JACC: CARDIOVASCULAR INTERVENTIONS VOL. 3, NO. 8, 2010

ISSN 1936-8798/$36.00
PUBLISHED BY ELSEVIER INC. DOI: 10.1016/j.jcin.2010.04.016

Outcomes of Percutaneous Coronary Intervention in Intermediate Coronary Artery Disease

Fractional Flow Reserve–Guided Versus Intravascular Ultrasound–Guided

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Objectives This study sought to evaluate the long-term clinical outcomes of a fractional flow reserve (FFR)–guided percutaneous coronary intervention (PCI) strategy compared with intravascular ultrasound (IVUS)–guided PCI for intermediate coronary lesions.

Background Both FFR- and IVUS-guided PCI strategies have been reported to be safe and effective in intermediate coronary lesions.

Methods The study included 167 consecutive patients, with intermediate coronary lesions evaluated by FFR or IVUS (FFR-guided, 83 lesions vs. IVUS-guided, 94 lesions). Cutoff value of FFR in FFR-guided PCI was 0.80, whereas that for minimal lumen cross sectional area in IVUS-guided PCI was 4.0 mm^2. The primary outcome was defined as a composite of major adverse cardiac events including death, myocardial infarction, and ischemia-driven target vessel revascularization at 1 year after the index procedure.

Results Baseline percent diameter stenosis and lesion length were similar in both groups (51 ± 8% and 24 ± 12 mm in the FFR group vs. 52 ± 8% and 24 ± 13 mm in the IVUS group, respectively). However, the IVUS-guided group underwent revascularization therapy significantly more often (91.5% vs. 33.7%, $p < 0.001$). No significant difference was found in major adverse cardiac event rates between the 2 groups (3.6% in FFR-guided PCI vs. 3.2% in IVUS-guided PCI). Independent predictors for performing intervention were guiding device: FFR versus IVUS (relative risk [RR]: 0.02); left anterior descending coronary artery versus non-left anterior descending coronary artery disease (RR: 5.60); and multi- versus single-vessel disease (RR: 3.28).

Conclusions Both FFR- and IVUS-guided PCI strategy for intermediate coronary artery disease were associated with favorable outcomes. The FFR-guided PCI reduces the need for revascularization of many of these lesions. (J Am Coll Cardiol Intv 2010;3:812–7) © 2010 by the American College of Cardiology Foundation

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Manuscript received January 13, 2010; revised manuscript received March 12, 2010, accepted April 17, 2010.

Because of the limitations of coronary angiography (1), adjunctive techniques to more accurately evaluate lesion severity are important in patients with intermediate coronary stenosis before percutaneous coronary intervention (PCI). Fractional flow reserve (FFR) has been the reference standard for the physiological assessment of coronary artery stenosis, particularly intermediate ones (2–4). Deferring intervention of intermediate coronary lesions with a FFR ≥0.75 or 0.80 is associated with favorable long-term clinical outcomes (5,6). An intravascular ultrasound (IVUS)–

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derived minimal lumen area (MLA) ≤4.0 mm^2, or minimal lumen diameter ≤1.8 mm have been shown to correlate with a FFR <0.75 (7), and deferring intervention in intermediate coronary lesions based on MLA ≥4.0 mm^2 results in favorable clinical outcomes (8). However, there are few studies that compared FFR- and IVUS-guided coronary intervention strategies in patients with de novo coronary intermediate lesions. The aim of this study was to evaluate the clinical outcomes of a FFR- versus IVUS-guided PCI strategy for intermediate coronary lesions.

Methods

Patient population and study design. The patient population consisted of 167 consecutive patients (177 lesions) who underwent FFR or IVUS assessment to decide whether to perform PCI or not for de novo intermediate coronary lesions between August 2006 and June 2008. An intermediate coronary lesion was defined as 40% to 70% diameter stenosis by visual assessment. For this study, the target vessel was a single lesion in the proximal or mid part of a major epicardial coronary artery with reference vessel diameter larger than 2.5 mm. The lesion had no documented evidence of ischemia by noninvasive tests (not performed, negative, inadequate, or not evaluable for a target lesion). Patients were not eligible for enrollment if they: 1) had undergone intervention in the setting of primary or emergent PCI for an acute coronary syndrome; 2) had prior coronary artery bypass graft surgery; 3) had multiple lesions in the same epicardial artery; 4) had left main disease, primary myocardial disease, or a major life threatening illness; or 5) had contraindications to adenosine, aspirin, or clopidogrel.

The use of FFR or IVUS was made based on operator preference. The cutoff value of FFR in the FFR-guided PCI group was 0.80 (6,9,10) and that of MLA in the IVUS-guided PCI was 4.0 mm^2 (7,8). Implanted stents were commercially available drug-eluting stents (DES) in all cases.

Procedural details. Coronary angiography was performed in multiple views after the intracoronary injection of 0.2 mg nitroglycerin. Percutaneous coronary intervention was performed following standard interventional techniques. Antiplatelet and antithrombotic agents were prescribed according to current PCI guidelines (3). All coronary angiograms were analyzed using standard definitions and measurements by quantitative coronary angiography (Quantcor QCA, version 4.0, Pie Medical Imaging, Maastricht, the Netherlands) by an experienced physician who was blinded to the type of PCI guidance.

Fractional flow reserve was defined as the ratio between mean distal coronary pressure and mean aortic pressure, both measured simultaneously at maximal hyperemia. Coronary pressure was measured using a 0.014-inch sensor-tipped PCI guidewire (Pressure Wire, Radi Medical Systems, Uppsala, Sweden). The wire was introduced through a 6- or 7-F guiding catheter, equalized, and advanced distal to the stenosis as previously described (9). The FFR value was checked after administration of adenosine to induce maximal hyperemia, either intravenously (140 μg/kg/min) or intracoronarily (40 μg in the right, 80 μg in the left coronary artery).

Abbreviations and Acronyms

DES = drug-eluting stent(s)
FFR = fractional flow reserve
IVUS = intravascular ultrasound
LAD = left anterior descending coronary artery
MACE = major adverse cardiac event
MLA = minimal lumen area
PCI = percutaneous coronary intervention
TVR = target vessel revascularization

Intravascular ultrasound guidance was performed using conventional 6- or 7-F guiding catheters and a 0.014-mm guidewire positioned distally, and IVUS catheters of 30 or 40 MHz (Boston Scientific Corp., Natick, Massachusetts) pulled back automatically at a constant speed of 0.5 mm/s. The lesion site selected for analysis was the image slice with MLA and minimal stent area, which were measured following the guidelines for IVUS measurements by the American College of Cardiology (11).

Definitions and study outcomes. The primary outcome was defined as a composite of major adverse cardiac events (MACE), defined as death, myocardial infarction, and ischemia-driven target vessel revascularization (TVR) at 12 months after the index procedure. Death was defined as all-cause mortality. The diagnosis of myocardial infarction was based on either the development of new pathological Q waves in ≥2 contiguous electrocardiogram leads and/or cardiac enzyme level elevation >3 times the upper limit of normal value. TVR included target lesion PCI and bypass surgery of the target lesion. TVR was performed only in the presence of symptoms and/or signs of ischemia. Stent thrombosis was defined according to the Academic Research Consortium guidelines (12).

Statistical analyses. Data are expressed as mean ± SD for continuous variables and as percentages for discrete vari-