Radial artery patency and occlusion detection: is time for a consensus?

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Conflict of interest

• none
Radial approach in 2019

- Guidelines ESC 2015 - NSTEMI: IA
- Guidelines ESC 2017 - STEMI: IA
- Guidelines ESC 2018 - PCI generally: IA

Main complication - radial artery occlusion (RAO)
but incidence in trials is very different ... <1-33%
Data from 2016:

Radial Artery Occlusion After Transradial Interventions: A Systematic Review and Meta-Analysis

Muhammad Rashid, MBBS*; Chun Shing Kwok, MBBS*; Samir Pancholy, MD; Sanjay Chugh, MD; Sasko A. Kedev, MD, PhD; Ivo Bernat, MD; Karim Ratib, MBChB; Adrian Large, MD; Doug Fraser, MBChir; James Nolan, MBChB; Mamas A. Mamas, BMBCh, PhD

Background—Radial artery occlusion (RAO) may occur posttransradial intervention and limits the radial artery as a future access site, thus precluding its use as an arterial conduit. In this study, we investigate the incidence and factors influencing the RAO in the current literature.

Methods and Results—We searched MEDLINE and EMBASE for studies of RAO in transradial access. Relevant studies were identified and data were extracted. Data were synthesized by meta-analysis, quantitative pooling, graphical representation, or by narrative synthesis. A total of 66 studies with 31,345 participants were included in the analysis. Incident RAO ranged between 1% and 33% and varied with timing of assessment of radial artery patency (incidence of RAO within 24 hours was 7.7%, which decreased to 5.5% at >1 week follow-up). The most efficacious measure in reducing RAO was higher dose of heparin, because lower doses of heparin were associated with increased RAO (risk ratio 0.36, 95% CI 0.17–0.76), whereas shorter compression times also reduced RAO (risk ratio 0.28, 95% CI 0.05–1.50). Several factors were found to be associated with RAO including age, sex, sheath size, and diameter of radial artery, but these factors were not consistent across all studies.

Conclusions—RAO is a common complication of transradial access. Maintenance of radial patency should be an integral part of all procedures undertaken through the radial approach. High-dose heparin along with shorter compression times and patent hemostasis is recommended in reducing RAO. (J Am Heart Assoc. 2016;5:e002686 doi: 10.1161/JAHA.115.002686)
Contemporary transradial access practices: Results of the second international survey

Adhir R. Shroff MD, Christopher Fernandez BS, MHS, Mladen I. Vidovich MD, Sunil V. Rao MD, Michael Cowley MD, Olivier F. Bertrand MD, PhD, Tejas M. Patel DM, Samir B. Pancholy MD

Preprocedure, noninvasive testing for collateral circulation is used more commonly in the United States (54.1%) than around the world (26.6%) but its use has decreased since 2010. In the US, 48.8% of operators never use ultrasound and 92.6% of OUS operators never use it; only 4.4% overall use ultrasound in >50% of cases. Use of bivalirudin has decreased. Nearly, 30% of operators do not assess for radial artery patency following hemostasis. US respondents used TRA less commonly for primary PCI for STEMI than their global counterparts.

Conclusions

There is wide variation in how TRA procedures are performed including relatively low rates of adherence to practices that are known to improve outcomes. Further education aimed at increasing use of best practices will impact patient outcomes.

Catheter Cardiovasc Interv, 19 November 2018
Goal of our work > 10 years is:

• To simplify postprocedural care after our TRI

• To minimalize all potential local complications

• To reduce the incidence of RAO close to 0%

• To shorten time of care after the procedure to minimum
Our results

• **Comparison of two doses of UFH and ulnar compression for soon RAO treatment** *(Am J Cardiol 2011)* - RAO ..... 2.9% (… 0,8%)

• **PROPHET II (JACC Cardiovasc Interv 2017)** - RAO ..... 2,7%

• **RAP and BEAT** *(Eurointervention 2017)* - RAO ..... 2,6%

• **Access-site bleeding and radial artery occlusion in transradial primary PCI: influence of adjunctive antiplatelet therapy** *(Coronary Atr Disease 2016)* - RAO ..... 0.6%

