SCAI Interventional Cardiology
Fall Fellows Course 2013
Selection and Use of Basic Equipment: Guiding Catheters, Wires and Balloons

December 8, 2013
8:30 am

John S. Douglas Jr, MD
Professor of Medicine
Emory University School of Medicine
Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

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<thead>
<tr>
<th>Affiliation/Financial Relationship</th>
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<tbody>
<tr>
<td>Grant/Research Support</td>
<td>J&amp;J, Medtronic, Boston Sci, Abbott, MedicinesCo</td>
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<tr>
<td>Consulting Fees/Honoraria</td>
<td>None</td>
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The Guiding Catheter: The Most Underrated Asset to Coronary Angioplasty – Commentary by Bernhard Meier MD, J Invasive Cardiology 2005;17:642-643
Basic Functions of a Guiding Catheter

• Provide a supportive conduit for advancement of guidewires and devices

• Serve as a vehicle for contrast injection

• Measure blood pressure
Important Characteristics of a Guiding Catheter

- Atraumatic tip
- Proper preformed shape (co-axial with vessel)
- Torque control
- Kink resistance
- Radiopacity
Guide Catheter Construction

- Outer Jacket
- Stainless Steel
- Inner Lining

Desirable Features:
- Large lumen
- Lubricious material
- No taper
Guide Catheter Construction

Primary Curve

Secondary Curve

tip
Curve Length

Judkins
Left

Curve Length = P-S distance (cm)

P = Primary Curve
S = Secondary Curve
Guide Catheter Dimension

Diameter
- Lumen Requirement
- Access site and proximal coronary artery size
  - 5-7 F femoral; 5-6F radial artery

Length
- 100 cm standard
- > 100 cm in tortuous aorta or radial access in tall patient
- < 100 cm for distal sites (snake graft, tortuous IMA)
Properly Sized Left Extra Backup Coronary Catheter Femoral
Left Amplatz Guide Catheter

A Catheter Associated with Increased Complications
Possible Solutions When the Right Coronary Originates More Anteriorly

- Right Judkins
- Right Judkins or Hockey Stick
- Hockey Stick or Left Amplatz
- Left Amplatz or Left Judkins (out of plane)
Possible Solutions to Difficult Right Coronary Guide Catheter Selection

Hockey Stick  Amplatz  Left Venous Bypass Graft  Arani or XBRCA
Catheter Selection For Saphenous Vein Grafts

- Multipurpose
- Multipurpose or Right Judkins
- Hockey Stick or Amplatz Left
- Hockey Stick
Achieving optimal arterial access for performance of percutaneous coronary intervention (PCI) should involve considerations of safety, efficacy, timeliness, and patient satisfaction with safety paramount. In this regard, there has been a heightened awareness of the importance of periprocedural access site bleeding due to its association with morbidity, mortality, and increased costs. In the current environment of intense scrutiny of procedural outcomes, quality monitoring and cost containment, bleeding avoidance strategies have emerged. Most notably, the pioneering works of Campeau and Kiemeney, coupled with refinements of radial access equipment and strategy, have permitted skilled operators to perform coronary angiography and intervention radially with an almost total exclusion of major access site bleeding. However, adoption of radial access for PCI by international operators has far exceeded that of United States (US) operators. Observational and small randomized studies comparing outcomes based on access site, radial versus femoral, reported better outcomes with radial access with respect to bleeding and in some cases ischemic complications as well. These studies led to an outcry from a small but vocal cadre of radial operators urging wider adoption of radial access in the US, where fewer than 5% of PCIs are performed radially. While this conversion to use of more radial access seems highly appropriate given the potential benefits, the issue is not as simple as it appears. Not all patients are equally good candidates for radial access. Not all PCI operators have the time or volume of cases that would permit them to retrain and acquire the skill set necessary to perform PCI radially. In addition, the call-to-arms to adopt radial access is only one of several bleeding avoidance strategies that should be considered. Accessing the risk of bleeding of the individual patient is the first step toward the safest possible PCI, whether performed via radial or femoral access.

