**Introduction**

Intravascular imaging guidance during percutaneous coronary intervention (PCI) significantly improves clinical outcomes (1,2). Intravascular ultrasound (IVUS) and optical coherence tomography (OCT) are the two commercially available intravascular imaging technologies used to guide decision-making and optimize PCIs. Intravascular imaging guidance improves outcomes by adequately informing clinicians of true vessel size, landing zones to guide stent length selection, plaque morphology to guide debulking strategies, identify PCI complications (edge dissection, stent malapposition) and mechanisms of stent failure (stent thrombosis/under expansion/fracture, neointimal hyperplasia, neoatherosclerosis) (3-7). This review compares and contrasts the utility of IVUS and OCT in contemporary PCI, identifying appropriate situations for utilizing these contrasting imaging modalities.

**IVUS and OCT: technical and procedural differences**

IVUS utilizes ultrasound whereas the OCT uses infrared light (8-10). OCT has 10 times greater resolution compared with IVUS; however, it requires clearing of blood typically with contrast, but also with dextran as a contrast-sparing agent (11,12). OCT has lower penetration (1–2 mm) compared with IVUS (5–6 mm). The quality of the OCT image worsens in presence of red thrombus (Figure 1). As a result of the short wavelength, red blood cells lead to ‘structural noise,’ and thus image distortion. Given the greater resolution of OCT, images are more reproducible compared with IVUS (13). On the other hand, IVUS provides visibility of all three arterial layers, its depth of penetration enables one to assess vascular remodeling which in turn more appropriately guides optimal vessel sizing enabling larger-sized stent implantation. OCT has a higher
resolution but has limited depth compared with IVUS. The resolution has improved with high definition-IVUS, true vessel size is much better appreciated on IVUS (Figure 2) compared with OCT for optimal stent selection. The commercially available devices are listed in Table 1.

**Plaque morphological assessment**

Angiographic detection of coronary calcification is as low as 40% (14), but when visible, it corresponds to a greater calcific burden. When compared with anatomical pathology, IVUS has a sensitivity of nearly 90% and
specificity ranging between 97–100% for identifying plaque calcification (15,16). OCT allows for a more precise visualization and image penetration in calcific coronary disease compared with IVUS, given that calcium reflects ultrasound waves. OCT, therefore, enables more accurate information regarding calcium depth and regionality. PCI in extensive calcific coronary disease is challenging and impedes stent expansion in the absence of appropriate plaque modification pre-stenting (17). A calcification arc of >180° and depth >0.5 mm thick are predictive of worse outcomes as a result of stent under-expansion and this finding on intravascular imaging should prompt the operator to consider adjunctive plaque modification strategies (such as cutting/scoring balloons and/or rotational atherectomy).

A Japanese study of 247 patients compared OCT-guided rotational atherectomy with IVUS-guided rotational atherectomy (18). The results demonstrated significantly larger final burr size (1.75 vs. 1.50 mm, P=0.001) and percent stent expansion (83% vs. 72%, P=0.0004) used in the OCT-guided rotational atherectomy cohort compared with the IVUS-guided cohort. However, target lesion revascularization (TLR) rates were similar across the 2 cohorts. Intravascular imaging is essential in calcified coronary lesions and appropriate plaque modification in the form of atherectomy (laser/cutting or scoring balloon/rotational/orbital atherectomy) is crucial in achieving adequate stent expansion.

Coronary intravascular lithotripsy balloons can be effectively used in circumferential calcific disease or in the presence of calcific arcs >270° arc based on OCT (19-22). A three-arm trial (NCT03574636) is currently underway comparing OCT with IVUS with quantitative coronary angiography during PCI for moderate-severely calcified lesions. The primary endpoint of the trial is in-stent late lumen loss (difference between the minimal lumen diameter immediately post PCI and the minimal lumen diameter by angiography review at 13 months post PCI). Figure 2 demonstrates circumferential calcification on OCT and IVUS.

