Sex differences in long-term outcomes of coronary patients treated with drug-eluting stents at a tertiary medical center

Nicolas W Shammas  
Gail A Shammas  
Michael Jerin  
Peter Sharis  
Midwest Cardiovascular Research Foundation, Davenport, IA, USA

**Background:** Limited data exist on contemporary sex-related differences in long-term outcomes of coronary patients receiving drug-eluting stents. In this study we evaluate differences for males (M) and females (F) in 2-year target lesion failure (TLF) in an unselected consecutive series of patients treated with everolimus-eluting stents (EES) and paclitaxel-eluting stents (PES) at a tertiary medical center.

**Methods:** Data on 348 consecutive patients (M 221, F 127) stented with EES and PES were retrospectively analyzed. The primary end point of the study was to compare sex-related outcomes in TLF, defined as the combined end point of cardiac death, nonfatal myocardial infarction, and target lesion revascularization (TLR). Secondary end points included TLR, target vessel failure, target vessel revascularization, acute stent thrombosis as defined by the Academic Research Consortium, and cardiac death. The cineangiograms of the first consecutive 162 patients (M 105, F 57) were independently reviewed by a cardiologist blinded to clinical outcome, and SYNTAX scoring was performed. Follow-up was achieved using medical records and/or phone calls and was censored at 2 years. Descriptive analysis was performed on all variables. Univariate analysis compared the M and F cohorts. Multivariate analysis using Cox regression was performed to determine independent predictors of TLF with time, including sex as an independent variable in the model.

**Results:** M had more prior percutaneous coronary interventions and restenotic lesions and a higher prevalence of smoking. They also had longer length of disease and received more stents than F. M were older and had a higher prevalence of prior stroke. Angiographic complexity was not statistically different between the two groups, as judged by SYNTAX scoring (M 20.8±13.8, F 19.7±13.9, P=0.650). At 2-year follow-up, TLF was 27.4% and 24.8% (P=0.614) with no statistical difference between TLR (23.3% versus [vs] 21.6%), cardiac death (2.8% vs 3.2%), and definite and probable stent thrombosis (2.3% vs 0.0%) in M and F, respectively. Cox regression analysis using backward elimination showed that the number of stents per patient was the only independent predictor of TLF with time (hazard ratio 1.201, 95% confidence interval 1.126–1.280, P=0.001).

**Conclusion:** In this cohort of patients receiving EES and PES, M and F did not have statistically different outcomes at 2-year follow-up, consistent with recent reports in the current era of percutaneous coronary interventions.

**Keywords:** coronary stent, drug-eluting stent, outcome, target lesion revascularization, sex, woman, man, stent thrombosis

**Introduction**

Prior to the era of drug-eluting stents (DES), several reports indicated that female sex is an independent predictor of adverse events after percutaneous coronary interventions (PCIs).1–3 This difference between males (M) and females (F) in long-term outcomes...
seem to have diminished recently. Several reports suggest that female sex, after adjusting for various clinical and procedural variables, does not appear to independently predict adverse late outcome after PCI. To the contrary, other reports have continued to indicate that female sex predicts an increased risk of major adverse events and target lesion revascularization (TLR), even in the era of modern PCIs.

In this report we examine our own data for differences between M and F in target lesion failure (TLF) in an unselected consecutive series of patients treated with everolimus-eluting stents (EES) and paclitaxel-eluting stents (PES) and followed for at least 2 years at our medical center, the Genesis Medical Center, Davenport, IA, USA.

Methods
Unselected consecutive patients treated with the PES Taxus® Liberté® (Boston Scientific, Natick, MA, USA) (n=159) and the EES Xience V® (or Promus®) (Abbott Laboratories, Abbott Park, IL, USA) (n=189) were retrospectively recruited from a single center from October 2008 to September 2009. An earlier manuscript has been published from this data by our group. As we have previously described, “Patients who received mixed stents during the index procedure or bypass graft treatment were excluded. The choice of the drug eluting stent was left to an individual operator.” All patients were treated using a femoral approach. Intravascular ultrasound was not used to verify stent apposition and expansion. The majority of patients received unfractionated heparin (82.5%) and the remaining bivalirudin (17.5%) during PCI. The use of glycoprotein IIb/IIIa inhibitors (eptifibatide and abciximab) was in <5% of patients. Demographics, clinical, procedural, and angiographic variables are shown in Tables 1 and 2. Angiographic variables (including ejection fraction from left ventriculography) were obtained by an independent blinded review of the angiograms to patients’ clinical variables and outcomes. Treated length included the entire stented segment rather than just lesion length. SYNTAX scoring was conducted on the first 162 patients (M 105, F 57) (46% of patients and consecutively) with statistically near identical results. Therefore, scoring the remaining patients would not likely have altered this conclusion.