Advantages and Limitations of Radial Access

In addition to reduced access-site bleeding and complications (pseudoaneurysm, arterio-venous fistula, groin hematoma, retroperitoneal bleeding), advantages of radial access include improved patient comfort, shortened time to ambulation, applicability for outpatient PCI, intervention without warfarin cessation, and potential reductions in cost. A recent report from the Transradial Committee of the SCAI nicely summarized many aspects of radial artery access for coronary and peripheral intervention. A recently reported large, randomized multicenter trial, the Radial Versus Femoral Access for Coronary Intervention (RIVAL) trial tested whether radial access was superior to femoral access in patients with acute
Advantages of Radial Access

• Reduced Bleeding
• Fewer Access Site Complications
• Improved Patient Comfort
• Shortened Time to Ambulation
• No Warfarin Interruption
• Applicability to Outpatient PCI
Disadvantages of Radial Access

- Longer learning curve
- Higher “cross-over” of about 5% due to inadequate puncture, spasm, dissection, loop, subclavian tortuosity, or poor guide support
- Limited lumen size
- Radial artery occlusion in 1-12%
The Physics of Guiding Catheters for Left Coronary Artery in Transfemoral and Transradial Intervention

Ikari et al. J Invas Cardiol 2005;17:636-641
Radial versus Femoral Artery Access

A

B

θ_r

θ_f

C

Resistance (gram force)

<table>
<thead>
<tr>
<th></th>
<th>TRI</th>
<th>TFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>&lt;0.001</td>
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</table>

Graph showing resistance comparison between TRI and TFI with p-value <0.001.
The Physics of Guiding Catheters for the Left Coronary Artery in Transfemoral and Transradial Interventions

Results

Catheter size and backup force. First, in this model, we compared the backup force of different-sized guiding catheters. The maximum resistance was considered to be the maximum backup force, as noted in the methods. When a JL4 was applied via the transfemoral approach, the maximum resistance was 63.1 ± 3.1 gF with a 6 Fr catheter, 95.7 ± 2.7 gF with a 7 Fr catheter, and 139.0 ± 4.3 gF with an 8 Fr catheter. These larger French size guiding catheters produced a significantly greater backup force (Figure 3).

Approach site and backup force. Second, we compared the backup force between right TRI and TRI. The backup force measured in the in vitro model was 1.8 times larger when a JL4 was used in TRI (Figure 4). When a JL4 was applied in TRI, the angle theta-r was smaller than theta-f in TRI (Figures 4A and B).

When we used a backup (EBUXB) type catheter in TRI and TFI, the backup force was larger in TFI than in TRI (Figure 5). There was a small (8%) but statistically significant difference between the TRI and TFI (p < 0.05). The angles a and b were similar, but the contact area was larger in TRI (Figures 5A and B).

We tested the Xill L (L) type catheter in TRI and TRI. The backup force was similar in TFI and TRI. The difference was not statistically significant in 10 measurements (Figure 6). The photographs revealed that both the angles and contact area were similar between TRI and TFI (Figures 6A and B).

Techniques to increase backup force in TRI using Judkins. Many experienced operators prefer the JL3.5 to JL4 in TRI. When the JL4 is applied in TRI, the angle theta-4 is smaller than the theta-3.5 of the JL3.5 (Figures 7A and B). The backup force measured in the in vitro model is significantly larger when the JL3.5 is used (Figure 7D).
Guide Catheter Selection and Use Influences Support

A. θ 4
B. θ 3.5
C. θ 4deep

D. Resistance (gram force)

- JL4
- JL3.5
- JL4 Deep
Comparison of Backup Force Generated by Various Guiding Catheter Shapes and Positions

