Percutaneous Coronary Intervention Complications and Guide Catheter Size

Bigger Is Not Better

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Objectives We evaluated the association between guiding catheter size and complications of percutaneous coronary intervention (PCI).

Background The association between guiding catheter size and complications of PCI in contemporary practice remains controversial.

Methods Procedure and outcome variables from 103,070 consecutive patients that underwent PCI with 6-F (n = 64,335), 7-F (n = 32,676), and 8-F (n = 6,059) guide catheters were compared.

Results Compared with 6-F guides, PCIs performed with 7- and 8-F guides were associated with incrementally more contrast agent use, and more post-PCI complications including contrast-induced nephropathy, vascular access site complications, bleeding, transfusion, major adverse cardiac event, and death. After multivariate analysis, the use of larger guides were associated with a higher risk of contrast-induced nephropathy (7-F odds ratio [OR]: 1.18, p = 0.0004; 8-F OR: 1.44, p < 0.0001), vascular complications (7-F OR: 1.19, p = 0.0002, 8-F OR: 1.68, p < 0.0001), decline in hemoglobin >3 g/dl (7-F OR: 1.12, p < 0.0001, 8-F OR: 1.72, p < 0.0001), and post-procedure blood transfusion (7-F OR: 1.08, p = 0.03; 8-F OR: 1.80, p < 0.0001), whereas major adverse cardiac events (7-F OR: 1.06, p = 0.13; 8-F OR: 1.37, p < 0.0001) and in-hospital mortality (7-F OR: 1.11, p = 0.13; 8-F OR: 1.34, p = 0.03) were increased with 8-F but not 7-F guides.

Conclusions Compared with 6-F guides, PCIs performed with 7- and 8-F guides were associated with more contrast medium use, renal complications, bleeding, vascular access site complications, greater need for post-procedure transfusion, and 8-F guides with increased nephropathy requiring dialysis, in-hospital major adverse cardiac events, and mortality. These data suggest that selection of smaller guide catheters may result in improved clinical outcome in patients undergoing contemporary PCI. (J Am Coll Cardiol Intv 2009;2:636 – 44) © 2009 by the American College of Cardiology Foundation
Percutaneous coronary intervention (PCI) procedural outcomes and complications have been related to many patient factors (1–6) and procedural (7,8), operator (9), and institutional (10–12) variables. Over the last few years, changes in technology have facilitated the performance of PCI with smaller guiding catheters. However, a number of operators favor larger-sized guiding catheters based on perceived better support and ease of use, and to provide more options to treat complex or bifurcation lesions and to use atheroablative devices. Whether the size of the catheter used during PCI impacts procedural outcomes and complications is unclear. We sought to evaluate the impact of guiding catheter size on PCI associated complications in a multicenter, regional consortium of health care institutions that perform contemporary PCI.

Methods

Study design. The study sample had 103,070 consecutive patients who underwent PCI with 6-, 7-, or 8-F guide catheters, between January 2001 and December 2006 at 21 institutions. The consortium and data collection process have been described previously (13,14). The study was approved by the Institutional Review Board of the University of Michigan and the other local institutional review boards.

Clinical, procedural, and outcome data were collected prospectively on a uniform data form at each participating center. Procedural variables, such as guiding catheter size, and contrast agent volume were collected in all cases. Patient variables such as age, sex, comorbidities, baseline and post-PCI hemoglobin (Hgb) and creatinine were recorded. Outcome measure definitions included were as follows. Nephropathy requiring dialysis was defined as a decrease in renal function requiring peritoneal dialysis or hemodialysis. Contrast-induced nephropathy (CIN) was defined as an increase in serum creatinine ≥ 0.5 mg/dl over baseline. In-hospital death was defined as death from either a cardiac or noncardiac cause. Vascular complications were defined as any vascular complication, including pseudoaneurysm, arteriovenous fistula, femoral neuropathy, retroperitoneal hematoma, any complication requiring surgical repair, and hematoma requiring transfusion, prolonged hospital stay, or causing a drop in Hgb >3.0 g/dl. Periprocedural myocardial infarction (MI) was defined as non–Q-wave MI (any rise in creatinine phosphokinase–myocardial band fraction above the normal at each individual institution within 24 h of PCI without new Q waves on an electrocardiogram) and Q-wave MI (development of new Q waves that are 0.03 s in width and/or more than one-third of the total QRS complex in contiguous leads and as evidenced by subsequent creatine kinase–myocardial band rise to 3 times the baseline value just before PCI). Major adverse cardiovascular event (MACE) was defined as a composite of stroke, MI, death, post-PCI coronary artery bypass graft surgery (CABG) or post-PCI revascularization at the same site.