Intravascular imaging using OCT or IVUS has been demonstrated to predict slow flow or no-reflow phenomena and subsequent peri-procedural myocardial infarction prior to stent implantation (23-26). The plaque characteristics predictive of these adverse outcomes included an attenuated plaque suggestive of a large necrotic core on IVUS (27) or acute plaque rupture or thin fibrous cap atheroma (Figure 3). An attenuated plaque with a longitudinal length of more than 5 mm on IVUS was associated with the ability to predict the no-reflow phenomenon (25). In an analysis of 336 individuals with acute coronary syndromes (ACS) (24), echo signal attenuated plaque was independently associated with no-reflow phenomena with an odds ratio of 5.59 (95% CI: 2.64–11.85). Should these higher-risk features be identified on intravascular pre-PCI imaging, additional steps could be considered such as intracoronary enalaprilat (28) or distal filter protection device in an attempt to minimize
Stent selection and optimization

The Multicenter Ultrasound Stenting in Coronaries Study (MUSIC) (30) was the first major trial to provide criteria for bare-metal stent optimization. This included a minimum stent area (MSA) $\geq 90\%$ of the average reference lumen area or $\geq 100\%$ of the smaller reference lumen area; or an MSA $>9 \text{ mm}^2$, with MSA $\geq 80\%$ of average reference lumen area or $\geq 90\%$ of smaller reference lumen. Achievement of these criteria resulted in a reduced incidence of TLR at 6 months. In the drug-eluting stent era, external elastic membrane (EEM) diameters minus 0.5 mm of the distal vessel segment is used to choose the appropriate stent size and the proximal reference vessel diameter is sometimes used as the reference balloon size to post dilate the stent. The AVIO trial (5) suggested the final optimal MSA was based on the IVUS-guided sized balloon area at nominal pressure. Table 2 summarizes the various IVUS stent optimization criteria. OCT-guided stent sizing is evolving and remains somewhat hampered by the difficulty in adequately visualizing the EEM across diseased segments.

Post PCI complications

Only 7% of angiographically normal-appearing vessels truly harbored no plaque on IVUS, and these regions typically contain significant plaque burden masked by the adaptive vessel remodeling response to plaque progression (37). Geographical miss is defined as an angiographically significantly diseased segment or (balloon) injured segment not treated by a stent (38). Geographical miss is linked to stent failure (restenosis and stent thrombosis) (39-41). Stent edge dissections and edge restenosis are frequently linked to greater stent edge plaque burden (>50%) and the presence of calcium/attenuated plaque (2,39,42). A dissection seen on IVUS resulting in a lumen area of <5.0 mm$^2$, with a length >3 mm and an arc $>60^\circ$ is significantly associated with the need for TLR (2) (Video 1). Based on the OCT literature, a distal edge dissection $>200 \mu$m and an MLA $<4.5 \text{ mm}^2$ are linked with adverse clinical outcomes (43). On OCT, a lipid arc of $185^\circ$ and an MLA $<4.1 \text{ mm}^2$ were related to edge restenosis (44). An untreated major dissection, characterized by an arc $>60^\circ$ or 3 mm in length, was less likely to be found in the OCT-guided PCI cohort compared with IVUS-guided cohort (45). Owing to its greater resolution, OCT enhances the ability to detect post-PCI complications such as major dissections and geographical miss, compared with IVUS.

Intravascular imaging and stent under expansion

A smaller post-PCI MSA (or stent under-expansion) is an independent predictor of poor outcomes, especially stent failure (thrombosis and restenosis) (43,46,47). In the non-left main segments, the optimal MSA cutoff on IVUS for most drug-eluting stents ranges between 5.3 to 5.7 mm$^2$ (48-50). Similarly, based on a large OCT registry of 786 patients, the MSA cutoff value of 5.0 mm$^2$ for drug-eluting stents was an independent predictor of major adverse cardiac events and TLR (51). Another analysis of 832 patients demonstrated that MSA values $<4.5 \text{ mm}^2$ on OCT were independently
associated with major adverse cardiac events (43).

