Basics of Transradial Catheterization and PCI

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Disclosures

- Advisory board Terumo, Medicines Company, AstraZeneca
Outcomes of Radial vs. Femoral Access

Meta-analysis of 23 RCTs of Radial vs. Femoral Access

Major bleeding
- Radial better: 1.0
- Femoral better: 0.27 (0.16-0.45)

Death
- Radial better: 1.0
- Femoral better: 0.74 (0.42-1.30)

Death, MI or stroke
- Radial better: 1.0
- Femoral better: 0.71 (0.49-1.01)

Clinical Outcomes: BARC Bleeding (BARC II and above)

<table>
<thead>
<tr>
<th></th>
<th>Radial</th>
<th>Femoral</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 %</td>
<td>4.5 %</td>
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</table>

P < 0.001
Clinical Outcomes: Vascular Complications

- Radial: 0.1%
- Femoral: 0.5%

P < 0.001
Clinical Outcomes: Blood Transfusion

P < 0.001

Radial: 1.1%
Femoral: 2.1%
Length of Stay

Length of stay shorter by 0.5 days in the radial PCI group

P < 0.001

1.5 days

Radial

2.0 days

Femoral
Procedure-Specific Measures of Quality of Life

Measured on 0-10 visual analog scales at 1 week after catheterization

Cooper CJ et al. Am Heart J 1999;138:430-6
Adjusted Costs of Radial PCI:
From 5 US Hospitals

$14,954
$15,784
$14,000
$14,500
$15,000
$15,500
$16,000

Δ $830 favoring radial PCI

P < 0.001

Radial Femoral

Better Nursing Care with Radial PCI

- There is also evidence that nursing workload is reduced.

- In a single-center study, the time spent to care for patients after PCI was reduced from 174 min with transfemoral access to 86 min with transradial access.

- In addition, nursing time outside the catheterization laboratory on the medical ward was also reduced from 720 min with transfemoral access to 386 min with transradial access.

Outcomes of Radial vs. Femoral Access

Meta-analysis of 23 RCTs of Radial vs. Femoral Access

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- **Death, MI or stroke**: Radial better, 0.71 (0.49-1.01)

Outcomes of Radial vs. Femoral Access

Meta-analysis of 23 RCTs of Radial vs. Femoral Access

- Major bleeding: Radial better, 0.27 (0.16-0.45)
- Death: Radial better, 0.74 (0.42-1.30)
- Death, MI or stroke: Radial better, 0.71 (0.49-1.01)
- PCI Procedure Failure: Radial better, 1.31 (0.87-1.96)
- Access site cross-over: Radial better, 3.82 (2.83-5.15)

Specific Skills Required for Radial PCI

- Catheter manipulation needed for coronary cannulation
- Learning curve ~ 100 cases
- Cases where it is difficult to reach the ascending aorta
  - Vascular anomalies
  - Elderly, hypertensive patients
  - Increased tortuosity of the radial and subclavian arteries
## Learning Curve

<table>
<thead>
<tr>
<th></th>
<th>&lt;80 Patients</th>
<th>&gt;80 Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access failure</td>
<td>14%</td>
<td>2%</td>
</tr>
<tr>
<td>Sheath insertion time</td>
<td>10.2 ± 7.6 min</td>
<td>2.8 ± 2.5 min</td>
</tr>
<tr>
<td>Procedure time</td>
<td>25.7 ± 12.9 min</td>
<td>17.4 ± 4.7 min</td>
</tr>
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</table>

Access
Guide Catheter Selection and Problems
Can I go Radial??
Start with the Barbeau Test
Barbeau Test

No damping of pulse tracing immediately after radial artery compression

Damping of pulse tracing

Loss of pulse tracing followed by recovery of pulse tracing within 2 minutes

Loss of pulse tracing without recovery within 2 minutes.