• **Patent hemostasis and comparison of two compression devices after transradial coronary catheterization and intervention** *(Cor et Vasa 2018)* - RAO ..... 0 %
Our postprocedural care starts in the cathlab including patent hemostasis control
How and when to detect RAO ... ???
Easy radial patency control after compression

- Reverse Barbeau Test
Gold standard for RA patency control

- Duplex ultrasound

RA diameter:

Color and pulse Doppler
When

Time of detection in trials:

• During first 24 hours
• Before discharge
• After 7 days
• After 30 days
• After 3 months
• After 6 months

Because incidence decreases in time ...
RAO ≤ 24 hours in :

- Metaanalysis from 2016: 7.7%, RCT 7.7% (>10 000 pts, RCT > 5000 pts)

- PROPHET II 2017: 2.7% (4.1% vs 1%) (3000 pts)

- CRASOC III 2017: 2.3% (800 pts)
Aim of our last study

To compare RAO detection by two methods
- reverse Barbeau test and duplex ultrasound

+ RAO incidence, compression time, hematomas, other complications
Methods

• 500 patients from our same day discharge program

• Radial artery compression by TR Band (95% left radial)

• Patent hemostasis

• RAO detection before discharge: 4-6 hours after the procedure
  - Reverse Barbeau test by the nurse in the Lounge with young physician control
  - Duplex ultrasound by another physician
### Baseline characteristics (n=500)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>70.4% (352)</td>
</tr>
<tr>
<td>Age</td>
<td>65 ± 9.4</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>29.9 ± 12.9</td>
</tr>
<tr>
<td>Hypertension</td>
<td>71.8% (359)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>69.6% (348)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>23.2% (116)</td>
</tr>
<tr>
<td>Smoking</td>
<td>19.2% (96)</td>
</tr>
<tr>
<td>Ex-smoking</td>
<td>26.2% (131)</td>
</tr>
<tr>
<td>Previous MI</td>
<td>17.0% (85)</td>
</tr>
<tr>
<td>Previous PCI</td>
<td>20.2% (101)</td>
</tr>
<tr>
<td>Previous CABG</td>
<td>5.6% (28)</td>
</tr>
<tr>
<td>Previous TRA</td>
<td>23.8% (119)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAG</td>
<td>100% (500)</td>
</tr>
<tr>
<td>PCI</td>
<td>24.2% (121)</td>
</tr>
<tr>
<td>ASA</td>
<td>77.8% (389)</td>
</tr>
<tr>
<td>Clopidogrel</td>
<td>31.6% (158)</td>
</tr>
<tr>
<td>Ticagrelor</td>
<td>1.8% (9)</td>
</tr>
<tr>
<td>Warfarin</td>
<td>7.2% (36)</td>
</tr>
<tr>
<td>NOAC</td>
<td>1.8% (9)</td>
</tr>
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VI TRANSRADIAL WORKSHOP TREC-2019
## Results

### RAO detection:

<table>
<thead>
<tr>
<th></th>
<th>RAO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse Barbeau</td>
<td>2 (0,4%)</td>
</tr>
<tr>
<td>test</td>
<td></td>
</tr>
<tr>
<td>Duplex ultrasound</td>
<td>2 (0,4%)</td>
</tr>
</tbody>
</table>

### Compression time:

97,5 ± 34,2 min

### Hematomas:

<table>
<thead>
<tr>
<th></th>
<th>II.</th>
<th>III.</th>
<th>IV.</th>
<th>V.</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 5-9 cm</td>
<td>5,4%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>≥ 10 cm</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Other local complications:

none
Conclusions of our last trial:

- Incidence of early RAO in our study with 500 patients was very low - 0.4%
- Both methods - RBT and duplex ultrasound are comparable in detection of RA patency and complete RA occlusion
- Local hematomas in our study were only first two degrees and without any clinical consequences
- There were no any other local complications
- Compression time was short (<100 minutes)
Is it the right time for consensus now when recommendation is IA and RAO incidence is so different in literature ??
RAO metaanalysis (24 from 66 trials with RAO ≤24h: 10938 pts)

- RAO ≤24h 7.7% (all 24 trials 10938 pts)
  - (only RCT 12 trials 5258 pts) >7%

Rashid et al. *JAHA* 2016
RAO

• may result from arterial spasm, endothelial injury, thrombus formation and neointimal hyperplasia.