Statistical analysis. Baseline characteristics were expressed as mean (± SD) and as percentages. Procedural and outcomes variables in patients undergoing PCI with 6-F guides were compared with those of patients undergoing PCI with 7- or 8-F guides. The Student t test and analysis of variance were used for continuous variables, and the chi-square test was used for categorical variables. Univariate and multivariate logistic regression modeling was used to calculate unadjusted and adjusted odds of periprocedural events in association with 7- or 8- versus 6-F guide catheter use.

To further adjust for the nonrandomized use of 8-F guides and for a possible selection bias in this cohort, a predictive model that adjusted for the propensity to receive an 8-F guide compared with a 6-F guide was also developed (15). The probability, or a propensity score, of receiving an 8-F guide was calculated using a nonparsimonious logistic regression model. The variables included in the model were age, sex, prior history of stroke, peripheral vascular disease, hypertension, diabetes, congestive heart failure, prior MI, history of renal failure with dialysis, prior gastrointestinal bleeding, prior revascularization, chronic obstructive airway disease, history of smoking, serum creatinine and Hgb, extent of coronary artery disease, presence of thrombus or calcification, pre-procedural medication use, left ventricular ejection fraction before the intervention, the year that the PCI was performed, and emergent PCI. The propensity score was then included as an additional explanatory variable in the final models. Moreover, we used Greedy matching techniques to select patients treated with 6-F guides as counterparts to patients treated with 8-F guides by choosing the patient with the nearest propensity score (16,17). In–hospital outcome was then compared within this propensity–matched cohort. Random effect models were fitted to control for variation by hospital. We estimated the univariate statistical significance of the effect of 8- versus 6-F guide use on adverse outcomes using generalized estimating equations cluster analysis (18,19). Statistical analysis was performed with SAS (SAS Institute, Cary, North Carolina).

Results

Baseline clinical characteristics are shown in Table 1. The mean age of patients in this study was 64 years, 34% were women, and 33% were diabetic. Femoral arterial access was used in 98.9% of patients, brachial artery access in 0.5%, and radial artery access in 0.6%. There were 6,059 PCIs performed with 8-F guides, 32,676 with 7-F guides, and...
64,335 with 6-F guides. Procedural characteristics are shown in Table 2. More patients in the 7-F group had acute or recent MI or underwent PCI of a restenotic lesion. Visible vessel calcification was more often identified in the 8-F guide group. A larger percentage of patients in both the 7- and 8-F groups had cardiogenic shock and multivessel coronary artery disease and underwent multivessel PCI. Vascular closure devices were more often used in the 6-F group. Beginning in 2003, data related to 6-, 7-, or 8-F guide catheter use for rotational atherectomy (1.43%, 3.03%, and 4.23%, respectively, \( p < 0.0001 \)) and laser atherectomy (0.09%, 0.15%, and 0.25%, respectively, \( p = 0.0004 \)) was collected. There were wide variations in the use of 8-F guide catheters across various participating health care institutions (Fig. 1).