Variations of the Superficial Palmar Arch

A. Typical radioulnar communication (35%).
B. Formation of complete arch by the ulnar artery (39%).
C. Completion of arch by ulnar and median arteries (4%).
D. Joining of ulnar, median, and superficial branches of the radial artery (1%).
E. Incomplete arch; formation of the proper digital arteries by the radial and ulnar arteries without communication between the radial and ulnar arteries superficially (16%).
F. Contribution of ulnar, median, and superficial branches of the radial artery to the digital vessels, without communication between the branches at the superficial level (5%).
Hand Ischemia
Secondary to Radial Cath?
Hand Ischemia Following Radial Artery Cannulation

Patient Setup
Patient Setup in the Cathlab

- The “Banjo Board” is placed with the large end near the controls.
- There should be no gap between the controls and the board.
- Else it is difficult to maintain a rail for device insertion.
Local Anesthesia

Radial Artery

Ulnar Artery
Local Anesthesia

Site of Puncture
1-3 cm above wrist joint

1-2 cc of lidocaine
AVOID the median nerve
Ideal Site for Puncture

IDEAL SITE

FLEXOR CREASE

2-3 cm.
Puncture techniques

- Single wall puncture
  - Bare metal needle, identical to femoral access

- Double wall puncture
  - Sheathed needle, advanced through the back wall of the vessel, specific for radial access
Radial Access – Single Wall Puncture Technique

Radial Puncture

1. Fix the radial artery with the index and middle finger of your left hand. Puncture the radial artery with a Jelco with the bevel pointing upward. The angle between the Jelco and the forearm should be 30 to 45 degrees.
2. Push the Jelco along the line of the arterial pulsations and watch for the backflow of blood in the hub of the needle. Backflow indicates a successful puncture of the radial artery.
Double Wall Puncture Technique – helpful for small vessels

Patel’s Atlas of transradial intervention
Sheath placement - skin incision is optional

Patel’s Atlas of transradial intervention
Be gentle when introducing the sheath.
Radial Access Summary

**Single Wall Technique**
- Use short metal needles
- Familiar to “femoralists”
- May have lower success rates

**Double Wall Technique**
- Use sheathed needles
- Requires training, but may allow faster access
- Back wall puncture theoretically associated with more vessel trauma and more spasm

- Use hydrophilic sheaths
- Suture them once placed
- Anticoagulate and use spasm - treating drugs
  - 5000 units heparin
  - 3-5 mg Verapamil
Advancing Catheters to the Aorta: Problems and Difficulties
Understanding Mechanisms and Predictors of TR PCI Procedural Failure

TR PCI Procedural Failures (N=98)

- Failure of arterial access
  - Inadequate arterial puncture 13 (13)
- Failure to advance catheter into ascending aorta
  - Radial artery spasm 33 (34)
  - Radial artery loop/tortuosity 10 (10)
  - Radial artery dissection 6 (6)
  - Radial artery stenosis 1 (1)
- Failure to complete PCI due to lack of guide support
  - Subclavian tortuosity 18 (18)
  - Inadequate guide back up support 17 (17)

Dehghani et al. JACC Intv 2009
Small arteries, loops, tortuosity and unfavorable arch
Small radial arteries represent a challenge for access

- 1.7 mm or less
- Small wrist
- Calcified, atherosclerotic

- Avoid hypotension
- Avoid cold saline
- Good sedation
- Consider double wall puncture
Radial looping and high takeoff

- Identify prior to anticoagulation
- Angiography if resistance
- 4F Glide catheter, coronary wire
- Straighten with a 0.35 wire
  - Semi-pronated arm
- Complete the procedure
Radial looping and high takeoff
Subclavian and innominate artery tortuosity

- Straight 0.35 wire
- Resistance – angiography
- Do not push
- Maintain wire purchase
  - Long wire vs. hydrophilic exchange
- Avoid braking catheters
Unfavorable arch

- LAO view Z shape
- Bicuspid AV
- Anomalies

- Breath assist
- Right coronary angiogram / PCI is easy
- Left coronary: wire support, 5F catheters
Catheter selection for diagnosis and intervention
Manipulation