Complete follow up on all patients was achieved at 2 years from index procedure using phone calls, medical records or both. The Institutional Review Board at our medical center approved the protocol. A verbal consent was obtained from patients by a phone call after they have been mailed a letter describing the protocol. A standardized script was used to obtain history from patients. “Patients who died during the follow up period had their death certificates retrieved to verify the cause of death.”

Table 1 Demographic and clinical variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Female</th>
<th>n</th>
<th>Male</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>127</td>
<td>68.6±12.5</td>
<td>219</td>
<td>65.0±11.1</td>
<td>0.007</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>125</td>
<td>30.4±7</td>
<td>220</td>
<td>31.0±6.6</td>
<td>0.469</td>
</tr>
<tr>
<td>NYHA class for failure on presentation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No dyspnea</td>
<td>126</td>
<td>79.4</td>
<td>220</td>
<td>80.9</td>
<td></td>
</tr>
<tr>
<td>Class I: dyspnea with high level of activity</td>
<td></td>
<td>5.6</td>
<td></td>
<td>7.7</td>
<td></td>
</tr>
<tr>
<td>Class II: dyspnea with regular level of activity</td>
<td></td>
<td>11.9</td>
<td></td>
<td>8.2</td>
<td></td>
</tr>
<tr>
<td>Class III: dyspnea with minimal level of activity</td>
<td></td>
<td>1.6</td>
<td></td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Class IV: dyspnea at rest</td>
<td></td>
<td>1.6</td>
<td></td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Prior percutaneous coronary intervention (%)</td>
<td>127</td>
<td>59.8</td>
<td>220</td>
<td>76.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Prior coronary artery bypass surgery (%)</td>
<td>127</td>
<td>21.3</td>
<td>220</td>
<td>23.1</td>
<td>0.790</td>
</tr>
<tr>
<td>Previous myocardial infarction (%)</td>
<td>127</td>
<td>34.6</td>
<td>221</td>
<td>37.1</td>
<td>0.728</td>
</tr>
<tr>
<td>Family history of premature CAD (%)</td>
<td>126</td>
<td>42.9</td>
<td>216</td>
<td>39.8</td>
<td>0.549</td>
</tr>
<tr>
<td>Renal failure (creatinine ≥2.0 at baseline) (%)</td>
<td>125</td>
<td>8</td>
<td>219</td>
<td>7.8</td>
<td>1.000</td>
</tr>
<tr>
<td>Chronic lung disease (%)</td>
<td>127</td>
<td>14.2</td>
<td>221</td>
<td>14.5</td>
<td>1.000</td>
</tr>
<tr>
<td>Peripheral vascular disease (%)</td>
<td>127</td>
<td>11</td>
<td>221</td>
<td>14.5</td>
<td>0.413</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>127</td>
<td>81.1</td>
<td>221</td>
<td>82.4</td>
<td>0.774</td>
</tr>
<tr>
<td>Cerebrovascular disease (%)</td>
<td>126</td>
<td>7.1</td>
<td>221</td>
<td>1.8</td>
<td>0.017</td>
</tr>
<tr>
<td>Hyperlipidemia (%)</td>
<td>127</td>
<td>94.3</td>
<td>221</td>
<td>89.1</td>
<td>0.240</td>
</tr>
<tr>
<td>Smoking history (%)</td>
<td>127</td>
<td>48.8</td>
<td>220</td>
<td>71.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Diabetes mellitus (%)</td>
<td>127</td>
<td>36.2</td>
<td>220</td>
<td>37.7</td>
<td>0.818</td>
</tr>
<tr>
<td>Clopidogrel at 1-year follow-up (%)</td>
<td>105</td>
<td>85.7</td>
<td>192</td>
<td>84.4</td>
<td>0.866</td>
</tr>
<tr>
<td>Aspirin at 2-year follow-up (%)</td>
<td>103</td>
<td>96.1</td>
<td>179</td>
<td>94.7</td>
<td>0.777</td>
</tr>
</tbody>
</table>

Note: *Data are shown as mean ± SD.

Abbreviations: CAD, coronary artery disease; NA, not applicable; NYHA, New York Heart Association.
The primary outcome of the study was differences between M and F in TLF, defined as cardiac death, nonfatal myocardial infarction (MI) related to target vessel, and TLR. Differences in secondary outcomes (target vessel revascularization [TVR], target vessel failure, acute stent thrombosis as defined by the Academic Research Consortium, nonfatal MI, and cardiac death) were prespecified as secondary end points.