When compared with PCIs performed with 6-F guides, the use of 7- and 8-F guide catheters were associated with the use of incrementally and significantly more contrast medium, and use of a volume of contrast agent that exceeded the maximum allowable contrast medium dose defined as contrast dose \( > [5 \text{ ml} \times \text{ kilogram (body weight)/creatinine (mg/dl)}] \) (20). Unadjusted outcomes in patients undergoing PCI with 6-, 7-, and 8-F guides are shown in Table 3. The larger guide catheters were associated with significantly more CIN and nephropathy requiring dialysis. Post-procedure Hgb was more likely to fall by \( > 3 \text{ g/dl} \) in the 7- and 8-F guide patients. Similarly, there were significantly more blood transfusions in the 7- and 8-F catheter groups. Vascular access site complications were more common in the 8-F group, regardless of whether vascular closure devices were used. Compared with PCI with 6-F guides, the use of 7- or 8-F guides was also incrementally associated with unadjusted increased incidence of myocardial infarction, stroke, MACE, and death.

After multivariate adjustment, when compared with 6-F guide catheters, 7- and 8-F guides were associated with more CIN, post-PCI decrease in Hgb \( > 3 \text{ g/dl} \), gastrointestinal bleeding, vascular complications, and post-procedure transfusion (Table 4). In addition, 8-F guide catheters were also associated with nephropathy requiring dialysis, post-PCI

| Table 1. Baseline Characteristics of the Cohort Based on Size of the Guiding Catheter |
|--------------------------------------|--------|--------|----------------|----------------|--------|
| Demographic                          |        |        |                |                |        |
| Age, yrs                             | 63.7 (12.2) | 64.0 (12.3) | 64.2 (12.3) | 0.0002 |
| Female sex                           | 35.2 | 32.9 | 32.4 | \(< 0.0001\) |
| Current smoking                      | 25.9 | 26.3 | 23.6 | \(< 0.0001\) |
| Lean (BMI <25 kg/m²)                 | 19.0 | 19.0 | 18.3 | 0.43 |
| Obese (BMI ≥30 kg/m²)                | 44.3 | 44.1 | 45.7 | 0.07 |
| Historical                            |        |        |                |                |        |
| Hypertension                         | 77.7 | 79.9 | 76.8 | \(< 0.0001\) |
| Prior myocardial infarction           | 34.4 | 34.1 | 36.4 | 0.002 |
| Diabetes mellitus                    | 32.9 | 33.1 | 32.1 | 0.32 |
| Congestive heart failure             | 12.7 | 12.3 | 14.2 | 0.001 |
| Extracardiac vascular disease        | 23.0 | 22.9 | 22.2 | 0.34 |
| Renal failure requiring dialysis     | 1.9 | 1.7 | 2.2 | 0.01 |
| Significant valve disease            | 4.3 | 4.7 | 3.2 | \(< 0.0001\) |
| Gastrointestinal bleeding            | 2.4 | 2.0 | 2.1 | 0.0002 |
| Prior PCI                            | 38.9 | 42.6 | 43.6 | \(< 0.0001\) |
| Prior CABG                           | 18.8 | 20.3 | 20.9 | \(< 0.0001\) |
| COPD                                 | 17.4 | 15.9 | 15.5 | \(< 0.0001\) |
| Laboratory                            |        |        |                |                |        |
| Baseline pre-Cr, mg/dl               | 1.18 (0.95) | 1.19 (1.30) | 1.22 (1.07) | 0.03 |
| Baseline Cr ≥1.5, mg/dl              | 11.6 | 12.2 | 13.5 | \(< 0.0001\) |
| Post-procedure Cr, mg/dl             | 1.26 (1.33) | 1.28 (1.22) | 1.37 (1.52) | \(< 0.0001\) |
| Initial hemoglobin, g/dl             | 13.6 (1.9) | 13.7 (1.89) | 13.5 (1.9) | \(< 0.0001\) |
| Pre-procedure WHO anemia             | 25.4 | 24.1 | 28.9 | \(< 0.0001\) |
| Nadir hemoglobin, g/dl               | 12.3 (2.03) | 12.2 (1.96) | 11.7 (2.12) | \(< 0.0001\) |
| Ejection fraction                    | 51.9 (11.4) | 51.7 (12.0) | 51.0 (12.3) | \(< 0.0001\) |
| Ejection fraction <50%               | 29.2 | 31.0 | 31.6 | \(< 0.0001\) |

Values are % (SD) or %.