- Advance catheter over guidewire
- Before removing wire, direct tip toward target
- Most femoral catheters not designed for radial approach
  - More manipulations & attempts may be required, especially early in the learning curve
- Do not try a new guiding catheter if the current one does not immediately cannulate the target vessel
  - Try to engage the coronary arteries directly or via the aortic valve
  - Try deep inspiration and expiration
  - Try changing catheter stiffness and configuration with aid of a guidewire (with or without valve)
Catheter Selection

- Engagement of the left main via the right radial artery requires smaller catheters compared with those used for femoral or left radial procedures.
  - (e.g., JL3.5 compared with JL4, XB3 compared with XB3.5)

- Engagement of the coronary ostia may be facilitated by leaving the guidewire within the catheter to enhance torquability.
Use of a smaller injecting syringe (i.e., 8 mL rather than 12 mL) or a power injector may optimize angiography with 5F catheters.

Limit exchanges, using a single catheter (Jacky, Sarah, Tiger, AL1, AL2, Kimny, Barbeau) for both left and right coronary angiography.

Catheter exchanges should always be performed with a guidewire remaining in the ascending aorta.
“One-Step” Diagnostic Catheters

- Enable angiography of both RCA and LCA with one catheter
- Eliminates catheter exchange step
- Shortens procedure and fluoroscopic time
- 5 Fr – Can be difficult to inject
## Transradial Guiding Catheter Shape Selection

<table>
<thead>
<tr>
<th></th>
<th>Left Coronary Artery</th>
<th>Right Coronary Artery</th>
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<tbody>
<tr>
<td>Left Radial</td>
<td>Standard catheters</td>
<td></td>
</tr>
<tr>
<td>Right Radial</td>
<td>XB/EBU ↓0.5</td>
<td>JR 5&gt;4</td>
</tr>
<tr>
<td></td>
<td>Amplatz L</td>
<td>Amplatz R/L</td>
</tr>
<tr>
<td></td>
<td>Ikari Left</td>
<td>Ikari Left or Right</td>
</tr>
<tr>
<td>SVG</td>
<td>Left radial: Standard guiding catheters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Right radial: Amplatz, Ikari Left, JR, XBR</td>
<td></td>
</tr>
<tr>
<td>LIMA</td>
<td>JR 3.5/4, IMA</td>
<td></td>
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Ikari Left (A) and Right (B)
Ikari Guide Catheters

\[ F \cos \theta = f \cos \theta' + \lambda \]

\[ f \cos \theta' + \lambda \]

\[ F_{\text{max}} = \frac{f \cos \theta' + \lambda}{\cos \theta} \]

Maximum backup force is achieved if
\[ \theta = 90 \text{ degree}; \theta' = 0 \text{ degree}; \text{ or } \lambda \text{ is large} \]

Ikari et al. J Invasive Cardiol 2005;17:636-41
Ikari Left Guide Catheters

Curve A to fit angle of brachiocephalic artery

Straight portion (20 mm) B to generate strong back-up force supported by opposite side of aorta wall
Ikari Left Guide Catheters
Comparison with Judkins Left

A
Judkins

B
Judkins
Relationship Between Back Up Support and Static Friction (Resistance)

![Graph showing resistance values for different conditions: JL4, JL4deep, BL3.5, IL4, IL4power. The graph includes error bars indicating variability.]
Ikari Right Guide Catheters

Curve A to fit angle of brachiocephalic artery

Straight portion B to generate strong back-up force supported by opposite side of aorta wall.
Ikari Right and Left Guide Catheters for RCA

The area of contact on the contralateral aorta of IR & IL for RCA is greater than the JR. Therefore, IR & IL for RCA generate greater backup force than the JR.
Kimny
Complex PCI with 6 Fr Guiding Catheters Procedural Outcomes with Ikari Catheter