**Statistical analysis**

Descriptive analysis was performed on all variables. Student’s t-test was used for continuous variables and chi-square testing for dichotomous variables. Univariate analysis compared the demographic, clinical, angiographic, and outcome variables between M and F. TLF survival analysis (Kaplan–Meier) was performed for both subgroups. Cox regression analysis using backward elimination showed that the number of stents per patient was the only independent predictor of TLF with time (hazard ratio 1.201, 95% confidence interval [CI] 1.126–1.280, P=0.001). TLF was not statistically different between M and F (hazard ratio 0.815, 95% CI 0.460–1.444, P=0.483) (Figure 1).

**Discussion**

Studies prior to the widespread use of DES suggested that F had a higher in-hospital mortality and poorer outcome, late after PCI, than M. Recent data suggest, however,
that long-term clinical outcomes and post-PCI mortality are unlikely to be different between the sexes.\(^1\)\(^{–}\)\(^15\) The Rapamycin-eluting Stent Evaluated at Rotterdam Cardiology Hospital (RESEARCH) and Taxus Stent Evaluated at Rotterdam Cardiology Hospital (T-SEARCH) studies showed no differences in 3-year outcomes between M and F using rapamycin and paclitaxel DES.\(^5\) Solinas et al.,\(^10\) in a pooled analysis from four randomized trials of sirolimus-eluting versus bare metal stents, analyzed clinical outcomes based on sex. Using multivariate analysis, female sex was not a predictor of clinical outcomes regardless of stent type and despite more comorbidities found in F than in M (older with more frequent presence of diabetes, hypertension, and congestive heart failure). Furthermore, a report from the Blue Cross Blue Shield of Michigan Cardiovascular Consortium PCI registry indicated no difference in mortality between M and F post-PCI.\(^6\) Our data are consistent with these reports showing that in multivariate analysis, female sex is not a predictor of TLF at 2-year follow-up, despite older age and higher rate of strokes on presentation.

A higher rate of TLF was seen in both M and F in our study than was reported by several registries or randomized trials.\(^2\)\(^2\)\(^3\) In SPIRIT IV,\(^21\) TLF was 4.2% and 6.8% for EES and PES, respectively. Furthermore, in Second-generation Everolimus-eluting and Paclitaxel-eluting Stents in Real-life Practice (COMPARE),\(^23\) the primary composite end point of all-cause mortality, MI, and TVR at 1 year occurred in 6% in EES and 9% in PES. Published data from real-world registries\(^24\)\(^25\) also showed a low TLR. In the Percutaneous Coronary Intervention with Second-generation Paclitaxel-eluting Stents Versus Everolimus-eluting Stents in United States Contemporary Practice (REWARDS TLX) multicenter registry,\(^24\) the primary composite end point of all-cause death, Q-wave MI, TVR, and stent thrombosis at 1 year was 7.8% for EES and 10.8% for PES. This is in contrast to our data where TLF and TLR were clinically significantly higher than reported in the literature.

The etiology of higher TLF in our data is unclear, but it is likely related to a higher complexity of disease,\(^26\) including a larger percentage of bifurcating lesions, ostial disease, and left main disease. Also, the number of stents used, as a reflection of the length of disease treated per patient, is considerably high in both sexes, and more so in M than in F. These lesion subsets correlate with higher TLR and adverse event rates. When adjusting for these complex angiographic variables, sex was not a predictor of TLF. Unadjusted TLF occurred in 32.3% for PES versus 21.5% for EES (\(P=0.027\)). However, we have noted no differences in the use of EES versus PES within each sex category (Table 2).

### Conclusion

Our data confirm that PCI is safe and effective in women and that differences between the older studies and those that are more recent reside mostly in adjusting for several variables that are independent of the sex category and that correlate with poorer outcomes after PCI. These factors include age (F present to PCI at an older age than M), time to presentation (F tend to recognize fewer heart attack symptoms),\(^27\) comorbid factors such as diabetes, and anatomic differences (F have smaller coronary arteries than M, a risk factor for TLR).

One of the limitations of this study is its relatively small size and its retrospective design. An unselected consecutive cohort of patients treated with EES and PES has reduced selection bias. Also, there was no statistical difference on cross-analysis between the choice of the DES and sex category. Another limitation of the study is that the two cohorts are not matched on several variables. Logistic
regression analysis was performed, however, to model for these differences and determine the role of sex category as an independent predictor for TLF. Finally, our data are consistent with recently published data on DES showing outcomes were not different statistically between sexes in the current era of post-PCI.

**Disclosure**

The Midwest Cardiovascular Research Foundation (MCRF) has received research and educational grants from Medtronic, Abbott, and Boston Scientific. This paper was supported in part by the Nicolas and Gail Research Fund at MCRF and was presented in part, in abstract form at Cardiovascular Research Technologies 2013, Washington DC, USA.

**References**