BMI = body mass index; CABG = coronary artery bypass graft; COPD = chronic obstructive pulmonary disease; Cr = creatinine; PCI = percutaneous coronary intervention; SD = standard deviation; WHO = World Health Organization.
emergency CABG, any post-PCI CABG, post-PCI MI, periprocedural in-hospital death, and MACE.

After adjusting for comorbidities and propensity (Fig. 2), when compared with 6-F catheters, the use of larger 8-F guides was associated with a significantly higher risk of CIN (adjusted odds ratio [OR]: 1.35, 95% confidence interval [CI]: 1.13 to 1.61, p < 0.0001). In addition, 8-F catheters were associated with significantly more vascular complications (adjusted OR: 1.73, 95% CI: 1.46 to 2.06, p < 0.0001), more frequent post-procedure Hgb decrease of >3 g/dl (adjusted OR: 1.68, 95% CI: 1.50 to 1.88, p < 0.0001), and a greater need for blood transfusion (adjusted OR: 1.85, 95% CI: 1.62 to 2.10, p < 0.0001). Interestingly, even after adjusting for comorbidities and propensity, the use of 8-F guide catheters was associated with significantly greater post-procedural in-hospital death (adjusted OR: 1.64, 95% CI: 1.25 to 2.14, p < 0.0003) and in-hospital MACE (adjusted OR: 1.48, 95% CI: 1.29 to 1.70, p < 0.0001).

Not only was the observed mortality in the 7- and 8-F guide catheter groups significantly higher than that of the 6-F guide catheter group, the standardized mortality in the 8-F group was also significantly higher (Fig. 3). Institutions were also ranked according to the 8-F guide use and divided into quartiles. Notably, mortality was significantly higher in the 8-F guide catheter group in all quartiles, regardless of the overall use of 8-F guides (Fig. 4).

In a propensity-matched cohort, in which each patient treated with a 6-F guide was matched to a similar patient treated with an 8-F guide, the use of an 8-F guide was significantly associated with PCI-associated vascular complications, significant drop in Hgb, post-PCI transfusion, post-PCI MI, and in-hospital MACE, with a trend toward increased CIN and in-hospital death (Table 5).

**Discussion**

In this study, when compared with PCI performed with 6-F guide catheters, the use of 7- or 8-F guide catheters was associated with unadjusted use of larger volume of contrast
agent, greater likelihood of post-procedure nephropathy, more vascular complications, greater post-procedure drop in Hgb, greater need for post-procedure blood transfusion, higher mortality, and more frequent post-procedural MACE. These findings were confirmed after adjustment for confounding patient and procedural variables for both 7- and 8-F guides compared with 6-F guide catheters, specifically related to post-procedure nephropathy, vascular complications, greater drop in Hgb, and need for post-PCI transfusion. The use of 8-F guides was also associated with greater adjusted incidence of post-PCI nephropathy requiring dialysis, myocardial infarction, CABG, death and MACE. Importantly, these findings are from a multicenter registry and include data gathered prospectively from procedures performed by more than 100 interventionists and, therefore, represent a large cross-section of contemporary interventional cardiology practice.