<table>
<thead>
<tr>
<th>Angiographic Characteristics</th>
<th>N=601</th>
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<tbody>
<tr>
<td>Left main</td>
<td>5.6%</td>
</tr>
<tr>
<td>Bifurcation</td>
<td>17.4%</td>
</tr>
<tr>
<td>Multivessel PCI</td>
<td>32.9%</td>
</tr>
<tr>
<td>CTO</td>
<td>16.3%</td>
</tr>
<tr>
<td>ACC/AHA Class B2/C Lesion</td>
<td>89.3%</td>
</tr>
<tr>
<td>Right and left in same procedure (same catheter)</td>
<td>98.1%</td>
</tr>
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<table>
<thead>
<tr>
<th>Procedural and In-Hospital Outcomes</th>
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<tr>
<td>Device success</td>
<td>96.6%</td>
</tr>
<tr>
<td>Procedure success</td>
<td>98.2%</td>
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Effect of TR- vs TF- Primary PCI on Bleeding, Time to Revascularization and 1-Year Outcomes

Door to Balloon Time (min)

<table>
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<tr>
<th></th>
<th>Radial</th>
<th>Femoral</th>
<th>P Value</th>
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<tr>
<td></td>
<td>123±63</td>
<td>129±81</td>
<td>NS</td>
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Arzamendi et al. Am J Cardiol 2010
Thank you!
Questions?
Hemostasis and radial artery patency
Radial artery injury and occlusion

- Vasospasm
- Poor anticoagulation
- Prolonged cannulation
- Multiple exchanges
- Large sheath use (>1:1 sheath to artery ratio)
- Occlusive hemostasis pressure

The most complication to avoid!
Incidence of radial artery occlusion

STEP 3
Manually Occlude

Deflate TR band air by 1 cc slowly until waveform returns
Repeat puncture

- Early (within 48 hours) – access 1 cm higher
- Later – as usual landmarks
- Expect intimal hyperplasia, use smaller sheaths or sheathless guides
- Spasm refractory to drugs = stenosis, Consider long sheath/guide or PTA
Discharge and office follow up
Discharge instructions

- Discharge with the sterile NON-OCCLUSIVE band-aid
- Instruct them to keep it clean and dry for 48 hours
- After 48 hours, replace the band-aid each morning until the site is completely healed
- They may take acetaminophen 650 mg QID x 3 days PRN mild to moderate discomfort
- They may resume driving and usual activities in 24 to 48 hours post-procedure unless otherwise indicated
- They should limit activities to self care only for the first 12 hours after procedure. Avoid heavy lifting and repetitive movements for 48 hours. Avoid strenuous exercise for 1 week
Office site check

- Reassurance, sterile dressing, pain control
- Radial artery patency testing
- Imaging not needed in vast majority of patients
- Notify physician of sudden arm numbness, pain with occluded radial artery
Complications of transradial catheterization, troubleshooting and case review
Complications

- Radial artery injury and occlusion
- Forearm hematoma
- Inflammatory skin reaction
- Arterial avulsion and bleeding
- Pseudoaneurysm and AV fistula
Hematoma and radial artery occlusion
Radial artery injury and occlusion

- Vasospasm, poor anticoagulation, prolonged cannulation and prolonged occlusive pressure, large sheath use (>1:1 sheath to artery ratio)
- Provide meticulous patent hemostasis
TR band and IV catheter use
Nonhealing wound
Sterile inflammation

Torque transmission resulting in avulsion injury
Radial Artery Avulsion After Prolonged PCI
Rules

Radial is Different than Femoral

- Precise puncture & never push (finesse over muscle)
- Prophylactic antispasm medication is needed
  - Verapamil 3 mg
- Anticoagulate to prevent (reduce) thrombosis
  - Heparin ~5,000 U (50-70 U/Kg in lighter patients)
- Hold on to hard won territory (exchange wire or jet-catheter exchange technique)
- Find a catheter series that works best for you (practice makes perfect)
- Remove the sheath at the end of the case
Thank you