A: θ_j
B: θ_b
C: θ_i
D: θ_ip

E: Graph showing resistance (gram force) for JL4, JL4 Deep, BL3.5, IL4, and IL4 Power.
Guide Catheter Related Complications

<table>
<thead>
<tr>
<th>Embolization</th>
<th>Dissection</th>
</tr>
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<tbody>
<tr>
<td>• Air</td>
<td>• Coronary Artery</td>
</tr>
<tr>
<td>• Atheroma</td>
<td>• Subclavian or IMA</td>
</tr>
<tr>
<td>• Thrombus</td>
<td>• Aortic root</td>
</tr>
<tr>
<td></td>
<td>• Abdominal Aorta</td>
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<tr>
<td></td>
<td>• Iliac Artery</td>
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</tbody>
</table>
Guide Catheter Scraping of Aortic Debris in 1000 Patients

Aortic Debris retrieved from > 50% of guide catheters

Keeley et al J AM Coll Cardiol 1998; 32:1861-1865
Guide Catheter Use

- Aspirate vigorously (atheroma or thrombus “scooped up” from the aorta)
- Insist on bleed back (prevent air embolus)
- Avoid blood standing in guide (flush frequently)
- Proximal or ostial disease
  - Avoid Amplatz
  - Care with side holes and deep engagement
Air Embolus

Clinical Features
- Acute Ischemia after Coronary Injection
- Transient Symptoms

Associated Conditions
- Large Diameter Catheters
- No “bleed back”
- Air visible in coronary

Treatment: Support Circulation, Aspirate air, Coronary Injection, Hyperbaric Oxygen
Ischemia Due to Obstructing Bubble

Muth et al. NEJM 2000; 342:476-482
Chest Pain, ST Elevation, Shock, VF, CPR Occurred
Patient Back to Normal in 15 Minutes
## Atheroembolus

<table>
<thead>
<tr>
<th>Clinical Features</th>
<th>Associated Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Unrelenting Ischemia after injection</td>
<td>• Calcified Aorta</td>
</tr>
<tr>
<td>• Slow flow in recipient vessel</td>
<td>• Abdominal aortic atherosclerosis or aneurysm</td>
</tr>
<tr>
<td></td>
<td>• Peripheral Vascular Disease</td>
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</table>

**Treatment:** Supportive, Treatment of Ischemia
# Guide Catheter Dissection

<table>
<thead>
<tr>
<th>Clinical Features</th>
<th>Associated Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Angiographic evidence of RCA or LM dissection</td>
<td>• Left Main Disease</td>
</tr>
<tr>
<td>• Ischemia and hemodynamic collapse</td>
<td>• Amplatz Catheters</td>
</tr>
<tr>
<td></td>
<td>• Difficult Coronary Intubation or Balloon or Stent Withdrawal</td>
</tr>
<tr>
<td></td>
<td>• Poor Fluoroscopic Visualization</td>
</tr>
</tbody>
</table>

**Treatment:** CABG; Emergency Stent
Left Main Injury Following LAD Stent
Left Main Injury Treated with Stent Implantation
Basic Coronary Guide Wire Characteristics

Steerable “Deliverable”

- Atraumatic Tip
- Adequate Rail Support
- Smooth Coating
Guidewire Construction

3 basic components

Central Core
Stainless steel Durasteel™
nitinol/Elastinite®

Tip:
Polymer sleeve
or
Coil-Spring Tip
Platinum
Tungsten
Stainless Steel

Lubricious Coating
Silicone
PTFE
Hydrophilic
Tip Coil Guidewire With Shaping Ribbon Design

- Central Core
- Tapered Core
- Polymer Sleeve
- Intermediate Coils
- Tip Coils
- Shaping Ribbon
Core-to-Tip Guidewire Design

Polymer/Plastic Cover
Hydrophilic/Hydrophobic Coating

Core-to-tip

Transitioned Taper
Smooth Taper Core Grind Design

- Smooth Taper Core Grind
- Polymer/Plastic Cover
  Hydrophilic/Hydrophobic Coating
- Core-to-tip
Core Diameter