Whereas the higher adjusted in-hospital post-PCI MACE and mortality were associated with 8-F guide catheter size, a larger percentage of patients underwent

### Table 3. Unadjusted Outcomes for Patients With 6-, 7-, and 8-F Guide Catheter Size

<table>
<thead>
<tr>
<th>In-Hospital Outcomes</th>
<th>Aggregate (n = 103,070)</th>
<th>6-F (n = 64,335)</th>
<th>7-F (n = 32,676)</th>
<th>8-F (n = 6,059)</th>
<th>p Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIN†</td>
<td>3.83</td>
<td>3.39</td>
<td>4.38</td>
<td>6.21</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>NRD</td>
<td>0.24</td>
<td>0.22</td>
<td>0.22</td>
<td>0.51</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Vascular complication</td>
<td>2.50</td>
<td>2.35</td>
<td>2.69</td>
<td>3.85</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Vascular complication with VCD</td>
<td>2.37</td>
<td>2.41</td>
<td>2.06</td>
<td>3.6</td>
<td>0.04</td>
</tr>
<tr>
<td>Vascular complication without VCD</td>
<td>2.62</td>
<td>2.33</td>
<td>2.79</td>
<td>3.89</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Gastrointestinal bleeding</td>
<td>1.19</td>
<td>1.12</td>
<td>1.27</td>
<td>1.93</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Drop in hemoglobin &gt;3 (g/dl)‡</td>
<td>9.20</td>
<td>8.55</td>
<td>10.23</td>
<td>14.01</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Post-procedure transfusion</td>
<td>5.15</td>
<td>4.72</td>
<td>5.26</td>
<td>9.23</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Emergency CABG</td>
<td>0.39</td>
<td>0.37</td>
<td>0.35</td>
<td>0.81</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Any CABG§</td>
<td>1.08</td>
<td>0.99</td>
<td>1.08</td>
<td>1.86</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Revascularization (same site)</td>
<td>0.59</td>
<td>0.48</td>
<td>0.67</td>
<td>0.53</td>
<td>0.0007</td>
</tr>
<tr>
<td>MI</td>
<td>1.66</td>
<td>1.56</td>
<td>1.74</td>
<td>2.67</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.37</td>
<td>0.33</td>
<td>0.42</td>
<td>0.63</td>
<td>0.0005</td>
</tr>
<tr>
<td>Death</td>
<td>1.13</td>
<td>0.97</td>
<td>1.20</td>
<td>2.38</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>MACE§</td>
<td>4.29</td>
<td>3.84</td>
<td>4.54</td>
<td>7.21</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Values are %. *The p value for comparison of 6-, 7-, and 8-F categories. †[Peak creatinine – baseline creatinine] >0.5 (mg/dl). Patients with a history of dialysis excluded. ‡[Baseline hemoglobin – nadir hemoglobin] >3 g/dl. §Any CABG includes emergency and nonemergency CABG. [Major adverse cardiac events are a composite of stroke, MI, post-PCI CABG or repeat PCI (same site), or death. CIN = contrast-induced nephropathy; MACE = major adverse cardiac event; NRD = nephropathy requiring dialysis; VCD = vascular closure device; other abbreviations as in Tables 1 and 2.

### Table 4. Unadjusted and Adjusted Odds Ratios for Adverse Events for 6-, 7-, or 8-F Guide Catheter Utilized

<table>
<thead>
<tr>
<th>In-Hospital Outcomes</th>
<th>7-F vs. 6-F</th>
<th>8-F vs. 6-F</th>
<th>Adjusted OR for 7-F and 8-F vs. 6-F</th>
<th>7-F vs. 6-F</th>
<th>8-F vs. 6-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIN*</td>
<td>1.30</td>
<td>1.88</td>
<td>1.18</td>
<td>0.0004</td>
<td>1.44</td>
</tr>
<tr>
<td>NRD</td>
<td>1.01</td>
<td>2.27</td>
<td>0.88</td>
<td>0.40</td>
<td>1.63</td>
</tr>
<tr>
<td>Vascular complications</td>
<td>1.15</td>
<td>1.66</td>
<td>1.19</td>
<td>0.0002</td>
<td>1.68</td>
</tr>
<tr>
<td>Gastrointestinal bleeding</td>
<td>1.14</td>
<td>1.74</td>
<td>1.14</td>
<td>0.05</td>
<td>1.46</td>
</tr>
<tr>
<td>Drop in hemoglobin &gt;3 g/dl‡</td>
<td>1.22</td>
<td>1.74</td>
<td>1.12</td>
<td>&lt;0.0001</td>
<td>1.72</td>
</tr>
<tr>
<td>Post-procedure transfusion</td>
<td>1.21</td>
<td>2.05</td>
<td>1.08</td>
<td>0.03</td>
<td>1.80</td>
</tr>
<tr>
<td>Emergency CABG</td>
<td>0.96</td>
<td>2.21</td>
<td>0.79</td>
<td>0.06</td>
<td>1.55</td>
</tr>
<tr>
<td>Any CABG§</td>
<td>1.09</td>
<td>1.90</td>
<td>0.91</td>
<td>0.23</td>
<td>1.51</td>
</tr>
<tr>
<td>MI</td>
<td>1.12</td>
<td>1.73</td>
<td>1.00</td>
<td>0.95</td>
<td>1.39</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.27</td>
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<td>Death</td>
<td>1.24</td>
<td>2.50</td>
<td>1.11</td>
<td>0.22</td>
<td>1.34</td>
</tr>
<tr>
<td>MACE§</td>
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<td>1.95</td>
<td>1.06</td>
<td>0.13</td>
<td>1.37</td>
</tr>
</tbody>
</table>

