The Impact of Epicardial Collateral Use on the Outcomes of Chronic Total Occlusion Percutaneous Coronary Intervention

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Introduction

The impact of the type of collateral vessel used on the outcomes of retrograde chronic total occlusion (CTO) percutaneous coronary intervention (PCI) has received limited study.

Methods

Study population

- We reviewed the baseline clinical and angiographic characteristics and procedural outcomes of 1,501 retrograde CTO PCIs performed in 1494 patients between 2012 and 2019 at 26 centers.

Analyses

- All statistical analyses were performed with JMP 11.0 (SAS Institute; Cary, North Carolina).

Results

Septal collaterals or bypass grafts were used in 66%, epicardial collaterals in 34% of lesions.

Table 1. Baseline clinical characteristics of the study patients, classified according to the used collateral type.

Variable	Overall (n= 1494)	Epicardial collaterals used (n=508)	Only septals or SVG used (n= 986)	P value
Age (years)[a]	65.0 ± 10	65.6 ± 10	64.8 ± 10	0.196
Men	86%	89%	84%	0.039
BMI (kg/m2)[a]	30.8 ± 6	30.4 ± 6	31.0 ± 6	0.113
Diabetes Mellitus	42%	36%	45%	0.003
Hypertension	91%	91%	91%	0.633
Dyslipidemia	92%	95%	91%	0.017
Smoking (current)	21%	18%	22%	0.086
LVEF (%)[a]	50 ± 13	49 ± 13	51 ± 13	0.082
Family History of CAD	37%	45%	34%	0.001
Congestive Heart Failure	31%	31%	32%	0.841
Prior Myocardial Infarction	51%	52%	51%	0.583
Prior CABG	44%	44%	44%	0.968
Prior CVD	11%	10%	11%	0.406
Prior PVD	17%	15%	17%	0.43
Baseline creatinine (mg/dL)[b]	1.1 (0.9,1.3)	1.1 (0.9, 1.3)	1.0 (0.9, 1.2)	0.108

BMI: body mass index; LVEF: left ventricular ejection fraction; CAD: coronary artery disease; CABG: coronary artery bypass grafting; CVD: cerebrovascular disease; PVD: peripheral vascular disease; SVG: saphenous vein graft
[a] mean ± standard deviation; [b] median (interquartile range)

Figure 1. Different type of collaterals.

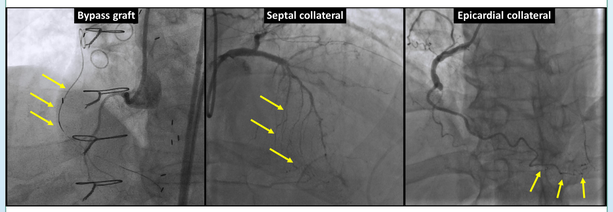


Figure 2. Technical, procedural success and MACE among study patients classified according to the type of collateral used.

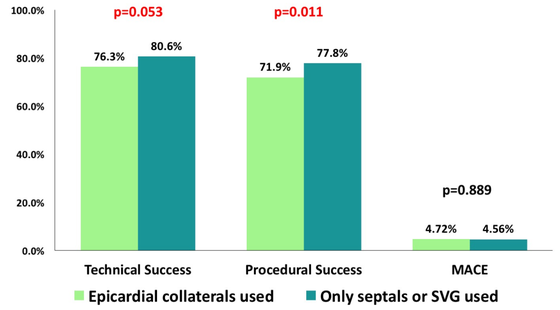
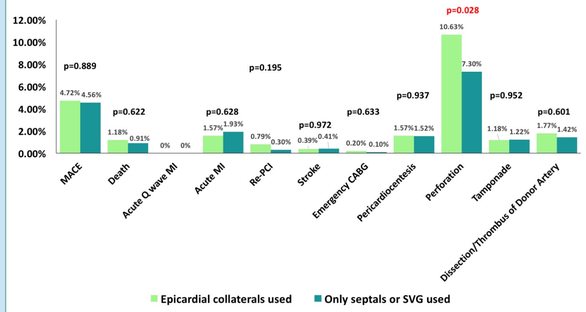


Figure 3. Procedural complications among study patients classified according to the type of collateral used.



MACE: major adverse cardiovascular events

Table 2. Procedural strategy and angiographic characteristics of the study lesions, classified according to the type of collateral used.

