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Repeat revascularisation: "An ounce of prevention is worth a pound of cure"

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Myocardial revascularisation procedures are among the most common invasive procedures performed[1,2]. The procedures, the clinical scenarios and the patients, for whom these procedures are carried out, are quite diverse. An expert panel of the European Association of Percutaneous Cardiovascular Interventions (EAPCI) has written an expert consensus document reviewing the options when patients with myocardial revascularisation "fail"[3].

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The paper consists of different scenarios for revascularisation failure. The suggestions for the management of these distinct groups of patients are then described. The document is of excellent quality, and the clinical scenario approach makes it useful to clinicians. While treatment options exist for revascularisation "failure", these frequently involve more complex intervention, with often modest long-term results. Thus, while a sound approach to revascularisation is highly desirable, it behoves us to recall the counsel of Benjamin Franklin, who stated that "an ounce of prevention is worth a pound of cure".

Importantly, as noted in the document, the majority of stent "failures", particularly in the era of newer-generation drug-eluting stents, including both stent restenosis and thrombosis, are believed to be due to issues regarding the initial stent deployment. These factors include inadequate lesion preparation (particularly in cases of heavily calcified lesions), stent underexpansion, and stent malposition. Utilisation of intravascular coronary imaging (e.g., intravascular ultrasound [IVUS], optical coherence tomography [OCT]) has long been proposed to ameliorate unappreciated underdilation, although randomised study data supporting such routine use are sparse.

As with percutaneous coronary intervention (PCI), surgical graft failure within the first month is related mostly to graft spasm or suboptimal surgical technique[4]. Acute arterial graft failure may be related to technical issues regarding anastomosis of the internal mammary artery (IMA) to the coronary artery and is associated with a markedly higher rate of the composite of death, myocardial infarction (MI), or repeat revascularisation[5]. The predictors of IMA failure include less severe left anterior descending artery (LAD) stenosis and additional grafting of the diagonal artery[5].

In some cases, despite angiographically adequate revascularisation, patients experience little or no symptomatic improvement. As stated in the expert consensus document[3], this may be the result of no functional assessment (e.g., fractional flow reserve [FFR], nuclear stress test) of the coronary anatomy before intervention. Without this, there may be either revascularisation of a non-haemodynamically significant lesion that is not the cause of the chest pain, or failure to appreciate the functional significance of other (perhaps "intermediate") lesions subtending other coronary territories. Such cases of revascularisation "failure" (i.e., failure to relieve angina) could be prevented by prior functional assessment of such lesions, as is generally recommended (at least for stable chest pain) in both European and American guidelines[6]. **Table 1** summarises the suggested methods used to prevent repeat revascularisation.

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Table 1. Suggestions on preventing the revascularisation failures in various clinical subsets.

	What to do to prevent	How to treat
Stent thrombosis	Use adjunct imaging (e.g., IVUS, OCT) to ensure adequate vessel preparation, stent expansion, and apposition	Use adjunct imaging (e.g., IVUS, OCT) to ensure adequate vessel preparation, stent expansion, and apposition. Also fix mechanical issues seen on the adjunct imaging
	Ensure DAPT compliance	Ensure DAPT compliance
		Assess platelet reactivity if no mechanical problem is found
In-stent restenosis	Use adjunct imaging (e.g., IVUS, OCT) to ensure adequate vessel preparation, stent expansion, and apposition	Use adjunct imaging to ensure stent expansion and apposition and fix mechanical issues
	Use DES for initial treatment	CABG in select cases
Acute functional failure after PCI	Use functional assessment (e.g., FFR, iFFR) during PCI to identify haemodynamically significant lesions	Use functional assessment (e.g., FFR, iFFR) to identify potentially missed haemodynamically significant lesions
Acute graft failure	Use appropriate CABG technique and select suitable patients, e.g., patients with significant lesions	PCI of the native vessel when feasible
		Emergency redo CABG
		Conservative treatment
Late graft failure	Use appropriate CABG technique	PCI of the native vessel when feasible
	Use IMA for revascularisation	Redo CABG when necessary, especially when no IMA is used
Progression of CAD	Treat DM, lipids, HTN	PCI or CABG when appropriate
		Use IMA if not previously used

CABG: coronary artery bypass graft; CAD: coronary artery disease; DM: diabetes mellitus; FFR: fractional flow reserve; iFFR: instantaneous fractional flow reserve; HTN: hypertension; IMA: internal mammary artery; IVUS: intravascular ultrasound; OCT: optical coherence tomography; PCI: percutaneous coronary intervention

Many cases of what is ultimately labelled as myocardial revascularisation failure are related less to the treated lesion or lesions, and more to unabated progression of atherosclerosis, both in the target vessel and throughout the coronary tree. Neither a stent nor a vein graft alone is a substitute for aggressive secondary preventive measures, including smoking cessation, aggressive cholesterol treatment, and blood pressure lowering.

