Swāsthya Health स्वास्थ्य

Precision intervention: Latest innovations in catheter interventions for coronary artery disease

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INTRODUCTION

Ischaemic heart disease (IHD) remains the leading cause of mortality worldwide. In 2019, it accounted for 9 million deaths, 16% of the global mortality.1 The absolute burden of the disease continues to rise, driven by an ageing and increasingly comorbid population.[1]

These patients are frailer with chronic multi-organ impairment, including left ventricular systolic dysfunction (LVSD). Their presenting coronary artery disease (CAD) is also increasingly complex, involving a high thrombotic and calcific burden in multiple vessels.2 Subdivided into patient, haemodynamic, and anatomical aspects, these factors variably define complex and high risk percutaneous coronary intervention (PCI).[2]

To safely and successfully treat these more complex patients, coronary intervention has witnessed a rapid evolution in device technology together with improved operator education and experience. Examples of standard modern practise include physiology-based lesion assessment, intra-coronary imaging, modification of arterial calcification, tailored antiplatelet regimens and temporary mechanical circulatory support (MCS).[2,3] Interventional cardiologists now have the evidence base and ability to treat most subsets of simple and complex CAD, including left main stem (LMS) disease, bifurcation disease and chronically occluded coronary arteries.

Contemporary interventional cardiology can facilitate precision therapy tailored to an individual patient's clinical and anatomical characteristics. The purpose of this article is to review the latest innovations in PCI.

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COMPREHENSIVE INTRACORONARY ASSESSMENT

Intracoronary physiology testing

The significance of an intermediate grade coronary stenosis is often unclear, especially in patients with multi-vessel disease or atypical chest pain. Fractional flow reserve (FFR) is an invasive physiological index that uses an intracoronary pressure wire or catheter to measure flow distal to a lesion as a fraction of proximal flow at maximum hyperaemia after adenosine administration. A ratio less than 0.80 is considered FFR-negative.[4-6]

The landmark trials, DEFER, FAME and FAME 2 led to two complementary conclusions. Firstly, medical management of FFR negative lesions is safe. In fact this reduces myocardial infarction (MI) rates likely related to peri-procedural stent thrombosis and later in-stent restenosis (ISR). Secondly, a positive FFR study identifies patients who are at increased risk of future major adverse cardiac events (MACE) and who would therefore benefit from revascularisation.[4-6]

Resting or non-hyperaemic indices include instantaneous wave-free ratio (iFR) and resting full-cycle ratio (RFR). These measurements do not require intravenous adenosine. They are however more liable to measurement error or drift and long-term outcome data is still needed.[2,3] In addition to the assessment of epicardial stenoses, intracoronary physiology measurements can help to define subsets of patients who have inducible coronary spasm (acetylcholine challenge) and microvascular dysfunction (coronary flow reserve [CFR] and index of microvascular dysfunction [IMR] measurements).

INTRAVASCULAR IMAGING

Intracoronary imaging through a specialised catheter can delineate the severity, length and morphology of coronary plaques; guide optimal stent sizing, deployment and apposition; and assess stent failures. The two most widely used technologies are intravascular ultrasound (IVUS) and optical coherence tomography (OCT), based on sound and infrared light waves respectively.[2,3]

The majority of existing evidence in favour of intravascular imaging comes from IVUS. Multiple meta-analyses demonstrate reduced target vessel/lesion revascularisation at 1 year in IVUS-guided vs. angiography-guided PCI, most likely driven by improved stent delivery through more aggressive post-dilation.[7]

In comparison to IVUS, OCT provides better near field resolution at the expense of reduced penetration of the vessel wall and therefore reduced deep intimal visualisation (Figure 1). In the ILUMIEN III: OPTIMIZE PCI trial, OCT was non-inferior to IVUS for minimum stent area and MACE.[8]

CORONARY CALCIUM MODIFICATION

Symptomatic atherosclerotic stenoses are frequently complicated by significant coronary artery calcification. In comparison to lipid rich or soft plaque, calcified plaques lead to arterial stiffness, sub-optimal stent expansion and therefore an increased risk of early and late complications.
These include arterial dissections, perforations, stent thrombosis and in the longer term, ISR. Strategies to modify intra-coronary calcium include high pressure non-compliant balloons, cutting and scoring balloons, athero-ablative technology and more recently intravascular lithotripsy (IVL) (Figure 2).

