Scraping of Aortic Debris by Coronary Guiding Catheters

A Prospective Evaluation of 1,000 Cases

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Objectives. This study was designed to determine the incidence and to quantitate aortic debris retrieved during placement of guiding catheters in patients undergoing percutaneous interventions.

Background. Studies have shown that atherosclerotic aortic debris predisposes patients to spontaneous or procedurally related ischemic events.

Methods. In 1,000 consecutive percutaneous interventions, the amount of visible atheromatous material from large-lumen guiding catheters was recorded. Clinical characteristics and in-hospital complications were prospectively collected and associated with debris production.

Results. Visible aortic debris (1+ to 3+) occurred more frequently with the Judkins left (JL) catheter, followed by the multipurpose (Multi) catheter compared to any other type of guiding catheter (65%, p = 0.001 and 60%, p = 0.01, respectively). Large debris (2+ and 3+) was observed most frequently with the Multi (odds ratio 3.79, C.I. = 2.32 to 6.21, p = 0.001), JL (odds ratio 2.83, C.I. = 1.98 to 4.05, p = 0.001) and voda left (VL) (odds ratio 2.73, C.I. = 1.51 to 4.95, p = 0.001) catheters. The Judkins right (JR) catheter type was least likely to produce any debris (24%, p = 0.001). A history of unstable angina (p = 0.05) or myocardial infarction (p = 0.003) was associated with a decreased incidence of debris production. The presence of debris was not found to be associated with in-hospital ischemic complications.

Conclusions. Studies have shown that atherosclerosis of the aorta is a potential source of systemic embolism in patients undergoing cardiac catheterization. Our study shows that in more than 50% of percutaneous revascularization procedures, guiding catheter placement is associated with scraping debris from the aorta. Design characteristics of the JL, Multi and VL guiding catheters make them most likely to produce such debris. Meticulous attention to allow the debris to exit the back of the catheter is essential to prevent injecting atheromatous debris into the vascular bed.

(J Am Coll Cardiol 1998;32:1861–5) ©1998 by the American College of Cardiology

The aorta is the most frequent source of arterial atheromatous emboli. Aortic arch plaques are recognized as an independent risk factor for stroke (1–7). Plaques in the thoracoabdominal aorta can embolize to the visceral arteries and limb circulation causing mesenteric ischemia, renal insufficiency and vascular complications (8–15).

Atheromatous material within the aorta may be dislodged during invasive aortic procedures (16). Transesophageal echocardiographic recognition of atherosclerotic aortic debris identifies patients at high risk for stroke and peripheral embolism during cardiac catheterization, inaortic balloon pump placement and cross-clamping of the aorta during coronary bypass surgery (17–28). The incidence of clinically apparent embolization and stroke associated with diagnostic cardiac catheterization is less than 1% (29). However, the incidence of catheter-related embolism in necropsy studies has been reported to be as high as 30% (30,31).

The overall complication rates of percutaneous revascularization procedures are higher than diagnostic catheterization (29). In patients undergoing percutaneous interventions, stiff, large-bore-guiding catheters are used. These design characteristics can be more traumatic to the aorta than diagnostic catheters, which are more flexible, have smaller lumens and tapered tips. We noticed that during advancement of guiding catheters, atheromatous debris scraped from the aorta exited the back of the catheter. This was almost never seen during diagnostic catheterization.

This study was designed to determine the incidence and to quantitate aortic debris (atheromatous material that exited the guiding catheter during its advancement into the descending aorta and around the aortic arch) retrieved in 1,000 consecutive patients undergoing percutaneous interventions. We sought to determine whether there were patient or catheter characteristics that predispose to the presence of aortic debris, which, if inadvertently flushed forward, may embolize. Finally, we determined whether the presence of debris was associated with in-hospital recurrent ischemia, myocardial infarction, acute renal failure or ischemic neurologic complications.

