Coronary Calcified Lesions: Introduction to the Focused Issue

Nicolas M Van Mieghem

Department of Cardiology, Thoraxcenter, Erasmus University Medical Center, Rotterdam, the Netherlands

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Correspondence: Nicolas M Van Mieghem, Department of Cardiology, Thoraxcenter, Erasmus University Medical Center, Office Nt 645, Dr Molewaterplein 40 3015 GD, Rotterdam, the Netherlands. E: n.vanmieghem@erasmusmc.nl

Much has been said about the allegedly final frontiers in interventional cardiology. Is it long-term outcome regarding percutaneous coronary intervention (PCI) for multivessel coronary artery disease? Is it the safety and efficacy of PCI versus coronary artery bypass grafting in patients with diabetes? There is definitely a movement within the interventional cardiology community that says it is the ability to reliably and successfully recanalise chronic total occlusions (CTO), and there are now claims the CTO conundrum is settled and done.

Arguably, controversy remains and, as we move towards precision medicine, attention should shift to an individualised approaches tailored to the specific phenotype of the patient at hand, taking into account substrate complexity, biological age, comorbidities, frailty and the patient's preference. Precision medicine implies continued iterations and strategies to improve feasibility, safety and efficacy. There are no final frontiers – only new goals.

This *Interventional Cardiology Review* focused issue revolves around the complexity of coronary calcified lesions and details the value of invasive imaging and coronary physiology, and various treatment modalities and strategies.

Up to a quarter of all patients with significant coronary artery disease have moderate to heavily calcified lesions. It is essential to consider the haemodynamic significance of a calcified lesion before embarking on a technically complex PCI. When in doubt, this requires (invasive) coronary physiology confirmation.

Intravascular ultrasound (IVUS) and optical coherence tomography (OCT) imaging present fundamentally different physical characteristics and generate different images when interacting with calcium. IVUS has less spatial resolution but superior tissue penetration, and therefore seems better suited to determine precise plaque burden and vessel size.

Paradoxically, in calcified lesions, OCT may be the most accurate modality to quantify total calcium burden because retro-acoustic shadowing with IVUS hinders accurate calcium thickness determination. The adoption of invasive imaging in clinical practice is still lagging behind its potential to improve PCI procedure success and outcome, despite the fact that the overall tenor of the interventional cardiology community confirms the value of invasive imaging.[1] Cost, suboptimal reimbursement policies and the impression of needless procedure prolongation may explain this.

Recent European Society of Cardiology and European Association for Cardio-Thoracic Surgery guidelines on myocardial revascularisation gave only modest and more general recommendations on the use of invasive imaging for PCI, more specifically for left main stem PCI or to detect stent-related mechanical problems leading to restenosis.[2]

Liberal use of invasive imaging may be of particular use for the management of calcified lesions by streamlining lesion preparation for optimal stent expansion and apposition. Proper stent apposition and expansion require adequate preparation of the lesion that contains excessive calcium.

A formidable armamentarium for calcified lesion preparation is available, and ranges from specialised balloon technology to atherectomy devices and lithotripsy. This focused issue catalogues the toolbox for complex calcified coronary lesions and may promote a rational selection of technology tailored to the patient and lesion.

Apart from balloon technology, rotational atherectomy has been available for more than three decades. However, the learning curve proved too long and steep for many interventionalists and its adoption remains restricted to specialised centres and in the hands of experienced operators.

The persisting unmet need for debulking and advanced lesion preparation in calcified disease has fuelled the development of other concepts and resulted in the introduction of orbital atherectomy and intravascular lithotripsy in the last decade.

Orbital atherectomy is reminiscent of rotational atherectomy, but features distinct principles with its one-sized eccentric burr design and bidirectional orbital movement. Intravascular lithotripsy leverages balloon technology to expel pulsatile mechanical energy through sonic pressure waves equivalent to the effect of 50 atm in the media of the vessel where the pulse waves interact with hard (and not soft) tissue components, and therefore calcium.

Rotational and orbital atherectomy will create superficial, endothelial fractures and reduce the overall calcium burden starting with the endoluminal calcium – the polishing effect. Intravascular lithotripsy will then interact more with the calcium in the vessel media and poses no or much less risk for major dissections or no-reflow phenomena due to distal debris embolisation.

All these modalities beyond conventional non-compliant and very-high pressure balloon dilatation seem complementary rather than competing technologies. Some lesions would benefit more from orbital/rotational atherectomy and others from intravascular lithotripsy. Indeed, protruding calcified plaques and severe narrowing may require orbital or rotational atherectomy because a low-profile lithotripsy balloon would not be able to negotiate the lesion. Conversely, lesions that are characterised by excessive circular calcium reaching beyond the intima may be excellent targets for intravascular lithotripsy.

Clearly, operators should incorporate invasive imaging into their routine clinical practice to help assess the overall burden and distribution of calcified lesions so they are able to select the best treatment strategy. This would include optimal lesion preparation before stenting and achieve optimal stent expansion/apposition and overall procedural success.

In anticipation of further research, this *Interventional Cardiology Review* focused issue on calcified coronary lesions captures contemporary science and knowledge and hopefully serves your clinical practice today. ■

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