*Peak creatinine – baseline creatinine] >0.5 (mg/dl). Patients with a history of renal failure with dialysis are excluded. †Baseline hemoglobin – nadir hemoglobin] >3 g/dl. §Any CABG includes emergency and nonemergency CABG. [Composite of stroke, MI, death, any CABG, and repeat PCI (same site). OR = odds ratio; other abbreviations as in Tables 1 and 3.
multivessel PCI in the 8-F group. Multivessel PCI has been associated with increased periprocedural MI, but no differences in long-term mortality (21). Post-PCI complications, however, such as CIN (20,22) and transfusion (23) have been independently associated with adverse outcome, including increased MACE and mortality. Hence, it is plau-

Figure 2. Adjusted and Unadjusted In-Hospital Outcomes of Patients Treated With 8-F Guiding Catheters Versus 6-F Guiding Catheters

The first plot (left) shows unadjusted odds ratios; the second plot (center) shows risk-adjusted odds ratios; and the third plot (right) shows risk-adjusted and propensity-adjusted odds ratios. Contrast-induced nephropathy, drop in hemoglobin by >3 g/dl, transfusion, coronary artery bypass graft, myocardial infarction, death, and major adverse cardiac events were more common in patients treated with the 8-F guide catheter, even after risk adjustment or after adjustment for the propensity to receive an 8-F guide catheter. Nephropathy requiring dialysis, gastrointestinal bleeding, and stroke were more common in the 8-F treated patients, but these differences were not significant after risk adjustment or after adjustment for the propensity to receive an 8-F guide catheter. CABG = coronary artery bypass graft; CIN = contrast-induced nephropathy; Drop in Hgb = drop in hemoglobin by >3 g/dl; GI = gastrointestinal; Hgb = hemoglobin; MACE = major adverse cardiac event; MI = myocardial infarction; NRD = nephropathy requiring dialysis; Post Proc Trans = post-procedure transfusion; Vasc Comp = vascular complication.

Figure 3. Standardized Mortality Rate in Patients Undergoing PCI Based Upon the Guide Catheter Size

The observed and predicted mortality of 8-F guide catheter PCI patients was higher than the observed mortality of the 6- and 7-F guide patients (p < 0.05 for both). The observed mortality in patients treated with 8-F guide catheters was higher than the predicted mortality (p < 0.05) and the observed mortality of those who underwent PCI with a 6-F guide was lower than the predicted mortality (p < 0.05). The SMR (a ratio of observed mortality and predicted mortality) of patients treated with an 8-F guide was significantly higher than the SMR of patients who underwent PCI with a 6- or 7-F catheter (p < 0.05). PCI = percutaneous coronary intervention; SMR = standardized mortality rate.
sible that a procedural variable, such as PCI guide catheter size, may have direct impact on the occurrence of severe, adverse outcomes, mediated by the increased occurrence of more moderate renal, vascular, and cardiac complications. Furthermore, the consistency of the mortality data across the consortium, regardless of baseline institutional 8-F guide use, the standardized mortality rate, and propensity adjustment all suggest that larger guide catheter use is associated with increased mortality.