Methods

Patients. In 1,000 consecutive percutaneous interventions, the amount of visible atheromatous material from large-lumen...
(8 and 9F) guiding catheters was recorded. To identify the clinical characteristics associated with visible atherosclerotic debris, data were prospectively collected on a standardized form. Gender, age, diabetes mellitus, hypercholesterolemia, smoking, hypertension, peripheral vascular disease, chronic renal insufficiency, chronic stable angina, unstable angina, history of myocardial infarction, history of transient ischemic attack and cerebral vascular accident, and history of coronary artery bypass surgery were documented (Table 1). In-hospital complications including myocardial ischemia, myocardial infarction, acute renal failure, and ischemic neurologic complications were prospectively collected and analyzed (Table 2).

**Catheter technique.** After the guiding catheter was advanced over an 0.035-inch wire into the descending aorta and around the aortic arch, the wire was removed, blood was allowed to exit the back of the catheter for at least three cardiac cycles and was collected on a sterile towel. This was visualized by the operator for the presence and relative amount of atheromatous material. The Y-connector system was then attached to the guiding catheter and coronary angiography with subsequent percutaneous revascularization was performed. A visual scoring system was devised to describe the amounts of atheromatous material termed aortic “debris.”

**Table 1. Multiple Logistic Regression Analysis of the Clinical Variables With the Presence of Any Debris (1 to 3+).**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Incidence</th>
<th>Odds Ratio</th>
<th>C.I.</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous MI</td>
<td>8.4%</td>
<td>.810</td>
<td>.704–.932</td>
<td>0.003*</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>64.5%</td>
<td>.869</td>
<td>.755–.999</td>
<td>0.05</td>
</tr>
<tr>
<td>Hypertension</td>
<td>56.8%</td>
<td>1.138</td>
<td>.981–1.319</td>
<td>0.08</td>
</tr>
<tr>
<td>Renal insufficiency</td>
<td>4.6%</td>
<td>1.177</td>
<td>.871–1.590</td>
<td>0.32</td>
</tr>
<tr>
<td>Male</td>
<td>68.9%</td>
<td>1.071</td>
<td>.805–1.110</td>
<td>0.38</td>
</tr>
<tr>
<td>Age</td>
<td>67 ± 3</td>
<td>—</td>
<td>—</td>
<td>0.38</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>24.6%</td>
<td>1.076</td>
<td>.916–1.264</td>
<td>0.40</td>
</tr>
<tr>
<td>CHF</td>
<td>11.8%</td>
<td>.908</td>
<td>.716–1.151</td>
<td>0.41</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>24.4%</td>
<td>.945</td>
<td>.805–1.110</td>
<td>0.49</td>
</tr>
<tr>
<td>PVD</td>
<td>11.6%</td>
<td>1.053</td>
<td>.861–1.287</td>
<td>0.62</td>
</tr>
<tr>
<td>Current smoking</td>
<td>16.8%</td>
<td>1.030</td>
<td>.867–1.223</td>
<td>0.74</td>
</tr>
<tr>
<td>Previous TIA/CVA</td>
<td>8.4%</td>
<td>1.016</td>
<td>.795–1.299</td>
<td>0.90</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>50.4%</td>
<td>.991</td>
<td>.861–1.141</td>
<td>0.90</td>
</tr>
<tr>
<td>Chronic stable angina</td>
<td>6%</td>
<td>.999</td>
<td>.719–1.388</td>
<td>0.99</td>
</tr>
</tbody>
</table>

*p < 0.05. Odds ratios are for the presence of any debris (1 to 3+). C.I. = confidence interval; CABG = coronary artery bypass graft; CHF = congestive heart failure; CVA = cerebral vascular accident; MI = myocardial infarction; PVD = peripheral vascular disease; TIA = transient ischemic attack.

The scoring system consisted of a score from 0 to 3, where 0 = no visible debris; 1+ = fine, crystal-like sparkles; 2+ = one or two solid particles 0.5 to 2 mm in diameter; and 3+ = greater than three such particles or debris larger than 2 mm in diameter (Figs. 1–3). Catheter shapes and “debris scores” were recorded for all 1,000 procedures (Fig. 4 and 5, Table 3).

