Cath Lab Essentials: Transradial Cardiac Catheterization

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WHY CHOOSE THE TRANSRADIAL TECHNIQUE FOR YOUR PATIENTS?...
AND NOT FEMORAL
History

- Dr. Lucien Campeau - first published experience with percutaneous transradial coronary catheterization in 1989

- Ferdinand Kiemeneij - first transradial PTCA in Amsterdam followed by the first transradial stent in 1993
Radial versus Femoral approach for diagnostic and PCI procedures:

Systemic overview and meta-analysis

12 randomized trials n = 3234

(J Am Coll Cardiol 2004 44: 349-356)
**Comparison: radial versus femoral access**

<table>
<thead>
<tr>
<th>Major vascular complications</th>
<th>RADIAL</th>
<th>FEMORAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiemeneij F et al J Am Coll Cardiol 1996</td>
<td>0</td>
<td>2%</td>
</tr>
<tr>
<td>Tift Mann et al J Invas Cardiol 1996</td>
<td>0</td>
<td>4%</td>
</tr>
<tr>
<td>Ziakas A et al Am J Cardiol 1998</td>
<td>0</td>
<td>1.5%</td>
</tr>
<tr>
<td>Tift Mann et al J Am Coll Cardiol 1998</td>
<td>0</td>
<td>4%</td>
</tr>
<tr>
<td>Choussat R et al Eur Heart J 2000</td>
<td>0</td>
<td>4.5%</td>
</tr>
<tr>
<td>Hildic S et al Catheter Cardiovasc Interv 2000</td>
<td>0</td>
<td>6%</td>
</tr>
<tr>
<td>Louvard Y et al Catheter Cardiovasc Interv 2002</td>
<td>0</td>
<td>1.3%</td>
</tr>
<tr>
<td>Saito S et al Catheter Cardiovasc Interv 2002</td>
<td>0</td>
<td>3%</td>
</tr>
<tr>
<td>Valsecchi O et al Ital Heart J 2003</td>
<td>0</td>
<td>1.2%</td>
</tr>
<tr>
<td>Philippe F et al Catheter Cardiovasc Interv 2003</td>
<td>0</td>
<td>5.5%</td>
</tr>
<tr>
<td>Lefevre T (TCT 2003)</td>
<td>0</td>
<td>2.3%</td>
</tr>
<tr>
<td>Pooled data</td>
<td>0</td>
<td>3.8%</td>
</tr>
</tbody>
</table>
Prior Meta-analysis of 23 RCTs of Radial vs. Femoral (N=7030)

<table>
<thead>
<tr>
<th>Event</th>
<th>Radial better</th>
<th>1.0</th>
<th>Femoral better</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major bleeding</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death, MI or stroke</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCI Procedure Failure</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Major bleeding: 0.27 (0.16-0.45)
- Death: 0.74 (0.42-1.30)
- Death, MI or stroke: 0.71 (0.49-1.01)
- PCI Procedure Failure: 1.31 (0.87-1.96)

Bleeding is associated with Death and Ischemic Events


N=34,146
OASIS Registry, OASIS 2, CURE trials

HR 5.37 (3.97-7.26)
HR 4.44 (3.16-6.24)
HR 6.46 (3.54-11.79)

Death
MI
Stroke

No Major Bleed
Major Bleed
Randomized comparison of RadIal Vs. femorAL access for coronary intervention in ACS (RIVAL)

<table>
<thead>
<tr>
<th>Primary Outcome</th>
<th>2N</th>
<th>% Radial</th>
<th>% Femoral</th>
<th>Interaction p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NSTE/ACS</strong></td>
<td>5063</td>
<td>3.8</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td><strong>STEMI</strong></td>
<td>1958</td>
<td>3.1</td>
<td>5.2</td>
<td>0.025</td>
</tr>
</tbody>
</table>

**Death, MI or stroke**

<table>
<thead>
<tr>
<th>Primary Outcome</th>
<th>2N</th>
<th>% Radial</th>
<th>% Femoral</th>
<th>Interaction p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NSTE/ACS</strong></td>
<td>5063</td>
<td>3.4</td>
<td>2.7</td>
<td>0.011</td>
</tr>
<tr>
<td><strong>STEMI</strong></td>
<td>1958</td>
<td>2.7</td>
<td>4.6</td>
<td></td>
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</tbody>
</table>

**Death**

<table>
<thead>
<tr>
<th>Primary Outcome</th>
<th>2N</th>
<th>% Radial</th>
<th>% Femoral</th>
<th>Interaction p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NSTE/ACS</strong></td>
<td>5063</td>
<td>1.2</td>
<td>0.8</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>STEMI</strong></td>
<td>1958</td>
<td>1.3</td>
<td>3.2</td>
<td></td>
</tr>
</tbody>
</table>