This study represents the largest investigation that relates larger guide catheter size directly to contrast agent use and complications associated with PCI. Previous investigators (24,25) have related catheter size directly to volume of contrast medium used during diagnostic angiography, but did not evaluate outcome variables. Using measurement of injection pressure, volume, and time, Dodge et al. (25) determined that as catheter sizes increase, injection volume and rate increased as injection duration decreased. Vascular complications associated with PCI can increase morbidity, prolong hospital stay, and increase costs (26–28). In addition, vascular access site bleeding complications can increase the need for transfusion (26,29). The association between sheath size and vascular access site complications, however, is controversial. In a study of 2,400 PCIs from 1991, PCI-related vascular access site complications were associated with 8-F or larger guide catheters (30). Conversely, a study of the predictors of retroperitoneal hematoma associated with PCI in 3,508 consecutive patients found no association of retroperitoneal hematoma with sheath size (31). One single center trial randomized 414 patients to PCI with 6- or 7-F guide catheters. Although there was more contrast medium used in the 7-F guide patients, there was no difference in vascular complications between the groups (32). In a study designed to identify predictors of vascular access site complications associated with PCI, the Northern New England Cardiovascular Disease Study Group evaluated 18,137 PCI procedures. Unfortunately, sheath size was not collected in the database and, therefore, not included in the analysis (33).

Advancement in technology has facilitated the use of smaller guide catheters to perform PCI. In fact, our data suggest a trend over the last 6 years to use smaller guides within the consortium (Fig. 5). However, as seen in this study, there are a significant number of interventionalists (24,25) have related catheter size directly to volume of contrast medium used during diagnostic angiography, but did not evaluate outcome variables. Using measurement of injection pressure, volume, and time, Dodge et al. (25) determined that as catheter sizes increase, injection volume and rate increased as injection duration decreased. Vascular complications associated with PCI can increase morbidity, prolong hospital stay, and increase costs (26–28). In addition, vascular access site bleeding complications can increase the need for transfusion (26,29). The association between sheath size and vascular access site complications, however, is controversial. In a study of 2,400 PCIs from 1991, PCI-related vascular access site complications were associated with 8-F or larger guide catheters (30). Conversely, a study of the predictors of retroperitoneal hematoma associated with PCI in 3,508 consecutive patients found no association of retroperitoneal hematoma with sheath size (31). One single center trial randomized 414 patients to PCI with 6- or 7-F guide catheters. Although there was more contrast medium used in the 7-F guide patients, there was no difference in vascular complications between the groups (32). In a study designed to identify predictors of vascular access site complications associated with PCI, the Northern New England Cardiovascular Disease Study Group evaluated 18,137 PCI procedures. Unfortunately, sheath size was not collected in the database and, therefore, not included in the analysis (33).

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![Figure 4. Hospital Quartiles According to Guide Use and Mortality](image)

Participating hospitals were ranked according to 8-F guide use and divided into quartiles. Within each quartile, the mortality of patients who underwent PCI with 8-F guides was significantly greater than that of the 6-F guide groups (p > 0.003). Q = quartile; other abbreviations as in Figure 3.