• thrombus formation is seen with triad of vascular injury, stasis and hypercoagulable state

• so prevention of RAO requires attention to all three components
Preventing Acute Radial Artery Occlusion
A Battle on Multiple Fronts*

Jennifer A. Rymer, MD, MBA, Sunil V. Rao, MD

Specifically, more data are needed to determine whether distal radial access reduces proximal radial artery occlusion (RAO) and to define the optimal dosing of unfractionated heparin to reduce RAO in patients receiving oral anticoagulant agents.

*JACC Cardiovasc Interv 2018
Importance of hemostasis time!

24h RAO rates (%)

- **Pancholy 2011**: 12%
  - 6H: 5.5%
  - 2H: 0.3%
- **RAP and BEAT 2017**: 6.7%
  - ≥6H: 6.7%
  - <2H: 0.3%
- **CRASOC trial 2017**: 7.9%
  - 4H: 2.3%
  - 1.5H: 0.3%

Hemostasis time:
- ≥6H
- <2H
- 4H
- 1.5H
Importance of compression time - RAP and BEAT trial

Aminian et al. Cath Cardiovasc Interv 2018

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**CRASOC** RCT trial - compression time and RAO in **3616 pts**

<table>
<thead>
<tr>
<th>I. 4 hours</th>
<th>13ml vs 10ml</th>
<th>9.4% vs 7.1%</th>
<th>2009-2010</th>
<th>1937 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>II. 3 hours vs 2 hours</td>
<td>10ml</td>
<td>4.8% vs 3.0%</td>
<td>2014</td>
<td>941 pts</td>
</tr>
<tr>
<td>III. 2 hours vs 1.5 hour</td>
<td>10 ml</td>
<td>2.8% vs 2.3%</td>
<td>2016</td>
<td>738 pts</td>
</tr>
</tbody>
</table>

**Re:** short and soft hemostasis leads to low RAO rate

*AJC 2017*
PROPHET-II
(Prevention of Radial Artery Occlusion - Prophylactic Hyperperfusion Evaluation Trial)

Pancholy et al. JACC CI 2016;9:1992–9
Primary endpoints - a) PROPHET II. - RAO in 24h and 30d
   b) RAP and BEAT - RAO at discharge
   c) CRASOC III. - RAO in 24h

Short compression time vs different types of hemostasis

Low incidence of RAO – a) 4,2% vs 1% (24h = 2,6%) and 3,0% vs 0,9% (30d)
   b) 3,5% vs.1,7% = 2,6%
   c) 2,8% vs 2,3% = 2,55%
RAO incidence: reported rates

24h RAO rates (%)

<table>
<thead>
<tr>
<th>Study</th>
<th>24h RAO rates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rashid et al meta-analysis 2016</td>
<td>7.7</td>
</tr>
<tr>
<td>Dharma et al 2015</td>
<td>10</td>
</tr>
<tr>
<td>Prophet II 2016</td>
<td>2.7</td>
</tr>
<tr>
<td>RAP and BEAT 2017</td>
<td>2.6</td>
</tr>
<tr>
<td>Crasoc III</td>
<td>2.4</td>
</tr>
<tr>
<td>Memory 2018</td>
<td>10</td>
</tr>
<tr>
<td>Chen et al 2018</td>
<td>10</td>
</tr>
<tr>
<td>Sanghvi et al 2018</td>
<td>5</td>
</tr>
<tr>
<td>Spirit of Artemis 2018</td>
<td>5.6</td>
</tr>
</tbody>
</table>

N=1706, N=3000, N=1836, N=1836, N=320, N=182, N=589, N=736.
What is important to read in trials with RAO?

- Time of diagnosis - mixture of RAO in first 24h vs 7d vs 30d vs later
- Sample size - hundreds or thousands of patients
- RCT vs other trials
- How was radial artery compressed and how long?
- What type of compression was used - pure x correct x optimal?
Conclusions

Short compression time together with adequate anticoagulation and patent hemostasis control, simultaneous ulnar artery compression and correct sheath/artery ratio were identified as main factors in prevention of RAO.

Optimal combination of these factors can reduce postprocedural RAO to minimum - from > 5% ....< 3% ... < 1% .