

**Complications  
of Transradial Catheterization:  
*What to Look For and How to Avoid  
Them***

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## **Conflicts of interest**

**None to declare**

# Transradial Catheterization Complications

**EP** Electrophysiology  
Innovations Congress

ADVANCING DEVICE TECHNOLOGIES AND  
TECHNIQUES IN RHYTHM MANAGEMENT

## Radial Artery Catheterization: The way to go

MORTON KERN, 2009

**“The complications from radial artery access are trivial compared to femoral, with  $\leq 4\%$  loss of radial artery pulse as the worst of it”**

**“Why do I persist with femoral artery access when complications from radial access are so much lower?”**

**“I left Quebec with the enthusiasm of a converted sinner, returning to UCI to begin our radial program ....”**

Transradial Catheterization Complications:

*What to Look for and How to Avoid Them*

**Why Use Radial Access?**

**Anatomical Considerations**

**Complications: Classification and Incidence**

**Complications: Prevention and Management**

Transradial Catheterization Complications:

## *Why Use Radial Access?*

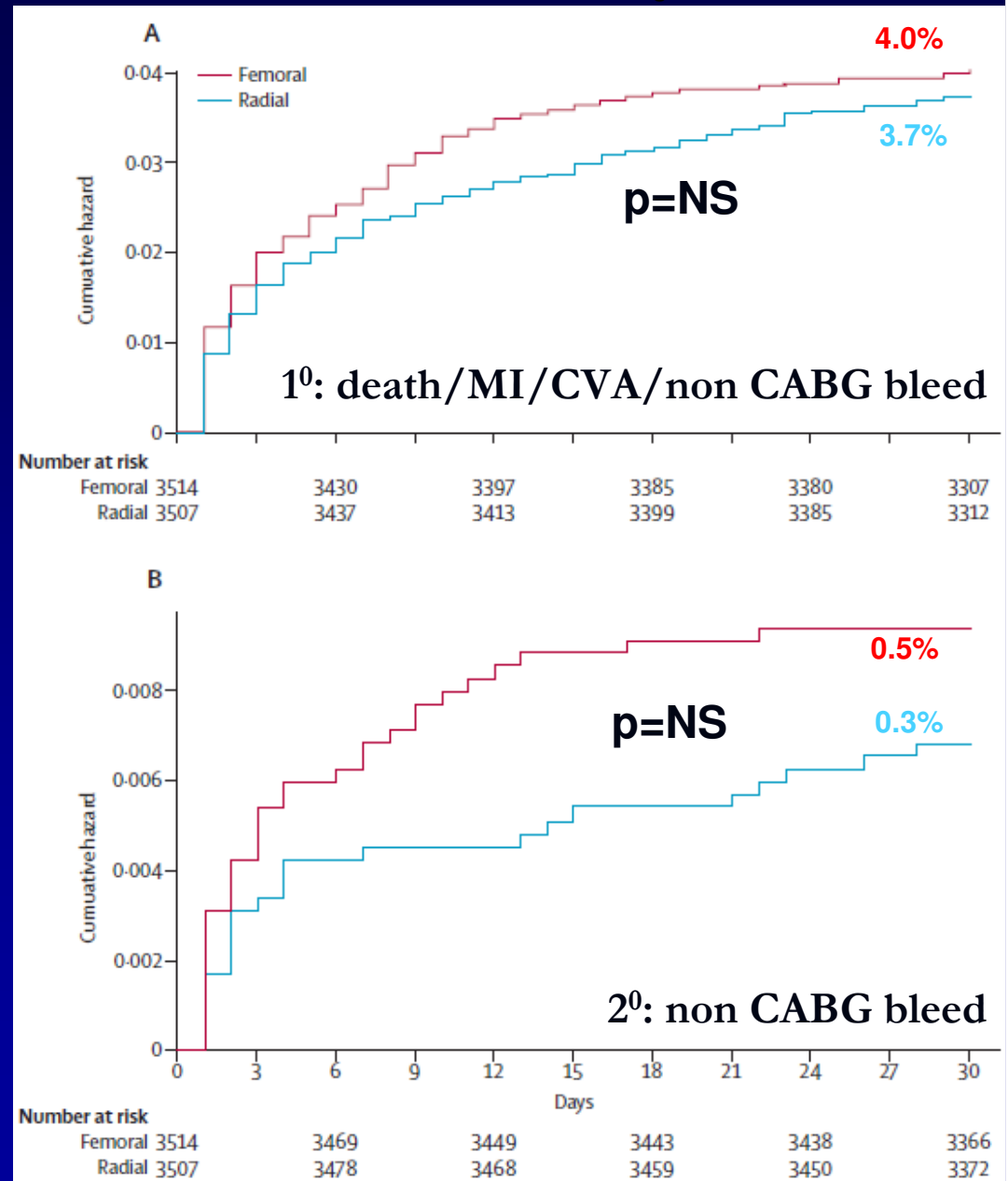
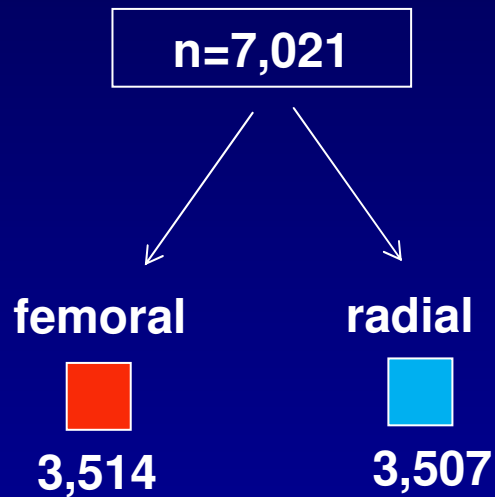
**Patient comfort, early ambulation/discharge**

