CARE OF THE PATIENT FOLLOWING CARDIAC CATHETERIZATION

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Providence Little Company of Mary Hospital
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Overview

- Types of procedures done in the cardiac catheterization laboratory
- Know and recognize potential complications that can result from each type of procedure
- Prepping the patient before the lab
- Post-procedural care
- Access site management
- Troubleshooting
  - Cardiac
  - Vascular
  - Pulmonary
  - Neuro
The Cath Lab...
Indications for catheterization procedures

- Acute coronary syndrome
  - STEMI, NSTEMI, unstable angina
- Pre-operative coronary assessment
  - Aortic stenosis, mitral valve regurgitation, high-risk vascular surgery
- Coronary/hemodynamic evaluation in CHF or valve disease
- Pulmonary hypertension
- Peripheral arterial disease including claudication, acute limb ischemia, and critical limb ischemia
  - Gangrene, nonhealing lower extremity wounds
- Cardiac tamponade
- Cardiogenic shock requiring hemodynamic support
- Heart block/Bradycardia
Cardiac Catheterization Procedures

- Right/Left heart catheterization
Cardiac Catheterization Procedures

- Right/Left heart catheterization
- Diagnostic coronary angiography
- Percutaneous coronary intervention (PCI):
  - Balloon angioplasty (PTCA)
  - Stenting
  - Atherectomy (Rotablator, Diamondback)
- Peripheral angiography
- Peripheral intervention
  - Atherectomy
  - Thrombectomy (Angiojet)
  - Lysis
  - Angioplasty and stenting
Cardiac Catheterization Procedures

- Electrophysiologic procedures
  - Device placement (PPM, ICD)
  - EP studies and ablations
  - Transseptal puncture
- Temporary transvenous pacing
- Pericardiocentesis
- Percutaneous aortic balloon valvuloplasty
- Transcatheter aortic valve replacement*
Cardiac Catheterization Procedures

a

b

c
Cardiac Catheterization Procedures

- Hemodynamic support catheters
  - Intraaortic balloon pump (IABP)
  - Impella
Complications of Cardiac Catheterization

• Death
• AMI
• Dysrhythmia
• Stroke
• Bleeding
• Hematoma
• Vascular Injury
• Contrast Induced Nephrotoxicity
• Allergic reactions/Anaphylaxis
• Pulmonary Edema
• Air/clot embolism
• Vagal reaction
## Major Complications

**Risk of cardiac catheterization and coronary angiography (based on 59,792 patients)**

<table>
<thead>
<tr>
<th>Complication</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>0.11</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0.05</td>
</tr>
<tr>
<td>Cerebrovascular accident</td>
<td>0.07</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>0.38</td>
</tr>
<tr>
<td>Vascular complications</td>
<td>0.43</td>
</tr>
<tr>
<td>Contrast reaction</td>
<td>0.37</td>
</tr>
<tr>
<td>Hemodynamic complications</td>
<td>0.26</td>
</tr>
<tr>
<td>Perforation of heart chamber</td>
<td>0.28</td>
</tr>
<tr>
<td>Other complications</td>
<td>0.28</td>
</tr>
<tr>
<td>Total of major complications</td>
<td>1.70</td>
</tr>
</tbody>
</table>

**Multivariate predictors of major complications of coronary angiography (based on 58,332 procedures)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moribund</td>
<td>10.22</td>
</tr>
<tr>
<td>Shock</td>
<td>6.52</td>
</tr>
<tr>
<td>Acute MI &lt;24 h</td>
<td>4.03</td>
</tr>
<tr>
<td>Renal insufficiency</td>
<td>3.30</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>3.29</td>
</tr>
<tr>
<td>Aortic valve disease</td>
<td>2.72</td>
</tr>
<tr>
<td>Mitral valve disease</td>
<td>2.33</td>
</tr>
<tr>
<td>Heart failure</td>
<td>2.33</td>
</tr>
<tr>
<td>New York Heart Association</td>
<td></td>
</tr>
<tr>
<td>Class I</td>
<td>1.00</td>
</tr>
<tr>
<td>Class II</td>
<td>1.15</td>
</tr>
<tr>
<td>Class III</td>
<td>1.32</td>
</tr>
<tr>
<td>Class IV</td>
<td>1.52</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.45</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>1.42</td>
</tr>
<tr>
<td>Outpatient/inpatient</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Moribund indicates a patient who responds poorly due to a life threatening condition.