**Statistics.** Data are reported as mean ± SD. Multiple logistic regression analysis was performed using the SAS System (version 6.12) to compare the clinical profile of patients, the type of catheter used, the presence and relative amount of aortic debris produced and in-hospital complications. A p value <0.05 was considered significant.

**Results.** Visible aortic debris (1+ to 3+) occurred more frequently with the Judkins left (JL) type guiding catheter, followed by the multipurpose (Multi) catheter compared to any other type of catheter (65%, p = 0.001, and 60%, p = 0.01, respectively) (Fig. 4, Table 3). The voda left (VL) was associated with debris production, but did not reach statistical significance (55%, p = 0.11) (Fig. 4, Table 3). Relative to the Judkins right (JR) catheter, minor debris (1+) was observed most frequently with the voda left (odds ratio 2.56, C.I. = 1.42 to 4.61, p = 0.003); hockey stick (HS) (odds ratio 2.47, C.I. = 1.43 to 4.55, p = 0.005); Amplatz right (AR) (odds ratio 2.11, C.I. = 1.07 to 4.15, p = 0.038); and JL (odds ratio 1.73, C.I. = 1.21 to 2.49).

**Figure 1.** Gross pathologic features of fine, crystal-like atheromas termed 1+ debris.
p = 0.002) catheters (Fig. 5). Large debris (2+ and 3+) was observed most frequently with the Multi (odds ratio 3.79, C.I. = 2.32 to 6.21, p = 0.001), JL (odds ratio 2.83, C.I. = 1.98 to 4.05, p = 0.001), VL (odds ratio 2.73, C.I. = 1.51 to 4.95, p = 0.001) and Amplatz left (AL) (odds ratio 2.49, C.I. = 1.42 to 4.33, p = 0.002) catheters (Fig. 5). The JR catheter was the catheter least likely to produce debris regardless of amount (24%, p = 0.001) (Fig. 4, Table 3).

A history of unstable angina or previous myocardial infarction was associated with a decreased incidence of any debris production (odds ratio .869 and .810, respectively) (Table 1). When analyzed according to size of debris particles (1+ to 3+), no additional significant association was seen between the presence or size of debris particles and increasing age of the patient. In-hospital recurrent ischemia, myocardial infarction, acute renal failure or ischemic neurologic complications occurred infrequently, and these were not associated with the presence or size of debris particles (1+ to 3+) (Table 2).

**Discussion**

Atheromatous lesions in the aorta have been shown to occur in half of middle-aged men and in one-third of women, and the prevalence continues to increase in the subsequent decades of life (4,30). Previous studies have shown that the presence of atheromatous material in the aorta (aortic debris) increases the risk of systemic embolization and stroke during cardiac catheterization (28) and also procedures that involve aortic manipulation such as coronary artery bypass surgery (23–27). When aortic debris is detected, substituting brachial for femoral catheterization and avoiding placement of an intraaortic balloon pump have both been recommended to reduce the risk of embolism.

Embolic complications, although infrequent, appear to account for a significant portion of the morbidity and mortality of coronary interventions. They are thought to be the result of clot formation due to prolonged procedures, but they may also be due to dislodgment of atheromatous material from the aorta during catheter and wire manipulation. During percutaneous interventions, large-lumen, stiff-guiding catheters are used. Atheromatous material frequently exits the back of the guiding catheters during their advancement in the descending aorta and around the aortic arch. This study was designed to describe the incidence of aortic debris, to semi-quantitate the amount of aortic debris, to determine whether patient or catheter characteristics have any bearing on debris production, and to determine if the presence of aortic debris is associated with in-hospital complications.