**Safety (...?)**

# Transradial Catheterization Complications

## Radial vs. Femoral Access: Safety

RIVAL  
CURRENT sub-study



# Transradial Catheterization Complications

## Radial vs. Femoral Access

RIVAL. LANCET 2011

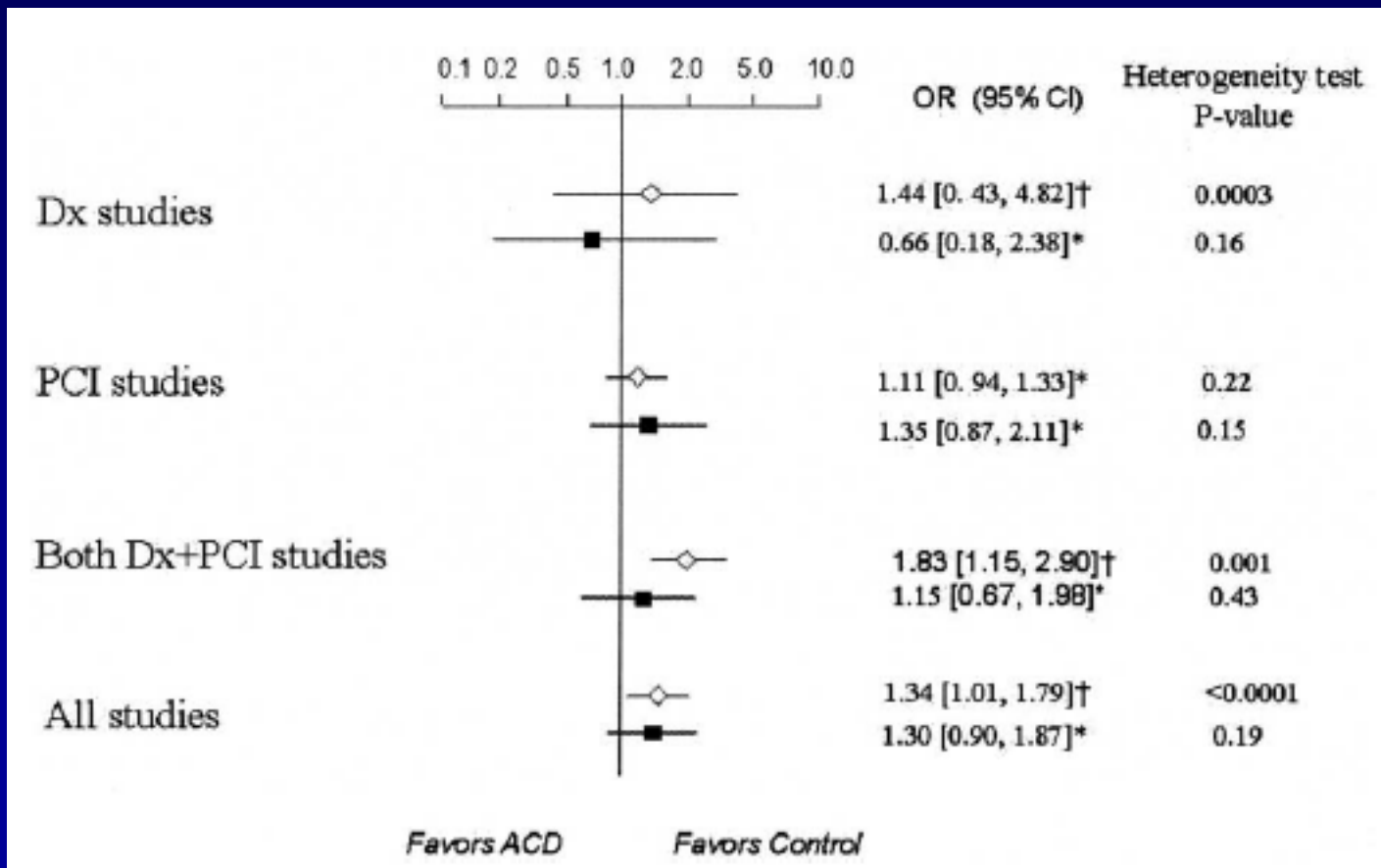


Other secondary outcomes	Radial	Femoral		
PCI success*	2204 (95.4%)	2235 (95.2%)	1.01 (0.95-1.07)	0.83
Access site crossover	265 (7.6%)	70 (2.0%)	3.82 (2.93-4.97)	<0.0001
Major vascular complications	49 (1.4%)	131 (3.7%)	0.37 (0.27-0.52)	<0.0001
Minor bleeding	100 (2.9%)	118 (3.4%)	0.84 (0.65-1.10)	0.21
Post-hoc exploratory outcomes				
ACUITY major bleeding†	66 (1.9%)	157 (4.5%)	0.43 (0.32-0.57)	<0.0001
Death, MI, or stroke, or ACUITY major bleed†	167 (4.8%)	256 (7.3%)	0.65 (0.53-0.78)	<0.0001
Non-CABG major bleeding and major vascular complications	67 (1.9%)	157 (4.5%)	0.43 (0.32-0.57)	<0.0001
Death, MI, stroke, non-CABG major bleeding, or major vascular complications	167 (4.8%)	260 (7.4%)	0.63 (0.52-0.77)	<0.0001

# Vascular Complications Associated With Arteriotomy Closure Devices in Patients Undergoing Percutaneous Coronary Procedures

## A Meta-Analysis

n=37,066





Transradial Catheterization Complications:

*What to Look for and How to Avoid Them*

**Why Use Access?**

**Anatomical Considerations**

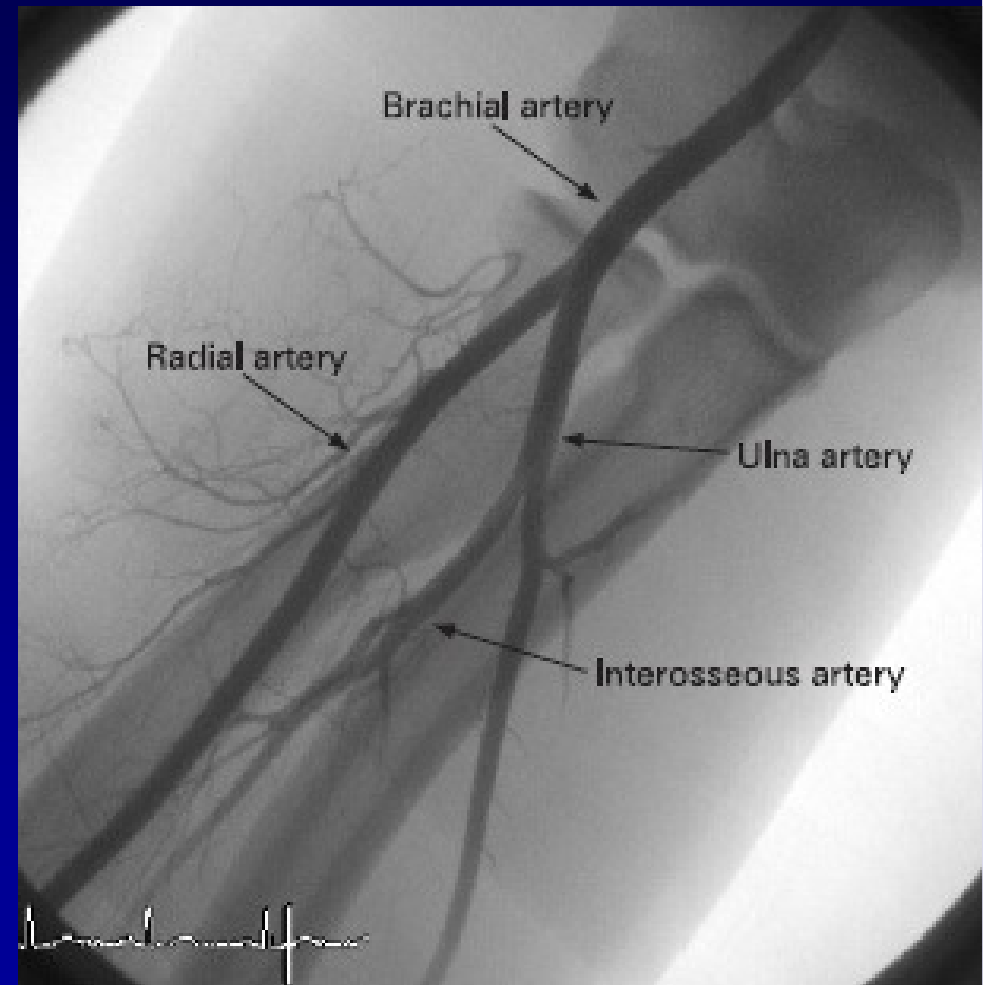
**Classification and Incidence**

**Prevention and Management**

Transradial Catheterization Complications:  
**Anatomical Considerations**

**Congenital variants**

**Arterial tortuosity**



Lo et al. Heart 2009

Rodriguez-Niedenfuhr et al. J Anatomy 2001

# Transradial Catheterization Complications: Anatomical Considerations

## Congenital anatomical variants

Location	Variant	
Arm	Superficial brachial	
	Accessory brachial	≈2-3:1,000
Arm and Forearm	Brachio-radial	≈15:100
	Brachio-ulnar	
	Brachio-interosseous	
	Brachio-median	
	Superficial brachio-radial	
	Superficial brachio-ulnar	
	Superficial brachio-ulnoradial	
	Forearm	Superficial radial
	Absent radial	≈3:10,000
	Absent ulnar	≈ 1-2:10,000