**Impact of intravascular imaging on clinical outcomes**

Meta-analyses of randomized trials and registry data have shown significant major adverse cardiovascular event (MACE) reductions with IVUS-guided PCI compared with conventional angiography-guided PCI (52-55). The IVUS-XPL trial (56) was a randomized study comparing IVUS-guided PCI with conventional angiography in 1,400 patients with lesions ≥28 mm in length that were treated with XIENCE (Abbott Vascular, Santa Clara, California) stents. At 5 years follow-up (56), MACE reductions were significant with a hazard ratio of 0.50 (95% CI: 0.34−0.75) in the IVUS-guided PCI cohort compared with conventional angiography. This was mainly driven by lower rates of TLR. A recent meta-analysis of 5,532 patients from 11 clinical trials showed statistically significant reductions in cardiovascular mortality (OR: 0.45, 95% CI: 0.25–0.80), TLR (OR: 0.56, 95% CI: 0.41–0.77) and stent thrombosis (OR: 0.47, 95% CI: 0.24–0.94) with IVUS-guided PCI compared with conventional angiography (52). In another meta-analysis, IVUS was particularly beneficial in complex coronary lesions such as left main disease, bifurcations, ACS and chronic total occlusions (CTO) (57). Figure 4 shows forest plots demonstrating cardiovascular mortality reduction in left main as well as non-left main lesions with IVUS-guided PCI in comparison with conventional angiography.

**IVUS and OCT: head to head comparison**

Bezerra et al. (12) assessed 100 frequency-domain OCT/IVUS pull backs in stented (n=44), and native vessels (n=56). OCT depicted more severe native coronary disease compared with IVUS (MLA OCT 2.33±1.56 mm² IVUS 3.32±1.92 mm², P<0.001). Reference vessel diameters and post-PCI MSA were similar across the OCT and IVUS pull backs. OCT was better at detecting neointimal hyperplasia, post-PCI malapposition and tissue prolapse compared with IVUS. The OPUS-CLASS study (58) performed a core laboratory analysis of IVUS and OCT studies on 100 patients with coronary artery disease. The MLA was significantly larger on IVUS compared with OCT (3.68±2.06 vs. 3.27±2.22 mm², P<0.001). There was strong correlation (r=0.95, P<0.001) observed among the two intravascular imaging modalities with good interobserver reproducibility.

### Table 2 IVUS stent optimization criteria

<table>
<thead>
<tr>
<th>Criterion</th>
<th>TULIP criteria (31)</th>
<th>AVID criteria (32)</th>
<th>MUSIC criteria (30,33)</th>
<th>RESIST criteria (34)</th>
<th>BEST criteria (35)</th>
<th>AVIO criteria (36)</th>
</tr>
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<tbody>
<tr>
<td>Complete stent apposition</td>
<td>MLA ≥90% of distal minimal vessel lumen CSA</td>
<td>Complete stent apposition</td>
<td>Complete stent apposition</td>
<td>IVUS criteria for crossover to stent: &gt;30% stenosis or MLA &lt;6 mm²</td>
<td>Stent CSA&gt;80% of the mean proximal and distal reference vessel CSA</td>
<td>2.25/3.5; 2.5/4; 3/6; 3.5/8; 4/10; 4.5/12;</td>
</tr>
<tr>
<td>MLD ≥80% of the mean of proximal and distal reference diameters</td>
<td>Complete stent apposition</td>
<td>MLA≥90% of the average reference lumen area or ≥100% of the lumen area of the reference segment with the lowest lumen area. MLA &gt;9.0 mm². MLA ≥80% of the average reference lumen area or ≥90% of the lumen area of the reference segment with the lowest lumen area</td>
<td>Symmetric stent expansion</td>
<td></td>
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</tr>
<tr>
<td>MLA ≥ distal reference lumen area</td>
<td>Dissections covered by the stent</td>
<td>Symmetric stent expansion</td>
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IVUS, intravascular ultrasound.
Figure 4 Forest plot demonstrating a reduction in cardiovascular death with IVUS PCI in contrast to conventional angiography in the left main and non-left main lesions. IVUS, intravascular ultrasound; PCI, percutaneous coronary intervention.

The ILUMIEN II study (59) assessed stent expansion across a 286 propensity-matched pairs (IVUS and OCT). Stent expansion was similar across the IVUS- and OCT-guided PCI cohorts. OCT was better at detecting stent malapposition, tissue protrusion, and edge dissections compared with IVUS. Habara et al. (60) published a randomized clinical trial comparing OCT-guided PCI to IVUS-guided PCI in 70 patients with de novo coronary lesions. There were no differences in procedural time and contrast volume between IVUS- or OCT-guided PCI. The MSA attained post-PCI was significantly larger with IVUS compared with the OCT-treated group. This was likely driven by suboptimal visualization of the EEM with OCT resulting in angiographic-equivalent sizing of the vessel in 40% of the cases.