MI: myocardial infarction.

Patient Preparation

• NPO for at least 6 hours
• Anticoagulation status
  • Is patient on coumadin, xarelto/eliquis/pradaxa, heparin
• Antiplatelet status
  • ASA, plavix, brilinta, effient
• Ability to lay flat
  • CHF, pulmonary edema
• Patient’s mental status and ability to cooperate
• Code status
  • Temporary reversal of DNR during procedure should be discussed
• Consent
  • Nursing staff should be familiar with the risks/benefits/alternatives of procedure
Common procedural steps 1

• Patient’s wrist/groin are shaved and sterilized with chlorhexidine
• Pre-operative neurologic baseline established
• Conscious sedation is typically administered (versed, fentanyl, benadryl)
• Access is obtained in the radial or femoral artery, femoral vein
  • Different size catheters may be introduced into the vessel, most commonly a 6 French catheter, =2mm in diameter
  • The larger the catheter, the higher the risk of vascular complications
Case Begins and Ends with ACCESS
Access sites

- **Radial artery**
  - Reduced risk of bleeding, vascular complications, death
  - Improved patient comfort

- **Femoral artery**
  - Operator experience
  - Higher vascular complications
  - Bedrest is necessary

- **Brachial artery**
  - Highest vascular complication rate
  - Rarely necessary

- **Femoral vein**

- **Antecubital vein**

- **Internal jugular vein**
Access Sites - Alternative

- Popliteal access
  - Rare access for select peripheral interventions
Access Sites- Alternative

- Pedal access
  - Select peripheral interventions
  - Access via dorsalis pedis, anterior tibial, or posterior tibial artery
Common procedural steps 2

- Depending on the type of procedure performed, anticoagulation may be given
  - For all radial artery catheterizations, heparin is given (usually 3000-5000 units)
  - For PCI or peripheral interventions, heparin or bivalirudin (Angiomax) is given temporarily
  - Additional agents may be given, including Glycoprotein IIbIIIa inhibitors (Integrel)
- Specific catheters, guidewires, and balloons/stents are used to complete procedure
Common procedural steps 2

• If PCI is performed, it is absolutely necessary that the patient has received ASA and an additional antiplatelet agent (plavix/effient/brilinta) by the termination of the case
  • Stent thrombosis may occur
    • Abrupt closure of a stent via thrombus formation
    • Carries nearly a 50% mortality rate
Common procedural steps 3

- At termination of procedure, access site is addressed
  - Radial artery: TR band is placed
  - Femoral artery
    - Closure device
      - AngioSeal
      - PerClose
      - StarClose
      - Mynx
    - Sheath is left in place
    - Manual compression
Sheath Removal

- Very important to perform correctly
- Remove ONLY if off anticoagulation and if PTT or ACT is below MDs specified order
- Potential complications (can occur even if closure device used)
  - Vasovagal response
  - Inadequate hemostasis resulting in:
    - Pseudoaneurysm (more common in “low” sticks)
    - Hematoma
    - Retroperitoneal bleed (more common in “high” sticks)
  - Hypotension
  - Compartment syndrome
  - Embolization
  - Arterovenous fistula
  - Death
Sheath Removal

RP

PSA
Manual Compression

- Anticipate problems!!
  - Venous access
  - Bag of NS hanging
  - Atropine at bedside
  - Recycle cuff every 5 minutes while pulling
  - Have assistance nearby
- For sheath sizes 7 Fr or less, typical hold time should be 20 minutes
- Always aspirate the sheath first to remove any clots
  - If sheath is not aspirating, hold negative suction on sheath as you remove
- Avoid full compression as you are removing sheath to avoid “shearing” off clot
- Hold 2-3cm above sheath insertion site, this is where sheath enters artery, over femoral head
- Full pressure x5 mins, lighten pressure every 5 mins
Assess Access Site For…