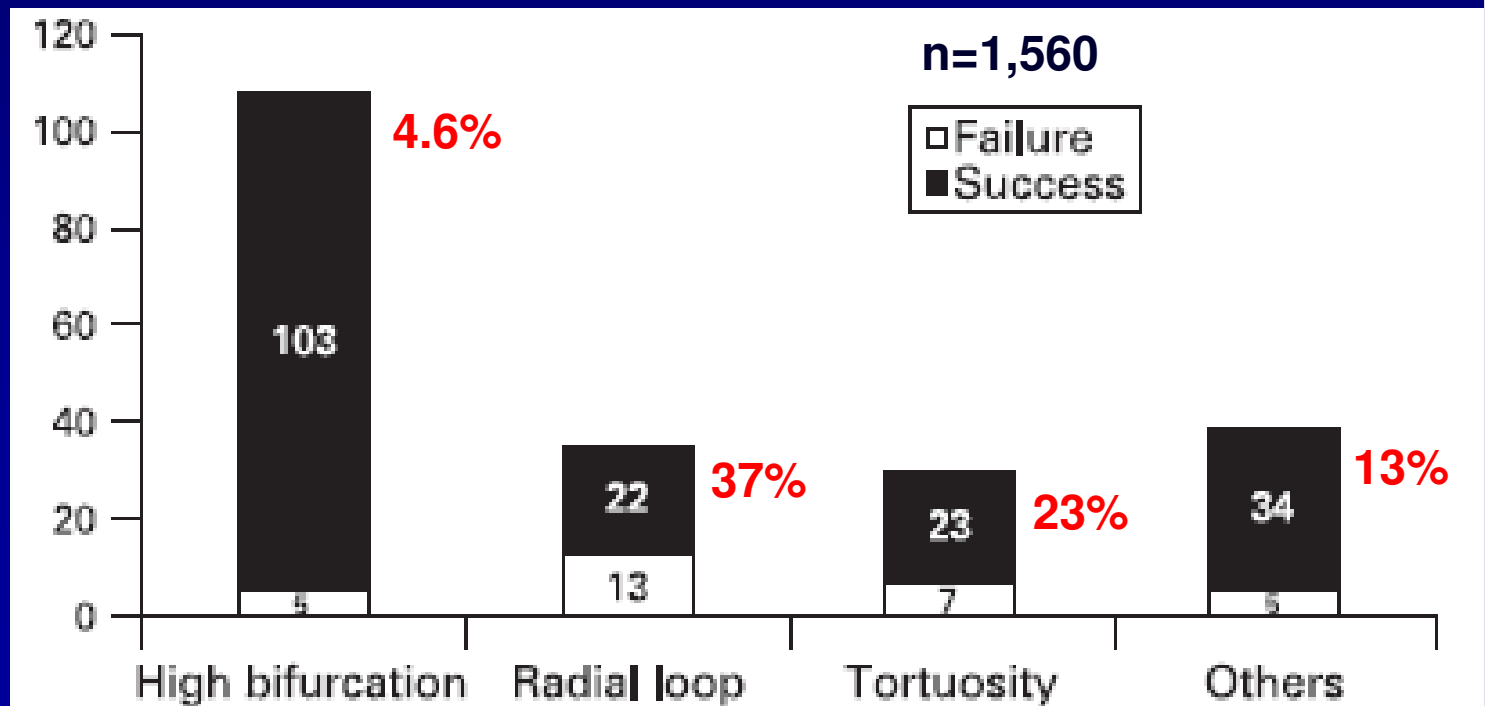
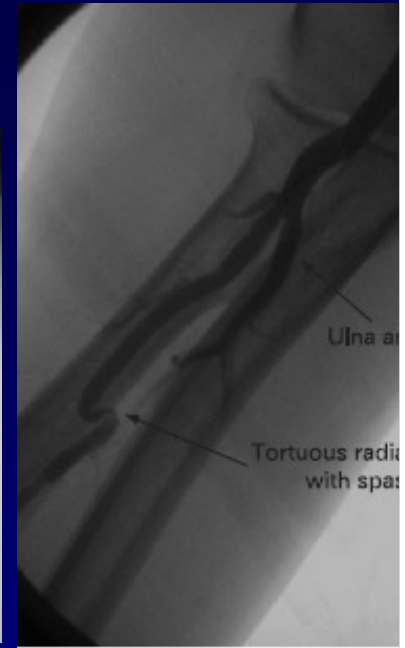
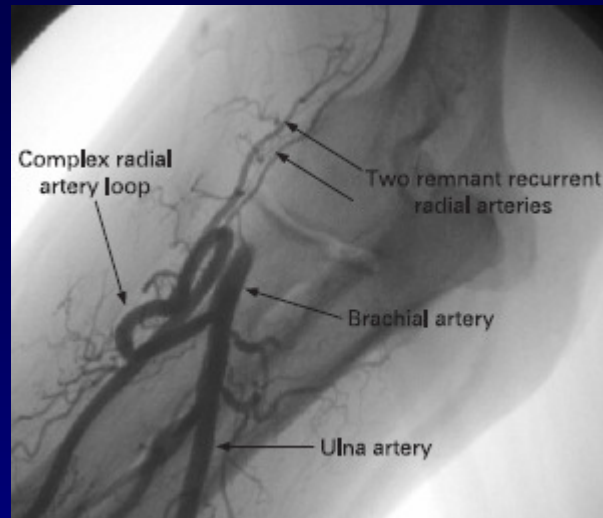