The OPINION trial (61) was a randomized study of 829 patients that compared OCT with IVUS-guided PCI. For those randomized to the OCT-guided PCI group, the distal reference lumen diameter was used whereas the IVUS-guided PCI cohort used the distal EEM measurement for stent selection and optimization. As a result, the IVUS-guided PCI arm had a significantly larger stent diameter compared with the OCT arm (2.99 vs. 2.92 mm, P=0.005). The incidence of target vessel failure was not different among the two cohorts. ILUMIEN III (45) was a prospective multicenter non-inferiority trial that randomized 450 patients to IVUS-guided PCI, OCT-guided PCI and conventional angiography-guided PCI. The primary efficacy endpoint was post-PCI MSA and the primary safety endpoint was peri-procedural MACE. This trial introduced a novel OCT criterion based on the EEM measurements. The EEM diameter of the distal vessel was used if the EEM circumference is visible beyond 180° (rounded down by 0.25 mm to the closest stent platform size). If not, the mean distal vessel lumen diameter was used to select the appropriate stent. Coronary artery tapering was considered in the OCT stent optimization criteria, and the stented section was split into proximal and distal segments. Acute procedural success was classified into optimal and acceptable. Optimal stent expansion was defined as the “MSA of the proximal segment being ≥95% of the proximal reference lumen area, with the MSA of the distal segment being ≥95% of the distal reference lumen area” (45). Acceptable stent expansion was defined as the “MSA of the proximal segment being ≥90% of the proximal reference lumen area, and the MSA of the distal segment being ≥90% of the distal reference lumen area” (45). With these criteria, OCT was found to be non-inferior to IVUS.
for the primary safety/efficacy endpoint. Major dissection and stent malapposition (Figure 5) were lower in the OCT arm compared with IVUS and conventional angiography.

Recently a small study of 29 patients (29 lesions) performed 60-MHz high definition IVUS and OCT before and after PCI. There was a greater correlation between high definition-IVUS and OCT concerning lumen area measurement before and after PCI. Pre-PCI, HD-IVUS was superior to OCT for EEM visualization, and OCT was superior in detecting plaque rupture or thrombus compared with HD-IVUS. Post PCI, OCT was better than HD-IVUS in identifying tissue protrusion, stent edge dissection, and acute stent malapposition. The OCTIVUS trial (NCT03394079) is currently underway comparing OCT with IVUS-guided PCI. The primary endpoint of this trial is target vessel failure at 1 year.

**IVUS superior to OCT**

**Left main and ostial disease**

The European Society of Cardiology 2018 guidelines offer a Class IIa recommendation for IVUS assessment of indeterminate left main coronary artery (LMCA) lesions (63). A minimal lumen area (MLA) <6 mm$^2$ correlates with a fractional flow reserve of less than 0.75 (64,65). Amongst Asians, this MLA cut-off appears lower at around 4.5–4.8 mm$^2$ (66). It is essential to perform IVUS pullbacks across the LMCA bifurcation (both LAD and LCx branches) to accurately classify the distal left main bifurcation based on plaque distribution (67). Identifying susceptible carina and substantial ostial calcification is crucial to prevent side branch loss (68,69). An appropriate bifurcation stent strategy should then be undertaken based upon plaque distribution. The LMCA ostium can be marked by IVUS and can be imaged in a coaxial fashion with guide catheter disengagement. This holds good for any aorto-ostial lesion. OCT is suboptimal for adequate visualization of aorto-ostial lesions due to inadequate blood clearance. Iatrogenic aortocoronary ostial dissections are uncommon but a fatal complication of coronary angiography (70). Following an iatrogenic coronary artery dissection, contrast injections should be avoided and IVUS should be performed to confirm the distal wire position in the true lumen as well as the extent of the dissection (71-73). Video 2 is an IVUS pullback that confirms the wire position in the false lumen.