**Non CABG Major Bleed**

<table>
<thead>
<tr>
<th>Primary Outcome</th>
<th>2N</th>
<th>% Radial</th>
<th>% Femoral</th>
<th>Interaction p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NSTE/ACS</strong></td>
<td>5063</td>
<td>0.6</td>
<td>1.0</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>STEMI</strong></td>
<td>1958</td>
<td>0.8</td>
<td>0.9</td>
<td></td>
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</tbody>
</table>

**Major Vascular Complications**

<table>
<thead>
<tr>
<th>Primary Outcome</th>
<th>2N</th>
<th>% Radial</th>
<th>% Femoral</th>
<th>Interaction p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NSTE/ACS</strong></td>
<td>5063</td>
<td>1.4</td>
<td>3.1</td>
<td>0.89</td>
</tr>
<tr>
<td><strong>STEMI</strong></td>
<td>1958</td>
<td>1.3</td>
<td>3.5</td>
<td></td>
</tr>
</tbody>
</table>
RIVAL : conclusions

- No significant difference between radial and femoral access in primary outcome of death, MI, stroke or non-CABG major bleeding.

- Rates of primary outcome appeared to be lower with radial compared to femoral access in high volume radial centres and STEMI.

- Radial had fewer major vascular complications with similar PCI success.
Cost of bleeding complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myocardial Infarction</td>
<td>$4,084</td>
</tr>
<tr>
<td><strong>Bleeding Complication</strong></td>
<td>$6,300</td>
</tr>
<tr>
<td>Repeat PCI</td>
<td>$8,187</td>
</tr>
<tr>
<td>In-Hospital CABG</td>
<td>$29,056</td>
</tr>
</tbody>
</table>

Patient preference for catheterization

Cooper et al., American Heart Journal 1999
Transradial Catheterization

Advantages:
- Lack of access site complications
- Improved quality of care
- Reduce cost
- Same day discharge
- Coronary and peripheral vascular interventions are possible in most cases.

Limitations:
- Technically difficult:
  - Access failure.
  - Radial spasm.
  - Radial and Subclavian artery loops/tortuosity
  - Learning curve to master technique
Patient selection: risk factors for transfemoral access

<table>
<thead>
<tr>
<th>Clinical</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Puncture location</td>
</tr>
<tr>
<td>Elderly</td>
<td>Large Sheath</td>
</tr>
<tr>
<td>Obese</td>
<td>Long sheath time</td>
</tr>
<tr>
<td>Low Body Weight</td>
<td>Large device, e.g. IABP</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Venous sheath</td>
</tr>
<tr>
<td>Anticoagulation, thrombocytopenia</td>
<td>Repeat Access</td>
</tr>
<tr>
<td>Renal Failure</td>
<td></td>
</tr>
</tbody>
</table>
Contraindications

- **Absolute contraindications:**
  - Approximately 10% of the population will have an abnormal Allen's test.
  - Patients who may require large size devices
  - Patients who require devices not compatible in smaller sheaths (larger Rotoblator burrs).
  - Patients (less than 5%) with known upper extremity vascular disease (including extreme tortuosity, anomalous take off of the radial artery, or severe atherosclerosis).
  - Patients with Buerger's Disease, severe Raynauds, or other forms of upper extremity peripheral vascular disease.

- **Relative contraindications:**
  - Patients with known internal mammary grafts contralateral to the site of entry.
  - When the radial artery may be considered as a conduit for coronary artery bypass grafting or for a dialysis graft.
Allen’s test and RA occlusion

First described in 1929 by Dr. Edgar Van Nuys Allen as a means to evaluate collateral circulation simultaneously in both hands of patients with thromboangiitis obliterans
The criteria for an abnormal Allen’s test result are not agreed upon, and the significance of an equivocal or abnormal test result is unclear.
Modified Allen’s Test with Plethysmography

- A pulse oximetry test is performed with the probe placed on the patient’s thumb.

- Persistence of waveform and high oximetry after digital occlusion of the radial artery is strong evidence of sufficient collateral flow to prevent hand ischemia if the radial artery should become occluded.
Modified Allen’s Test: which patients to select

- Modified Allen’s test to assess patency of the palmar arterial arches. Barbeau Classification

- The presence of an arterial waveform (even if delayed or with reduced amplitude) and a hemoglobin oxygen saturation > 90% (Barbeau grades A, B, and C) confirms the adequacy of a collateral vascular supply to the hand.

- An arm with an abnormal modified Allen’s test result (Barbeau grade D) should be avoided.

- *Biloudeau et al. Cardiac Interventions Today. March/April 2010*
Radial Artery Anatomy

- Level of the wrist, the RA lies atop of the scaphoid bone, the trapezium and the external lateral ligament.

- The RA has a bifurcation to the superficial palmar branch at the wrist. If one tries to cannulate the artery too distal, they will encounter the reticulum and find the artery is diving deep and lateral.
Variation in anatomy

Fujii et al. Journal of Invasive Cardiology. Vol 22 (8); 2010.