Rodriguez-Niedenfuhr et al. J Anatomy 2001

# Transradial Catheterization Complications: Anatomical Considerations

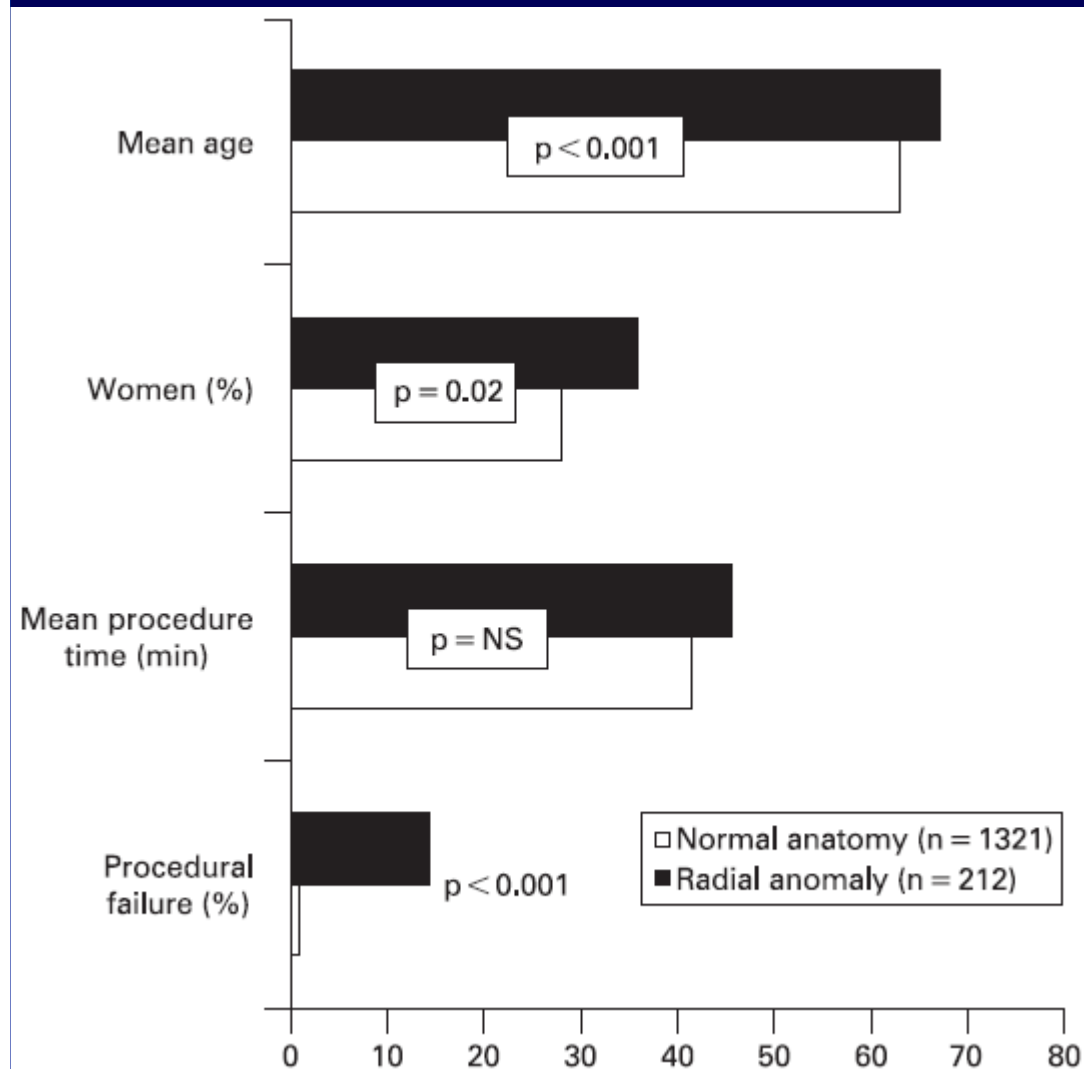
## Arterial tortuosity

Location	Variant	
Radial	Loops	≈2.5:100
	Tortuosity	≈2:100



# Transradial Catheterization Complications: Anatomical Considerations

*Radial Anomaly* ■ *vs. No Radial anomaly* □



**Transradial Catheterization Complications:**  
***What to Look for and How to Avoid Them***

**Why Use Access?**

**Anatomical Considerations**

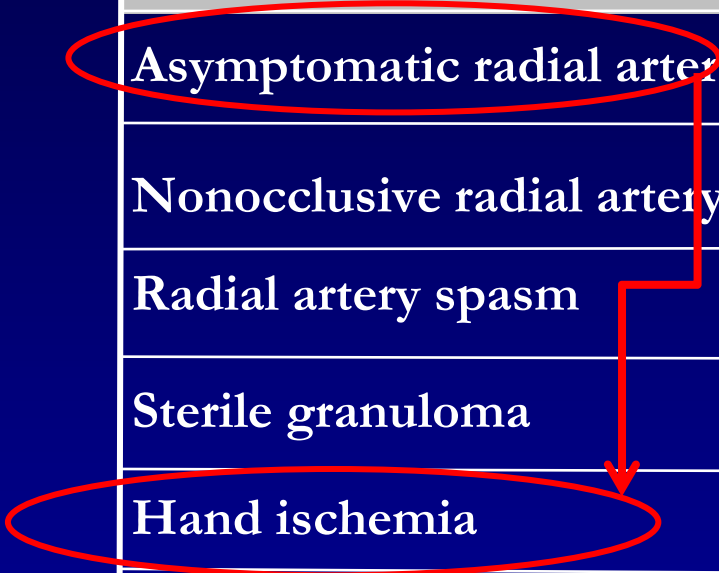
**Classification and Incidence**

**Prevention and Management**

# Transradial Catheterization Complications: Classification and Incidence

Kanei al. CCI 2011

Event	Rate
Asymptomatic radial artery occlusion	2-18%
Nonocclusive radial artery injury	common
Radial artery spasm	5-10%
Sterile granuloma	2.8%
Hand ischemia	rare
Perforation	rare
Pseudoaneurysm	rare
AV fistula	rare
Nerve damage	rare
Hemorrhage/transfusion	rare



# Transradial Catheterization Complications: Risk Factors

Event	Risk factors
Asymptomatic radial artery occlusion	<ul style="list-style-type: none"> <li>• Prolonged high pressure compression</li> <li>• ↑Sheath/Artery diameter</li> </ul>