• Bleeding
• Hematoma
• Distal pulses/color/temperature
  • Embolization or access site closure due to thrombosis or dissection
• Tenderness
## Femoral Artery Access Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry site bleeding</td>
<td>173</td>
<td>1.25%</td>
</tr>
<tr>
<td>Hematoma</td>
<td>278</td>
<td>2.00%</td>
</tr>
<tr>
<td>Retroperitoneal bleeding</td>
<td>26</td>
<td>0.19%</td>
</tr>
<tr>
<td>Dissection</td>
<td>25</td>
<td>0.18%</td>
</tr>
<tr>
<td>Pseudoaneurysm</td>
<td>45</td>
<td>0.32%</td>
</tr>
<tr>
<td>Surgical device removal</td>
<td>6</td>
<td>0.04%</td>
</tr>
<tr>
<td>Entry site infection</td>
<td>2</td>
<td>0.03%</td>
</tr>
<tr>
<td>Occlusion</td>
<td>10</td>
<td>0.07%</td>
</tr>
<tr>
<td>Pulse loss</td>
<td>7</td>
<td>0.05%</td>
</tr>
<tr>
<td>Fistula</td>
<td>3</td>
<td>0.02%</td>
</tr>
<tr>
<td>Any vascular complication</td>
<td>468</td>
<td>3.37%</td>
</tr>
</tbody>
</table>

Femoral Complications

- Rare, but potentially catastrophic
- Early recognition and management is key
- The groin/leg/retroperitoneal spaces are large and can hide large quantities of blood before evident

Hematoma  Pseudoaneurysm
Groin Hematoma

- Usually evident within 12 hours of sheath removal
- Local discomfort, hypotension
- Avoid by careful puncture, compression, closure, immobility
- Risk factors
  - Women
  - SBP > 160 mm Hg
  - Artery puncture >1
  - Sheath time > 16 min
  - ACT ≥ 175 sec
  - Glycoprotein (GP) IIB/IIIa inhibitors
  - Low Molecular Weight Heparin before procedure
  - Personnel change during compression
  - Anti-coagulant-treatment before procedure
Retroperitoneal Hematoma

- Bleeding into the retroperitoneal space
- Initially may go undetected since no bleeding occurs at the surface
- Results in significant bleeding with hypotension, flank pain
- Diagnosis with CT or ultrasound
Retroperitoneal Bleeding

Grey Turner’s Sign

Cullen’s Sign
## Femoral Access Site Risk Factors

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>1.73</td>
<td>[1.38–2.17]</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Sheath size (actual size)</td>
<td>1.32</td>
<td>[1.13–1.54]</td>
<td>0.0004</td>
</tr>
<tr>
<td>Renal failure</td>
<td>1.70</td>
<td>[1.08–2.68]</td>
<td>0.02</td>
</tr>
<tr>
<td>Emergency indication</td>
<td>1.43</td>
<td>[1.08–1.89]</td>
<td>0.01</td>
</tr>
<tr>
<td>Previous PCI</td>
<td>0.76</td>
<td>[0.59–0.98]</td>
<td>0.3</td>
</tr>
<tr>
<td>Interventional cath.</td>
<td>3.18</td>
<td>[2.40–4.22]</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Institutional cath. volume</td>
<td>0.50**</td>
<td>[0.39–0.63]</td>
<td>&lt; 0.0001</td>
</tr>
</tbody>
</table>

*Other variables that were included in the original model, but then discarded because of lack of statistical significance include: age, race, body mass index, New York Heart Classification (NYHC), diabetes, hypertension, peripheral vascular disease, left main coronary artery stenosis, shock, and history of congestive heart failure.

**Odds ratio pertains to a comparison of institutions with more than the average number of catheterizations (562) vs. those with less.