Diameter affects flexibility, support and torque

Smaller Diameter = More Flexibility

Larger Diameter = More Support & Torque
Core Taper

 Longer taper - superb wire tracking, less prolapse

 Shorter taper - longer segments of consistent support, more prolapse
Core Taper

• Abrupt or short tapers produce a core which provides greater segment length of support but also greater tendency to prolapse
Core Taper

• Broad, gradual or long tapers produce a core which offers greater tracking and wire which prolapses less
Core Material

- Affects flexibility, support, steering and tracking

Stainless Steel

Nitinol/Elastinite®

High Tensile Strength Stainless Steel/Durasteel™
Core Material

- Stainless steel
  - Original core material technology
  - Good support, push force and torque
  - Less flexible than newer core materials
Core Material

• **Nitinol/Elastinite®**
  - Super-elastic alloy designed for kink resistance
  - Excellent flexibility and steering
  - Durable nature may facilitate treatment of multiple lesions and/or tortuous vessels
  - No memory
Work-Horse Guide Wire Characteristics

- Intermediate Core Diameter
- Gentle Core Taper
- Resilient Core with good torque control
- Soft Tip
- Coils or Covers
- Smooth Coating
Change Coronary Guide Wire Characteristics

Steerable "Deliverable"

- Stiff Tip
- Increased Rail Support
- Hydrophilic Coating

Dissections & Perforations
Straightening Artifacts
Perforation
Pseudolesion

Safian et al
<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
<th>Compromise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Occlusion</td>
<td>0.009” wire and/or hydrophilic coating</td>
<td>Less rail support with 0.009” wire, wire perforation</td>
</tr>
<tr>
<td>- Tapered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Blunt</td>
<td>Stiff Tip</td>
<td>Increased Dissection and Perforation</td>
</tr>
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### Device Delivery Problems

<table>
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<th>Solution</th>
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<td>Unable to deliver a balloon or stent around a corner</td>
<td>Stiffer wire or buddy wire or flexible stent or better guide or Guideliner</td>
<td>Cost; straightening artifacts; increased risk</td>
</tr>
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</table>
Balloon Angioplasty

Advantages

• Broad Applicability
• Low Cost
• Repeatable

Limitations

• Suboptimal Acute Results in Complex Anatomy
• Restenosis

Rarely “Stand Alone”
Balloon Angioplasty Alone

- Treatment of focal in-stent restenosis (especially BMS or multiple layers)
- Anastomosis lesions soon after surgery
- Bifurcations (treatment of daughter limb)
- Small vessels (<2mm)
Bigger is Better – Restenosis Rates of Quintiles of Luminal Diameter Following Coronary Intervention

Kuntz et al JACC 1993;21:21
Issues in Balloon Sizing

• Angiography most commonly used but underestimates vessel size
• Balloon oversizing leads to increased dissections (Roubin et al 1988)
• Balloon Compliance must be known
Balloon Modifications

• Cutting balloon: 3 or 4 atherotomes; useful in resistant lesions, recoil (aorto-ostial), ISR, to prevent balloon slippage (melon seeding)

• AngioSculpt Scoring Balloon: 3 rectangular nitinol spiral struts may reduce dissection

• Drug coated balloons may reduce restenosis in peripheral applications and in DES restenosis
The AngioSculpt Nitinol Scoring Element

- Flexible, nitinol scoring element with 3 rectangular spiral struts provides an extra margin of safety resulting in zero perforations and no slippage.

Scheinert et al. Circulation 2006
Important Basic Issues to Always Discuss Prior to the Case

• Access site and guide catheter selection?
• Guidewire characteristics desired?
• Strategies to be implemented (balloon, modified balloon, BMS, DES, etc.)?
• What complications are likely as the result of application of these basic PCI strategies?
THANK YOU