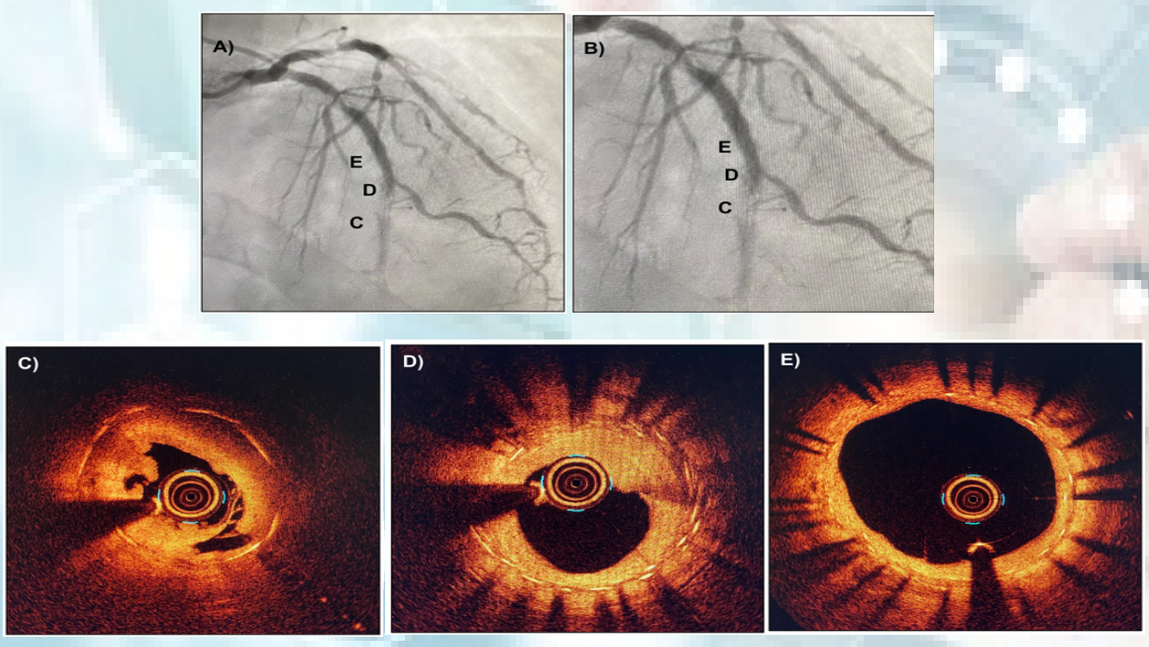

Figure 1

The mechanistic goal is to fracture plaque calcium, reduce its tensile strength and thereby facilitate greater stent expansion and wall apposition at lower inflation pressures.[9]

Cutting and scoring balloons

Cutting balloons have radially arranged blades along the balloon that incise into the hard plaque during balloon inflation. Scoring balloons use a mounted cage in a spiral configuration to cut into

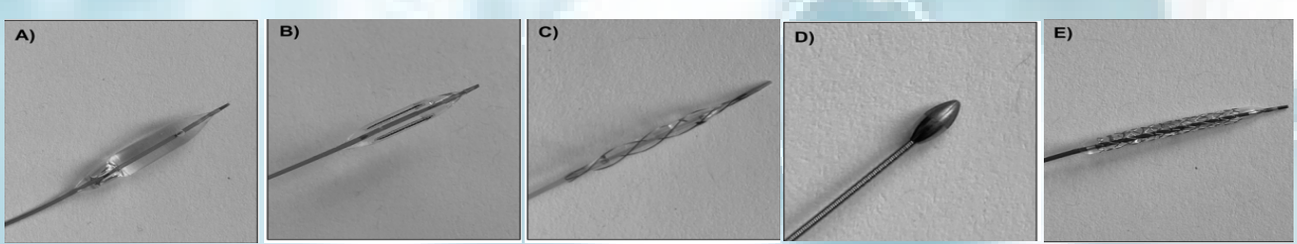

Figure 2

continues to emerge with regard to the best regimen of anti-thrombotic therapy specific to individual clinical and anatomical characteristics.

CONCLUSION

The population of patients who have uniquely challenging anatomy and often poor haemodynamic parameters continues to grow. With surgical revascularisation frequently unfavourable, precision coronary intervention, using detailed intracoronary assessment, adjuvant lesion preparation and tailored anti-thrombotic therapy is a safe and effective treatment option.

RESOURCES

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