Access Site Care- Radial Artery

- TR band placed at termination of case
TR Band

• Radial
  • While TR band is on, check wrist every 15 minutes for bleeding, hematoma, cap refill, color, warmth, and pulse oximetry signal
  • Start to deflate in 2 hours following diagnostic procedure, per protocol
  • Start to deflate in 4 hours following intervention
  • Once off, check site every 15 minutes for the first hour, then every 30 minutes for the next hour, then every hour for the next two hours
  • Bedrest is NOT necessary
Radial Access Complication- Hematoma

- Notify MD
- Can follow forearm diameter
- Elevate arm
- Place additional TR band above/below initial band
- CoFlex wrap to moderate pressure up to forearm
- Inflate BP cuff to <20mmHg of systolic pressure if grade III/IV hematoma, deflate every 15 minutes
  - Can place pulse oximeter on finger to ensure presence of waveform
- Place bag of ice or cold compress on hematoma
EASY Hematoma Classification after Transradial/Ulnar PCI

<table>
<thead>
<tr>
<th>GRADE</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCIDENCE</td>
<td>≤ 5%</td>
<td>&lt; 3%</td>
<td>&lt; 2%</td>
<td>≤ 0.1%</td>
<td>&lt; 0.01%</td>
</tr>
<tr>
<td>DEFINITION</td>
<td>Local hematoma, superficial</td>
<td>Hematoma with moderate muscular infiltration</td>
<td>Forearm hematoma and muscular infiltration, below the elbow</td>
<td>Hematoma and muscular infiltration extending above the elbow</td>
<td>Ischemic threat (compartment syndrome)</td>
</tr>
<tr>
<td>TREATMENT</td>
<td>Analgesia, Additional bracelet, Local ice</td>
<td>Analgesia, Additional bracelet, Local ice</td>
<td>Analgesia, Additional bracelet, Local ice, Inflated BP cuff</td>
<td>Analgesia, Additional bracelet, Local ice, Inflated BP cuff</td>
<td>Consider surgery</td>
</tr>
<tr>
<td>NOTES</td>
<td>Inform physician</td>
<td>Inform physician</td>
<td>Inform physician</td>
<td>Inform physician</td>
<td>STAT call to physician</td>
</tr>
</tbody>
</table>
| REMARKS | - Control blood pressure (BP) (importance of pain management)  
- Consider interruption of any anticoagulation and/or antiplatelet infusion  
- Follow forearm and arm diameters to evaluate requirement for additional bracelet and/or BP cuff inflation  
- Additional bracelet(s) can be placed alongside artery anatomy  
- Ice cubes in a plastic bag or washcloth are placed on the hematoma  
- Finger O2 saturation can be monitored during inflated blood pressure cuff  
- To inflate blood pressure cuff, select a pressure of 20 mmHg < systolic pressure and deflate every 15 minutes  
- After bracelet removal, use “Velpeau bandage” around forearm/arm for a few hours to maintain mild positive pressure |
### Radial vs Femoral Access Complications

<table>
<thead>
<tr>
<th>Types</th>
<th>Radial</th>
<th>Femoral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematoma &gt;5cm</td>
<td>&lt;1%</td>
<td>3-5%</td>
</tr>
<tr>
<td>Pseudoaneurysm</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>A-V Fistula</td>
<td>&lt;1%</td>
<td>1-2%</td>
</tr>
<tr>
<td>Skin Infection</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Dissection/Rupture</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Thrombosis</td>
<td>&lt;1-10%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Distant bleeding</td>
<td>–</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Nerve Injury</td>
<td>–</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>
### Comparison of the Radial and Femoral Approaches for Cardiac Catheterization

<table>
<thead>
<tr>
<th>Metric</th>
<th>Radial</th>
<th>Femoral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of Total Stent Procedures Performed in US</td>
<td>&lt;4</td>
<td>&gt;95</td>
</tr>
<tr>
<td>Bed rest, h</td>
<td>0</td>
<td>2–6</td>
</tr>
<tr>
<td>Procedural success, %*</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Need to switch access site to complete procedure, %*</td>
<td>7.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Major vascular complications, %*</td>
<td>1.4</td>
<td>3.7</td>
</tr>
<tr>
<td>Artery closure requiring surgery, %*</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Patient prefers radial for next procedure, %*</td>
<td>90</td>
<td>50</td>
</tr>
</tbody>
</table>

