Intravascular Ultrasound for the Assessment of Coronary Lesion Severity and Optimization of Percutaneous Coronary Interventions

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KEYWORDS

• Intravascular ultrasound • Coronary disease • Stent

KEY POINTS

- The major use of intravascular ultrasound (IVUS) is to plan interventional strategy and optimize stent deployment.
- The use of IVUS to identify which lesions should be treated is problematic: recent data suggest that a minimal lumen area (MLA) $\leq$2.4 mm^2 may be the optimal cutoff to predict functional significance by fractional flow reserve, although IVUS-derived MLA alone cannot replace noninvasive or invasive functional assessment.
- Stent optimization by IVUS includes the evaluation of stent expansion, apposition, lesion coverage, and the presence or absence of stent edge dissection.
- Observational studies suggest that IVUS guidance during drug-eluting stent implantation reduces the risk of major adverse cardiac events, including stent thrombosis, particularly in the setting of unprotected left main percutaneous coronary interventions (PCI).
- The as-treated analysis of the long-lesion RESET randomized trial reported that the use of IVUS guidance during PCI with a drug-eluting stent resulted in significantly larger final minimal stent area and a lower risk of 1-year major adverse cardiac events compared with angiographic guidance alone.

INTRODUCTION

Intravascular ultrasound (IVUS) has provided valuable information regarding cross-sectional coronary vascular structure (Fig. 1). It plays a key role in contemporary stent-based percutaneous coronary interventions (PCI) by accurately assessing coronary anatomy, assisting in selection of treatment strategy, and defining optimal stenting outcomes.[1–3] In the bare metal stent (BMS) era, randomized trials and meta-analyses reported that IVUS-guided PCI was associated with a lower risk of angiographic restenosis and target vessel revascularization than PCI guided by angiography alone.[4,5] Drug-eluting stents (DES), which markedly reduce the rate of in-stent restenosis and target vessel revascularization, could therefore reduce the clinical usefulness of IVUS. However, the reduced risk of in-stent restenosis with DES is offset by concerns about stent thrombosis. In addition, the increased use of DES has led to the treatment

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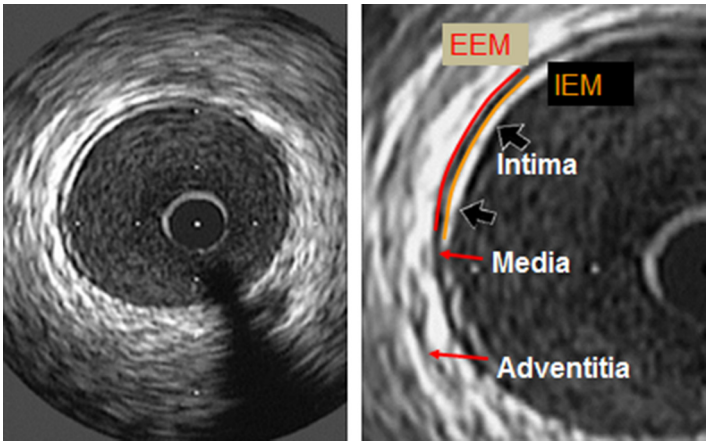

Fig. 1. IVUS findings of normal coronary artery. EEM, external elastic membrane; IEM, internal elastic membrane.

of more complex lesions and higher-risk patients, in which the risk of early and late stent failure is greater. A recent meta-analysis[6] reported the benefit of IVUS-guided DES implantation compared with angiography-guided implantation in reducing the risk of death, myocardial infarction, stent thrombosis, and repeat revascularization. In this review, a comprehensive approach to the evaluation of coronary lesions and the optimization of PCI with DES using IVUS is presented.

INTRAVASCULAR LESION ASSESSMENT

Anatomic Lesion Assessment

The major use for IVUS is to plan interventional strategy and optimize stent deployment. Preintervention IVUS accurately assesses reference lumen dimensions and lesion length for appropriate stent sizing (Fig. 2). In addition, IVUS findings such as severe superficial calcium, or thrombus, can alter the mechanical or pharmacologic strategy, including prestent rotational atherectomy for plaque modification, more potent anticoagulant therapies, or mechanical thrombectomy. Poststent IVUS assessment may detect complications of PCI and suboptimal stent deployment (Fig. 3),[7] which lead to further interventions for optimal stent implantation, thereby minimizing stent-related adverse clinical outcomes. Table 1 summarizes the quantitative and qualitative parameters measured by IVUS before and after stent implantation.[1]

Functional Lesion Assessment

Although IVUS cannot directly estimate the functional significance of coronary stenosis, attempts have been made to determine the IVUS parameters that correspond to a functionally significant

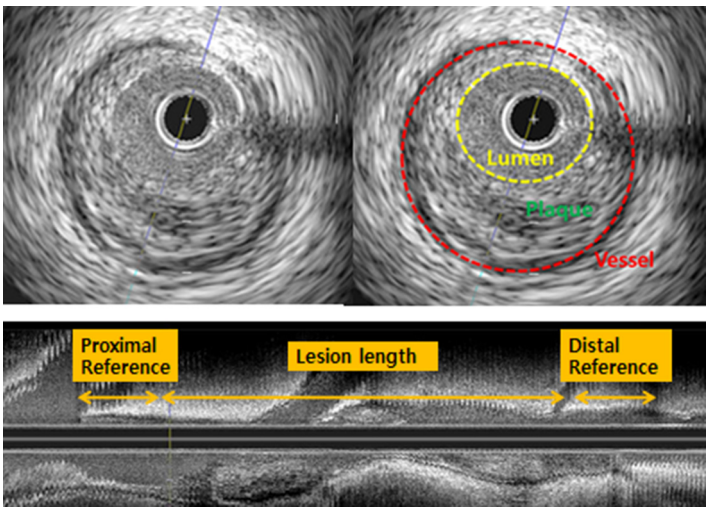

Fig. 2. IVUS evaluation of diseased lesion.