Variable	Overall (n= 1501)	Epicardial collaterals used (n=511)	Only septals or SVG used (n= 990)	P value
CTO Target Vessel				
▪ RCA	68%	62%	72%	
▪ LAD	15%	14%	16%	
▪ LCX	15%	22%	12%	<.0001
▪ LM	0.5%	0.2%	0.6%	
▪ SVG	0.07%	0%	0.1%	
▪ Other	0.8%	1.8%	0.2%	
Successful Crossing Strategy				
▪ Antegrade wiring	8%	7%	8%	
▪ Retrograde	61%	55%	64%	
▪ Antegrade dissection and re-entry	12%	17%	10%	<.0001
▪ None	19%	21%	18%	
First Crossing Strategy				
▪ Antegrade wiring	55%	55%	55%	
▪ Retrograde	39%	39%	40%	0.807
▪ Antegrade dissection and re-entry	6%	6%	5%	
J-CTO score [a]	3.19 ± 1.06	3.34 ± 1.02	3.11 ± 1.07	<0.0001
Progress CTO score [a]	1.18 ± 0.95	1.34 ± 1.02	1.09 ± 0.90	<0.0001
Calcification (moderate/severe)	68%	73%	65%	0.002
Proximal vessel tortuosity (moderate/severe)	47%	55%	42%	<0.0001
Proximal cap ambiguity	56%	58%	55%	0.271
In-stent restenosis	13%	13%	14%	0.654
Prior failure to open CTO	26%	29%	25%	0.049
Side branch at the proximal cap	61%	64%	60%	0.274
Blunt/no stump, %	80%	83%	79%	0.020
Vessel diameter (mm)[b]	3.0 (2.5, 3.1)	3.0 (2.5, 3.0)	3.0 (2.5, 3.2)	0.005
Occlusion length (mm)[b]	35 (25, 56)	38 (25, 60)	35 (24, 50)	0.102
Number of stents used	2.9 ± 1.1	2.8 ± 1.2	2.9 ± 1.1	0.096
Werner collateral connection grade				
▪ CC0	9%	9%	9%	0.052
▪ CC1	58%	66%	55%	
▪ CC2	33%	26%	36%	
Rentrop collateral filing grade				
▪ Grade 0	1.6%	0%	2%	
▪ Grade 1	19%	28%	15%	0.002
▪ Grade 2	43%	41%	44%	
▪ Grade 3	37%	31%	39%	

RCA: right coronary artery; LAD: left anterior descending artery; LCX: left circumflex artery; CTO: Chronic total occlusion; J-CTO score: Japan chronic total occlusion score; Progress CTO score: Prospective Global Registry of Chronic Total Occlusion Interventions score, SVG: saphenous vein graft.
[a] Values are mean ± standard deviation; [b] median (interquartile range)

Table 3. Procedural outcomes of the study patients, classified according to the type of collateral used.

Variable	Overall	Epicardial collaterals used	Only septals or SVG used	P
Technical Success	79.1%	76.3%	80.6%	0.053
Procedural Success	75.8%	71.9%	77.8%	0.011
Procedural time (min)[b]	184 (136, 239)	195 (151, 250)	178 (131, 237)	0.004
Fluoroscopy time (min)[b]	78 (57, 103)	82 (64, 104)	76 (55, 102)	0.0003
Air kerma radiation dose (Gray)[b]	3.52 (2.10, 5.38)	3.78 (2.40, 5.42)	3.40 (1.90, 5.32)	0.019
Contrast volume[b]	280 (200, 399)	300 (221, 414)	270 (200, 370)	<.0001
MACE	4.62%	4.72%	4.56%	0.889
Death	1.00%	1.18%	0.91%	0.622
Acute Q wave MI	0%	0%	0%	
Acute MI	1.81%	1.57%	1.93%	0.628
Re-PCI	0.47%	0.79%	0.30%	0.195
Stroke	0.40%	0.39%	0.41%	0.972
Emergency CABG	0.13%	0.20%	0.10%	0.633
Pericardiocentesis	1.54%	1.57%	1.52%	0.937
Perforation	8.43%	10.63%	7.30%	0.028
Dissection/Thrombus of Donor Artery	1.54%	1.77%	1.42%	0.601

MACE: major adverse cardiac events; MI: myocardial infarction; Re-PCI: repeated percutaneous coronary intervention; CABG: coronary artery bypass graft surgery.
[b] median (interquartile range)

Study limitations

- Observational registry without adjudication of clinical events by an independent committee
- Quantitative coronary angiographic analyses were not performed
- Procedures were performed by experienced operators in CTO PCI, limiting extrapolation of the study results to less experienced centers and operators

Conclusion

In a contemporary, multicenter registry epicardial collaterals were used in approximately one-third of retrograde CTO PCIs. Use of epicardial collaterals was associated with lower success but similar major complication rates.

Disclosures
Dr. Karmpaliotis: speaker bureau, Abbott Vascular, Medtronic, and Boston Scientific. Dr. Alaswad: consulting fees from Terumo and Boston Scientific; consultant (non-financial) for Abbott Laboratories. Dr. Jaffer: Consultant: Abbott Vascular and Boston Scientific. Research grant: Canon, Siemens and National Institutes of Health. Dr. Yeh: research grants and consulting for Abbott Vascular, Boston Scientific and Medtronic, Dr. Kandzari: research/grant support and consulting honoraria from Boston Scientific and Medtronic Cardiovascular, and research/grant support from Abbott. Dr. Brilakis: consulting/speaker honoraria from Abbott Vascular, American Heart Association (associate editor Circulation), Amgen, Biotronik, Boston Scientific, Cardiovascular Innovations Foundation (Board of Directors), CSI, Elsevier, GE Healthcare, InfraRedx, Medtronic, Siemens, and Teleflex; research support from Regeneron and Siemens. Shareholder: MHI Ventures.
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