Our data show a high incidence of aortic debris scraped by the guiding catheter (51% of cases overall) but a wide range depending on the shape of the catheter used (24% to 65%). The JL and Multi guiding catheters were associated with a significant increase in overall aortic debris production, particularly large debris, visible at the time of catheter advancement compared to the other guiding catheters evaluated. Voda left catheters also tended to be associated with debris but did not reach statistical significance, likely due to a small sample size.
However, when large debris was observed, the voda left catheter (similar to the Multi and JL catheters) was more likely to be responsible. We postulate that the shapes of the JL, Multi and VL catheters are more traumatic to the aorta owing to their long secondary curves, acting as “atherectomy devices” as they pass across friable plaques. The JR catheters were the least likely to lead to debris production.

Interestingly, the patient population at decreased risk for debris production were patients with unstable angina or a history of myocardial infarction. This may be due to a more thrombotic and less atherosclerotic process leading to the acute ischemic syndrome, or lifestyle and medication modification with atherosclerotic regression in the postmyocardial infarction patients.

The presence of aortic debris was not found to be associated with the in-hospital complications of recurrent ischemia, myocardial infarction, acute renal insufficiency or neurologic ischemic complications regardless of the relative size and amount. This may be due to the technique used in this study where all guiding catheters were allowed to bleed back onto a sterile towel after wire removal and prior to attachment of the Y-connector. This technique theoretically could decrease the incidence of embolizing atheromatous material forward into the coronary or cerebral or peripheral circulation. Moreover, the small event rate and innumerable other factors contributing to complications will make the relationship between debris and clinical events difficult to ascertain.

Figure 5. Odds ratios and confidence intervals for the production of 1+, 2+ and 3+ debris, relative to the JR catheter. AL = Amplatz left; AR = Amplatz right; HS = hockey stick; JL = Judkins left; JR = Judkins right; LIMA = left internal mammary artery; Multi = multipurpose; VL = voda left.

Table 3. Overall Incidence of Debris According to Catheter Type

<table>
<thead>
<tr>
<th>Catheter Type</th>
<th>No. of Catheters</th>
<th>1+ Debris</th>
<th>2+ Debris</th>
<th>3+ Debris</th>
<th>Any Debris</th>
<th>No Debris</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judkins L</td>
<td>540 (54)</td>
<td>140 (26)</td>
<td>130 (24)</td>
<td>81 (15)</td>
<td>351 (65)</td>
<td>189 (35)</td>
</tr>
<tr>
<td>Judkins R</td>
<td>260 (26)</td>
<td>31 (12)</td>
<td>18 (7)</td>
<td>13 (5)</td>
<td>62 (24)</td>
<td>198 (76)</td>
</tr>
<tr>
<td>Amplatz L</td>
<td>48 (4.8)</td>
<td>6 (13)</td>
<td>11 (23)</td>
<td>2 (4)</td>
<td>19 (40)</td>
<td>29 (60)</td>
</tr>
<tr>
<td>Multipurpose</td>
<td>46 (4.6)</td>
<td>12 (27)</td>
<td>11 (23)</td>
<td>5 (11)</td>
<td>28 (60)</td>
<td>18 (40)</td>
</tr>
<tr>
<td>Voda L</td>
<td>34 (3.4)</td>
<td>9 (26)</td>
<td>7 (21)</td>
<td>3 (9)</td>
<td>19 (55)</td>
<td>15 (45)</td>
</tr>
<tr>
<td>Hockey stick</td>
<td>32 (3.2)</td>
<td>10 (31)</td>
<td>4 (13)</td>
<td>1 (3)</td>
<td>15 (48)</td>
<td>17 (52)</td>
</tr>
<tr>
<td>Amplatz R</td>
<td>30 (3)</td>
<td>7 (23)</td>
<td>5 (17)</td>
<td>1 (3)</td>
<td>13 (43)</td>
<td>17 (57)</td>
</tr>
<tr>
<td>LIMA</td>
<td>10 (1)</td>
<td>2 (20)</td>
<td>2 (20)</td>
<td>1 (10)</td>
<td>5 (49)</td>
<td>5 (51)</td>
</tr>
</tbody>
</table>

Values in parentheses indicate percentages. LIMA = left internal mammary artery; L = left; R = right.
avoid embolizing atheromatous debris during contrast injections.

References