A randomized trial (74) of over 300 patients demonstrated a substantial reduction in cardiac mortality with IVUS-guided LMCA PCI when compared with conventional angiography. Subsequently, a meta-analysis (75) of nearly 4,500 patients showed that IVUS-guided LMCA PCI was superior to conventional angiography with a significant reduction in major adverse cardiac events, all-cause mortality, cardiac mortality, myocardial infarction, and stent thrombosis. A Swedish Registry (76) of over 2,400 patients with 25% IVUS use confirmed IVUS-guided LMCA PCI...
was associated with a considerable MACE reduction at 10 years (HR: 0.65, 95% CI: 0.50–0.84) compared with conventional angiography. In Asians, in-stent restenosis rates are lower if the minimal stent area (MSA) post LMCA PCI is more than 5.0 mm² (for the ostial left circumflex), 6.0 mm² (ostial left anterior descending), >7.0 mm² (polygonal of confluence), and >8.0 mm² (left main body) (48). For non-Asians it would be reasonable to add 0.5 mm to these cut-offs. There is currently no literature supporting the use of OCT in LMCA disease. The ILUMIEN III: OPTIMIZE PCI trial (45) excluded left main or ostial right coronary artery stenosis, highlighting the limitation of OCT.

**CTO and complex disease**

IVUS has established itself in the realm of CTO PCI. IVUS has been used as an adjunct tool to cross an ambiguous cap or flush occlusion of a large epicardial vessel. IVUS confirms the wire position after successful entry. In addition, IVUS can assess plaque morphology, burden and appropriate landing zones (77). IVUS-guided cap puncture and redirection during antegrade wire escalation and dissection reentry, respectively cannot be replaced by OCT. IVUS also identifies the appropriate balloon size and a calcium-free zone to perform reverse controlled antegrade and retrograde tracking (78). Lastly, there is evidence to suggest that IVUS-guided CTO intervention is associated with lower rates of stent thrombosis, myocardial infarction, and TLR when compared with conventional angiography (79,80).

Similarly, IVUS has also been proven to be beneficial in optimizing outcomes in bifurcations and complex coronary lesions (81). On the other hand, the role of OCT is currently being studied to assess stent apposition/complex histopathological remodeling after CTO PCI (82,83), as well as for optimizing bifurcation stenting (84,85). Multiple Japanese studies have been published so far that have utilized OCT to meticulously find and prove distal stent strut passage of guidewire during bifurcation stenting for optimal strut configuration (86-89). This technique is promising and helps to achieve symmetric stent expansion; however, in practice it is time-consuming requiring multiple runs of OCT increasing contrast administration (85).

**Renal dysfunction**

Contrast-induced nephropathy after PCI is a poor prognostic factor and often delays discharge resulting in greater resource utilization and hospitalization costs (90). IVUS is a contrast-sparing modality and is particularly useful in advanced chronic kidney disease (91-93) and valuable in the context of contrast allergy (94). IVUS-guided minimum-contrast PCI significantly lowers contrast use, risk of contrast-induced nephropathy, and the need for dialysis (91,92,95,96). Residual kidney function in patients on dialysis is linked to better quality life, supporting the benefit of IVUS over OCT in this high-risk population for PCI optimization (97). Patients with end-stage renal failure harbor often heavily calcified plaque and thus require plaque modification (i.e., rotational atherectomy) (19). Zero-contrast PCI in calcified lesions facilitated by rotational atherectomy can be safely accomplished in this group (98). The use of dextran instead of contrast to perform OCT (11,99) has been reported in the literature to prevent contrast-induced acute kidney injury.

**Advantages of OCT**

**Stent failure**

Intravascular imaging plays a crucial role in understanding the mechanism of stent failure. Stent under-expansion is a major cause of stent failure (100,101). Neointimal calcification is found in circa 20% of the cases with in-stent restenosis and owing to its greater imaging resolution, OCT is generally superior in visualizing these changes compared with IVUS. An OCT registry consisting of 40% bare-metal stents and 60% drug-eluting stents accurately defined the mechanism of 23 definite stent thromboses and 97 late or very late stent thromboses (102). Definite stent thrombosis was attributed to stent malapposition (48%), severe stent under-expansion (26%), and distal edge dissection (8%). These findings were similar to previously published IVUS data (41). Late or very late stent thrombosis etiologies include stent malapposition (Figure 5) (32%), ruptured neatherosclerosis (28%), evagination (10%), uncovered stent struts (10%), stent edge-related disease progression (8%), and severe stent under-expansion (7%). Tissue protrusion is a common phenomenon following stenting; more likely to occur in patients presenting with an ACS. Tissue protrusion indicates larger stent expansion when seen on IVUS. It is typically not associated with worse outcomes unless there is lumen compromise that could lead to stent thrombosis (41,103). On OCT, asymmetrical tissue protrusion has been linked to target vessel failure (51).