To determine the optimal radial puncture point. Analyzed the anatomy and luminal diameter of the right radial artery (RA) by quantitative angiography.
It is important therefore to attempt cannulation approximately 1-3cm from the flexion crease of the wrist.

The ulnar artery also branches off the brachial artery and passes along the inner aspect of the forearm. At the level of the wrist, it divides into two branches that join the radial artery and its superficial branch to form the deep and superficial palmar arches.
Cumulative frequency of radial artery diameter

(black line: male patients; gray dotted line: female patients). Colored flags denote the outer diameter of the Glidesheath and Pinnacle (Terumo Interventional Systems) lines of hydrophilic introducer sheaths.
Radial artery friction and spasm

Radial artery
(Lumen 1.8-2.5mm)

Femoral artery
(Lumen 8.5-12mm)

Catheter/Sheath

Vessel wall

6F

5F: 1.65 mm
6F: 1.98 mm
7F: 2.31 mm

www.drsvenkatesan.com
Work closely with staff

Organization, delegation and collaboration among healthcare professionals to get new program started

A transradial access creates a protocol that will provide consistency for each case
Have everything prepared for access
US access of RA
The Radial Artery Access with Ultrasound Trial (RAUST) - A. Seto et al

- Ultrasound reduced the number of attempts needed to insert the needle as well as the mean and median times to sheath insertion.

- US also increased the odds that the first pass would be successful.
Access failure

- The radial loop is the most common congenital anomaly of the radial artery and may be a cause of access failure.

- It occurs in 1-2% of patients and may be unilateral or bilateral.

- Wide loops can be crossed with hydrophilic guidewires and 5 Fr catheters.
Radial Artery Spasm

- No additional effect on spasm when verapamil added to nitroglycerin intra-arterially. Suggested administration of nitroglycerin 100 µg together with heparin (1)

- Spasm thought to be mediated by stimulation of alpha-adrenoreceptors, and alpha-blockers like phentolamine (2)

- Verapamil was a stronger spasmolytic agent (2)

- The beneficial effect of a hydrophilic sheath in spasm management has been demonstrated by several other groups as well (3,4)

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Figure: Bazemore et al Journal Of Invasive Cardiol. Vol: 13; May 01 2005

Perforation
Venous procedures via the arm in conjunction with transradial access
1929 : Werner Forssmann hypothesized that a catheter could be inserted directly into
the heart, for such applications as directly delivering drugs, injecting radiopaque
dyes, or measuring blood pressure. Successfully demonstrated that human heart
catheterization was possible and safe.
UE Venous anatomy

- Entire forearm rich source of veins
- Upper forearm veins > 10mm diameter
- Medial (ulnar region) veins → basilic → brachial → axillary → subclavian vein.
- Lateral (radial) drain into cephalic or basilic vein—T junction → axillary vein.

Figure: Veins of the forearm. (Adapted from Kimber DC, Gray CE. Anatomy and Physiology for Nurses-5th Ed, New York: Macmillian Company, 1919). Gilchrist. Card Int Today, March 2010
**UE Venous anatomy**

- T junction intersection at right angle. Impedes passage of large, stiff catheter. Venogram may assist.
- Hydrophilic 5Fr sheath
- 5Fr balloon tipped and thermodilution catheters
- Balloon tipped catheter inflated only when T junction has been crossed
- NTG for venospasm (rare)
- Ca antagonists not useful

Figure: Veins of the upper arm. (Adapted from Kimber DC, Gray CE. Anatomy and Physiology for Nurses-5th Ed, New York: Macmillian Company, 1919.) Gilchrist. Card Int Today, March 2010
Easier through the arm....
If no peripheral IV - other techniques: Ultrasound
Access – other techniques
Access
Navigating vascular loops
Bypass grafts and transradial

Angiogram of artery
Engage SVG and LIMA
Transfemoral complications and Renal artery take-off

- Hematoma at puncture site
- Bleeding (minor and major)
- FA aneurysm
- Groin hematoma requiring transfusion or surgery
- Occlusion of CFA
- Infection
- Pseudoaneurysm

Schematic representation of average take-off angle of renal arteries from aorta derived from post-mortem study in humans (Wozniak WT. Folla Morphol-Warsz 2000) Angle A 75°, Angle B 85°

Trani et al. Catheterization and Cardiovascular Interventions 2009
RA stenting with MP and JR catheter

Trani et al. Catheterization and Cardiovascular Interventions 2009
Transradial closure devices

Hemoband
TR Band
Bengal Band
Finale
Helix
RadiStop
Summary: transradial catheterization

- Start with diagnostic cases then move to PCI. May be more difficult in smaller (< 65 inches) individuals
- Show commitment, train and encourage staff
- Take time in improving your and staff skills
- Perform modified Allen’s test with Barbeau classification
- Reduce patient anxiety. Good sedation/pain control: spasm
- Cross over to other wrist or FA for initial failed TR procedure
- Right heart catheterization, temporary pacing wire, or even right ventricular biopsy can be performed via the arm in concert with transradial arterial approach.