Angiographic Patterns of Restenosis After Paclitaxel-Eluting Stent Implantation

To the Editor: Polymer-based paclitaxel-eluting stents (PES) (Taxus, Boston Scientific, Natick, Massachusetts) have been shown to reduce neointimal hyperplasia and risk of restenosis (1,2). Operators are now using drug-eluting stents for a wide variety of clinical and anatomical situations, many of which have not been investigated in randomized studies.

The clinical and morphologic features of restenosis after PES implantation have not been adequately evaluated (1,2). The purpose of this study was to describe the angiographic patterns of restenosis after PES implantation in “real-world” patients. This knowledge may help in finding the solution to this important problem.

We identified 977 consecutive patients who underwent PES implantation (977 procedures, 1,688 lesions, 2,023 stents) in three institutions between April 2002 and March 2004. Patients that had in-stent restenosis (ISR) lesions treated, prior brachytherapy at the target vessel, or acute myocardial infarction <48 h before the index procedure were excluded. All patients were pretreated with ticlopidine or clopidogrel and aspirin; a loading dose of 300 mg clopidogrel was given to patients not previously taking the agent. Aspirin was continued indefinitely and clopidogrel or ticlopidine for at least six months after PES implantation. Glycoprotein IIb/IIIa inhibitors were administered at the operators’ discretion.

During follow-up, coronary angiograms were obtained as clinically driven (>30 days after procedure, indicated by symptoms or positive ischemic tests). In addition, follow-up angiograms were obtained at 6 ± 1 month in patients treated with PES implantation for bifurcations, left main, chronic total occlusions, small vessels, and long stented length (>36 mm). Cineangiograms were analyzed using a validated edge detection system (CMS, version 5.2, MEDIS, Leiden, the Netherlands). Standard qualitative and quantitative analyses and definitions were used (3). Angiographic success was defined as a minimum stenosis diameter <20% after stenting. For the current study, ISR cases were categorized according to Mehran classification (4).

Baseline demographics, lesion, and procedural characteristics are shown in Table 1. Twenty-six percent of the patient population had diabetes and 78% of the lesions were complex (B2 or C type). In addition, 19% of the lesions were bifurcational and 7.9% were total occlusions. All patients had successful PES implantation, and there was no angiographic evidence of any residual dissection after PES implantation. The mean stent per lesion ratio was 1.23, and glycoprotein IIb/IIIa inhibitors were used in 40% of the patients.

To date, all 977 patients have completed >6 months from the index procedure. At a mean follow-up of 10.5 ± 3.6 months, the rates of target lesion revascularization, target vessel revascularization (TVR) and major adverse cardiac events (death, myocardial infarction, or TVR) were 7.2%, 10.3%, and 11.4%, respectively. A follow-up coronary angiogram was obtained in 576 patients (59%) (747 lesions), and in 201 patients (35%) the angiogram was clinically driven. Among these, ISR was identified in 81 patients and 98 lesions. The mean baseline reference vessel diameter was 2.60 mm. Mean baseline lesion length was 14.10 ± 10.12 mm, and restenotic lesion length was 9.96 ± 6.07 mm (range 2.18 to 26.18 mm), which corresponds to 29% reduction.

Restenosis was found in the body and the edges in 71 lesions (72%), in the edges only in 16 lesions (16%), and in the body of the stent only in 11 lesions (11%). A schematic representation of the patterns of ISR is shown in Figure 1. The pattern of ISR in 49 lesions (50%) was focal (≤10 mm in length) or multifocal (12% of the focal lesions). In the remaining 49 lesions (50%), the pattern of ISR was non-focal: diffuse ISR (>10 mm in length) in 28 lesions.

Table 1. Baseline Demographics, Lesion and Procedural Characteristics, and Pre- and Post-Intervention Angiographic Analysis

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>PES</th>
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<tbody>
<tr>
<td>Procedure (n)</td>
<td>977</td>
</tr>
<tr>
<td>Maximum balloon diameter (mm)</td>
<td>3.04 ± 0.51</td>
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<tr>
<td>Maximum balloon inflation (atm)</td>
<td>15.9 ± 3.5</td>
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<tr>
<td>Stent length per lesion (mm)</td>
<td>27.45 ± 12.56</td>
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<tr>
<td>Stents per lesion</td>
<td>1.23 ± 0.55</td>
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<tr>
<td>Glycoprotein IIb/IIIa inhibitors (%)</td>
<td>40</td>
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<td>Quantitative coronary angiography</td>
<td></td>
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<tr>
<td>Lesions (n)</td>
<td>1,688</td>
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<tr>
<td>Preintervention</td>
<td></td>
</tr>
<tr>
<td>RVD (mm)</td>
<td>2.60 ± 0.70</td>
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<tr>
<td>MLD (mm)</td>
<td>0.96 ± 0.25</td>
</tr>
<tr>
<td>DS (%)</td>
<td>66 ± 18</td>
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<tr>
<td>Lesion length (mm)</td>
<td>14.10 ± 10.12</td>
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<tr>
<td>Post-intervention</td>
<td></td>
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<tr>
<td>MLD (mm)</td>
<td>2.73 ± 0.62</td>
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<tr>
<td>DS (%)</td>
<td>13 ± 11</td>
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</tbody>
</table>

Values are presented as numbers (relative percentages) or mean ± SD.

DS = diameter stenosis; MLD = minimal lumen diameter; PES = paclitaxel-eluting stent; RVD = reference vessel diameter; TIMI = Thrombolytic In Myocardial Infarction.
involved in the stent edges and more frequently the proximal than the distal border. Diffuse proliferative ISR and ISR with total occlusions are the predominant patterns when non-focal ISR occurs.

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REFERENCES


Letters to the Editor

Rescue Angioplasty—The MERLIN Trial

Some of the issues raised by Drs. Grines and O’Neill in their editorial in JACC (1) accompanying the Middlesbrough Early Revascularization to Limit Infarction (MERLIN) trial report (2) should be addressed.

Before the trial initiation, we estimated 18% mortality in the conservative group and 6% in the rescue group, as described in the statistical methods section. This may have been optimistic, but was based upon a careful literature search. Power calculations cannot be