Acute stent malapposition is twice more likely to be detected on OCT compared with IVUS (58). Malapposed stents, irrespective of the degree and despite adequate
stent expansion, are associated with worse short- and long-term outcomes (41,43,51,104,105). Late-acquired stent malapposition is a phenomenon attributed to positive vessel remodeling with or without thrombus resolution. Very late stent thrombosis has been linked to late-acquired stent malapposition (106). As IVUS can evaluate the vessel wall in its entirety, it is commonly the preferred modality for detecting late-acquired stent malapposition. On the other hand, OCT is superior to IVUS for detecting neoatherosclerosis, and incomplete tissue coverage/uncovered stent struts (102,107). Intravascular imaging with OCT (108) helped to ascertain the cause of stent thrombosis in over 30% more cases compared with conventional angiography alone. Figure 6 demonstrates multiple layers of stent on OCT with severe in-stent restenosis and neointimal hyperplasia.

**Diagnostic dilemmas**

Myocardial infarction with non-obstructive coronary arteries (MINOCA) is a common clinical presentation and often perplexing (109). No clear etiology is often identified for MINOCA; however, this entity carries a 1-year mortality rate of nearly 5% (110). OCT helps to exclude thin-cap fibroatheroma/plaque rupture and thrombus or spontaneous coronary artery dissection (SCAD) as potential substrates for MINOCA (111). In a prospective study of 38 MINOCA patients, OCT and cardiac magnetic resonance imaging were performed to identify the infarct-related artery (111). The mean age of the cohort was 62 years consisting predominantly of women (55%), and over one-third of them presented with ST-segment elevation. Plaque disruption and thrombus was present in 42% of the patients and could be linked to the location of the ischemic-type myocardial injury on cardiac magnetic resonance imaging.

**Safety and cost-effectiveness**

The incidence of complications in a large series of intravascular imaging-guided procedures (1,142 OCT and 2,476 IVUS procedures) (112) was around 0.5%. This included transient ST-elevation (OCT =0.26% and IVUS =0.08%), bradycardia (OCT =0.18% and IVUS =0.04%), coronary spasm (OCT =0.09% and IVUS =0.04%), thrombus formation (OCT =0.09% and IVUS =0.16%), dissection (OCT =0% and IVUS =0.12%), and stent deformation (OCT =0% and IVUS =0.04%). Most of these complications were self-limiting following imaging catheter removal. There were no IVUS or OCT-related mortalities (112). IVUS is a cost-effective strategy (54,113) at one year. This economic impact is even greater in individuals with renal dysfunction, diabetes, and ACS. The health-economic impact continues to be seen with the use of second-generation drug-eluting stents at 1- and 2-year post PCI (6,114). The 5-year results of the IVUS-XPL trial (56) further support the health-economic impact of IVUS.
Conclusions

Intravascular imaging plays an important role in contemporary PCI for optimizing stent and patient-oriented outcomes. IVUS and OCT are based on differing imaging principles, yet each harbor unique advantages according to the specific clinical situation at hand. IVUS is superior in the diagnosis and management of patients with LMCA disease, renal dysfunction, aorto-coronary ostial lesions, and CTO. The visualization of the EEM with IVUS enables one to acquire a larger MSA compared with OCT. OCT is a relatively newer technology with superior image resolution to IVUS, with an emerging evidence-base outlining its use. OCT is superior to IVUS in assessing the etiology of stent failure, calcific coronary disease, and MINOCA. Ultimately, the relevant intravascular imaging modality should be chosen appropriately to cater to the needs of the specific patient during cardiac catheterization, based upon the clinical context and comorbidities.

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References


46. Moussa I, Moses J, Di Mario C, et al. Does the specific intravascular ultrasound criterion used to optimize stent expansion have an impact on the probability of stent restenosis? Am J Cardiol 1999;83:1012-7.


111. Opolski MP, Spiewak M, Marczak M, et al. Mechanisms of Myocardial Infarction in Patients With Nonobstructive Coronary Artery Disease: Results From the Optical Coherence Tomography Study. JACC Cardiovasc Imaging

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