* Data from the largest randomized comparison between radial and femoral access sites: the Radial Versus Femoral Access for Coronary Angiography and Intervention in Patients With Acute Coronary Syndromes (RIVAL) trial ¹
In Addition to the Access Site, Monitor the Patient including Vitals…

- Every 15 minutes x 4, then every 30 minutes x 2, then every hour
- Assess:
  - Symptoms
    - Chest pain, SOB, back pain, Access site pain, pain in extremity
  - Mental status
    - Stroke, over-sedation
  - Blood pressure
    - SBP>160
    - SBP<90
  - Respiratory status
    - CHF, anaphylaxis (check body for rash)
Troubleshooting

• Think of four organs: CVPN
  • Cardiac
    • Ischemia/Infarction, Tamponade, Arrhythmia, Coronary artery perforation, coronary artery dissection, air embolus, heart block, bradycardia
  • Vascular
    • Aortic dissection, access site complication, distal embolization
  • Pulmonary
    • Pulmonary edema due to CHF or large contrast load, anaphylaxis
  • Neurologic
    • Stroke due to atheromatous/air embolization, sedative effect, global ischemia from shock
Hypotension

- Coronary artery perforation resulting in cardiac tamponade
  - Pericardiocentesis, coil embolization
- Cardiogenic shock due to infarct or ongoing ischemia
  - Vasopressors, IABP or other support device
- RV infarct
  - Triad of clear lungs, elevated JVP, hypotension
  - Treatment: IVF, avoid nitrates, Dobutamine if pressors required
- Bradycardia
  - Temporary pacing wire, vasopressors
- Hypovolemia
- Vagal response
- Arrhythmia
- Access-site bleeding
- Sedation effect
Chest Pain

• Coronary artery dissection
• Acute coronary artery closure
• Ongoing ischemia from residual CAD
• Aortic dissection due to catheter/guidewire manipulation
• Pulmonary embolism
Patient who returned from lab following a PCI of a chronic total occlusion. Atherectomy using Rotablator was performed with good angiographic result. The patient over the last several hours has become tachypneic, tachycardic, restless, and hypotensive…
Cardiac Tamponade

- Tachycardia
- Tachypnea
- Narrowed Pulse Pressure
- Pulsus Paradoxus
Pericardiocentesis

Myocardium

Pericardial sac

16-18 gauge needle
48yo female admitted with anterior STEMI returned from the cathlab 12 hours ago following stenting of the LAD. She complains of return of chest pressure. You see this on her monitor (has a femoral sheath as A-line)
Cough CPR
2 hours following return from the cathlab, a 76yo male who just underwent diagnostic coronary angiography via a right radial artery approach develops altered mental status

- On exam, very weak in the left arm and left leg
- Code Stroke activated
- MRI eventually demonstrates a small right MCA distribution stroke
Post-Procedural Stroke

• Rare but devastating complication
• Incidence 0.07-0.1% but most are asymptomatic embolic event
• Risk factors includes:
  • Severity of coronary artery disease
  • Length of fluoroscopy time
  • Diabetes
  • Hypertension
  • Prior stroke
  • Renal failure
  • Aortic stenosis
• Mostly caused by disruption of atheromatous plaques on the wall of aorta - other sources can be- surface of valves and cardiac chambers
• Majority of periprocedural stroke patient have poor outcome and in hospital mortality can be as high as 32%
Care Beyond the First 24 Hours…

- Cardiac rehabilitation
  - 5-yr death rates 45% lower for cardiac rehab patients

- Class IA indications following PCI
  - ASA therapy indefinitely
  - Statin therapy
  - Pharmacotherapy for BP control
  - Smoking cessation
  - Cardiac rehab

- Activity following PCI
  - Immediate: Walk, cardiac rehab
  - Within days: sexual activity
  - Within 1 week: driving
Thank You
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