

3. Results

3.1. Clinical characteristics

During the study period, 318 consecutive patients were referred to our CTO PCI program. Of these, 81 (25%) procedures were performed through the retrograde approach in 75 patients: 38 (51%) using NEC (31 septals, 7 bypass grafts), while 37 (49%) through EC (34 contralateral, 3 ipsilateral). Fig. 1 shows the study workflow. Overall mean age, gender, prevalence of diabetes, and other cardiovascular risk factors and conditions were similar between groups (Table 1). EC patients showed a trend towards higher prevalence of prior PCI and lower left ventricular and renal function. NEC subjects tended to have a higher prevalence of prior transient ischemic attack or stroke.

3.2. Angiographic and procedural characteristics

Angiographic data are shown in Table 2. Coronary artery disease burden, as assessed with the SYNTAX score, was similar between groups (EC 18.9 ± 8.2 vs. NEC 17.9 ± 9.8; $p = 0.63$). Analogously, there were no differences with regards to CTO target-vessel and occlusion complexity between EC and NEC (J-CTO score: 2.1 ± 1.1 vs. 2.1 ± 1.2, respectively; $p = 0.92$). However, collateral tortuosity was markedly more pronounced in the EC group: in particular, "corkscrew" anatomy was observed in 16% vs. 0% of patients in EC vs. NEC, respectively ($p = 0.004$).

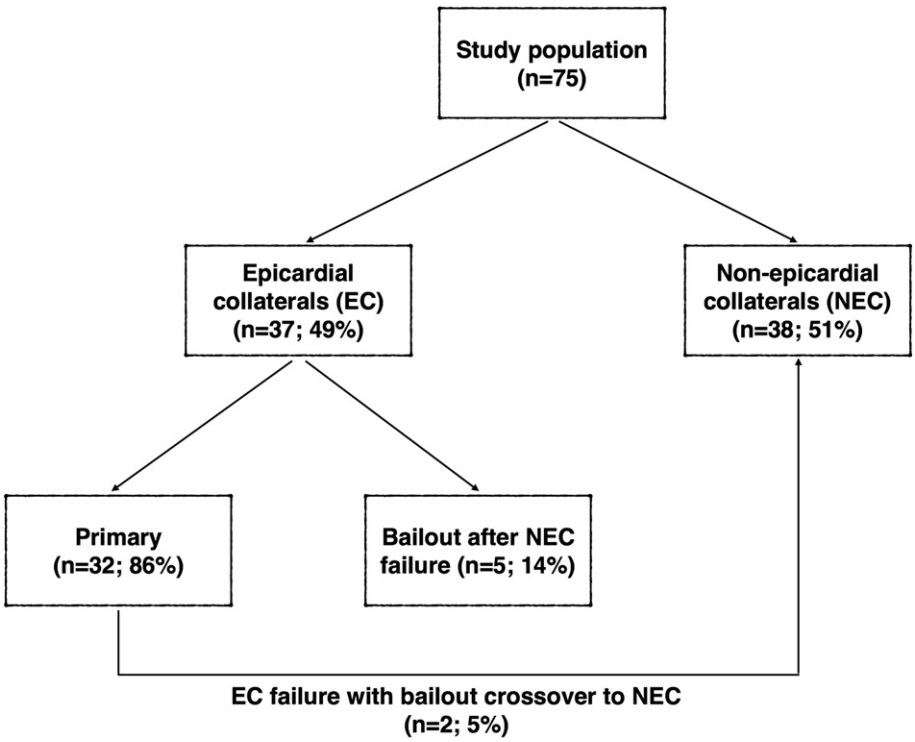

Fig. 1. Study workflow. Note: as detailed in the Methods, any attempt to utilize an epicardial collateral was considered in the EC group. Failed EC cases with subsequent crossover to NEC were considered in the EC group.

Please cite this article as: Benincasa S, et al, Outcomes of the retrograde approach through epicardial versus non-epicardial collaterals in chronic total occlusion percutaneous c..., Cardiovasc Revasc Med (2017), http://dx.doi.org/10.1016/j.carrev.2017.03.013