The expert consensus document on myocardial revascularisation failure[3] is a welcome addition to the literature on the management of patients with coronary artery disease. We must, however, also remember that factors such as appropriate haemodynamic assessment of lesion significance, optimum lesion preparation and stent deployment in the case of PCI, surgical techniques and utilisation of arterial conduits, compliance with dual antiplatelet therapy (DAPT), and aggressive secondary prevention measures can all decrease the incidence of myocardial revascularisation failure. In short, "an ounce of prevention is worth a pound of cure".

Conflict of interest statement

The authors have no conflicts of interest to declare.

References

1. Virani SS, Alonso A, Benjamin EJ, Bittencourt MS, Callaway CW, Carson AP, Chamberlain AM, Chang AR, Cheng S, Delling FN, Djousse L, Elkind MSV, Ferguson JF, Fornage M, Khan SS, Kissela BM, Knutson KL, Kwan TW, Lackland DT, Lewis TT, Lichtman JH, Longenecker CT, Loop MS, Lutsey PL, Martin SS, Matsushita K, Moran AE, Mussolino ME, Perak AM, Rosamond WD, Roth GA, Sampson UKA, Satou GM, Schroeder EB, Shah SH, Shay CM, Spartano NL, Stokes A, Tirschwell DL, VanWagner LB, Tsao CW; American Heart Association Council on Epidemiology and Prevention Statistics Committee and Stroke Statistics Subcommittee. Heart Disease and Stroke Statistics-2020 Update: A Report From the American Heart Association. *Circulation.* 2020;141:e139-596.

2. Masoudi FA, Ponirakis A, de Lemos JA, Jollis JG, Kremers M, Messenger JC, Moore JWM, Moussa I, Oetgen WJ, Varosy PD, Vincent RN, Wei J, Curtis JP, Roe MT, Spertus JA. Trends in U.S. Cardiovascular Care: 2016 Report From 4 ACC National Cardiovascular Data Registries. *J Am Coll Cardiol.* 2017;69:1427-50.

3. Stefanini GG, Alfonso F, Barbato E, Byrne R, Capodanno D, Colleran R, Escaned J, Giacoppo D, Kunadian V, Lansky A, Mehilli J, Neumann FJ, Regazzoli D, Sanz-Sanchez J, Wijns W, Baumbach A. Management of myocardial revascularisation failure: an expert consensus document of the EAPCI. *EuroIntervention.* 2020;16:e875-90.

4. Harskamp RE, Williams JB, Hill RC, de Winter RJ, Alexander JH, Lopes RD. Saphenous vein graft failure and clinical outcomes: toward a surrogate end point in patients following coronary artery bypass surgery? *Am Heart J.* 2013;165:639-43.

5. Harskamp RE, Alexander JH, Ferguson TB Jr, Hager R, Mack MJ, Englum B, Wojdyla D, Schulte PJ, Kouchoukos NT, de Winter RJ, Gibson CM, Peterson ED, Harrington RA, Smith PK, Lopes RD. Frequency and Predictors of Internal Mammary Artery Graft Failure and Subsequent Clinical Outcomes: Insights From the Project of Ex-vivo Vein Graft Engineering via Transfection (PREVENT) IV Trial. *Circulation.* 2016;133:131-8.

6. Levine GN, Bates ER, Blankenship JC, Bailey SR, Bittl JA, Cercek B, Chambers CE, Ellis SG, Guyton RA, Hollenberg SM, Khot UN, Lange RA, Mauri L, Mehran R, Moussa ID, Mukherjee D, Nallamothu BK, Ting HH, American College of Cardiology Foundation, American Heart Association Task Force on Practice Guidelines, Society for Cardiovascular Angiography and Interventions. 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Society for Cardiovascular Angiography and Interventions. *J Am Coll Cardiol.* 2011;58:e44-122.