<table>
<thead>
<tr>
<th>In-Hospital Outcomes</th>
<th>6-F Guide (n = 4,008)</th>
<th>8-F Guide (n = 4,008)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIN*</td>
<td>148 (4.89%)</td>
<td>180 (5.91%)</td>
<td>0.08</td>
</tr>
<tr>
<td>NRD</td>
<td>14 (0.35%)</td>
<td>23 (0.57%)</td>
<td>0.1</td>
</tr>
<tr>
<td>Vascular complication</td>
<td>119 (2.97%)</td>
<td>167 (4.17%)</td>
<td>0.004</td>
</tr>
<tr>
<td>Gastrointestinal bleeding</td>
<td>71 (1.77%)</td>
<td>81 (2.02%)</td>
<td>0.4</td>
</tr>
<tr>
<td>Decrease hemoglobin &gt;3 g/dl†</td>
<td>355 (8.86%)</td>
<td>504 (12.57%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Transfusion</td>
<td>277 (6.91%)</td>
<td>392 (9.78%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Emergency CABG</td>
<td>29 (0.72%)</td>
<td>34 (0.85%)</td>
<td>0.5</td>
</tr>
<tr>
<td>Any CABG‡</td>
<td>62 (1.55%)</td>
<td>79 (1.97%)</td>
<td>0.15</td>
</tr>
<tr>
<td>Repeat revascularization</td>
<td>24 (0.60%)</td>
<td>25 (0.62%)</td>
<td>0.9</td>
</tr>
<tr>
<td>MI</td>
<td>80 (2.00%)</td>
<td>121 (3.02%)</td>
<td>0.003</td>
</tr>
<tr>
<td>Stroke</td>
<td>22 (0.55%)</td>
<td>24 (0.60%)</td>
<td>0.8</td>
</tr>
<tr>
<td>Death</td>
<td>64 (1.60%)</td>
<td>87 (2.17%)</td>
<td>0.06</td>
</tr>
<tr>
<td>MACE§</td>
<td>224 (5.59%)</td>
<td>303 (7.56%)</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

*Peak creatinine – baseline creatinine) ≤0.5 (mg/dl). Patients with a history of renal failure with dialysis are excluded. †(Baseline hemoglobin – nadir hemoglobin) >3 g/dl. ‡Any CABG includes emergency and nonemergency CABG. §Composite of stroke, MI, death, any CABG, and repeat PCI (same site).

Abbreviations as in Tables 1 and 3.
who prefer larger guide catheters for PCI. Moreover, some interventional textbooks recommend the use of larger guide catheters (34). The device industry has focused on the development of technologies compatible with smaller guide catheters largely due to the perception that the interventional cardiology community prefers smaller catheters, because they were linked with fewer vascular complications and shorter post-procedure recovery. The data from this study suggest that the use of smaller guiding catheters during PCI is associated with significantly better outcome, including improved post-procedural morbidity and reduced mortality.

**Study limitations.** The results of this study are based upon observational data, and outcomes were not centrally adjudicated. As such, the choice of guide catheter size was not randomized, but determined at the discretion of the interventionalist at the time of the PCI. The use of 8-F guiding catheters was associated with several clinical factors that are correlated with adverse PCI outcome, including significantly more patients with baseline cardiogenic shock, more multivessel disease, and more multivessel PCI. These and multiple other clinical factors were included in the risk adjustment, propensity, and standardized mortality analyses. However, data related specifically to intervention on bifurcation lesions was not collected during the majority of the time frame included in this registry and thus not included in the analyses. In addition, it is possible that we were unable to adjust for other unknown factors that may influence guide of choice and procedural outcomes. Finally, the vast majority of PCIs in this registry were performed with femoral arterial access. Though the bulk of PCIs performed via brachial or radial artery access are completed with smaller guide catheters, the influence of brachial or radial artery access on PCI outcome could not be directly assessed in this registry.

**Conclusions**

Compared with smaller 6-F guide catheters, PCIs performed with larger 7- and 8-F guide catheters are associated with more contrast agent use, more CIN, more significant post-PCI Hgb drop, and a greater need for blood transfusion. In addition, 8-F guides were associated with increased nephropathy requiring dialysis, in-hospital MACE, and an increased mortality. These data suggest that selection of smaller guide catheters may result in improved clinical outcomes in patients undergoing contemporary PCI.

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Key Words: percutaneous coronary intervention ■ coronary guide catheter size ■ coronary intervention complications ■ coronary intervention complications ■ coronary intervention outcomes.