Nonocclusive radial artery stenosis	<ul style="list-style-type: none"> <li>• Multiple puncture attempts</li> </ul>
Hand ischemia	<p style="text-align: center;"><b><u>Operator-related factors:</u></b></p> <ul style="list-style-type: none"> <li>• multiple punctures</li> <li>• inadequate “spasmolysis”/anticoagulation</li> <li>• large caliber catheters</li> <li>• multiple catheter exchanges</li> <li>• aggressive wiring</li> <li>• occlusive hemostasis</li> </ul>
Radial artery spasm	
Perforation	
Pseudoaneurysm	
AV fistula	
	<ul style="list-style-type: none"> <li>• Excessive anticoagulation</li> <li>• Large sheaths</li> </ul>
AV fistula	<ul style="list-style-type: none"> <li>• Multiple punctures</li> </ul>
Sterile granuloma	<ul style="list-style-type: none"> <li>• Cook sheaths</li> </ul>
Nerve damage	<ul style="list-style-type: none"> <li>• Multiple punctures</li> </ul>



Transradial Catheterization Complications:  
**Radial Occlusion and Critical Hand Ischemia**

**Case Report (I)**





## Case Report (II)

56 y.o. ♀

Suspected troponin positive ACS

Urgent TRC cath (negative Allen test) ⇒ NCA

Severe “hand pain”

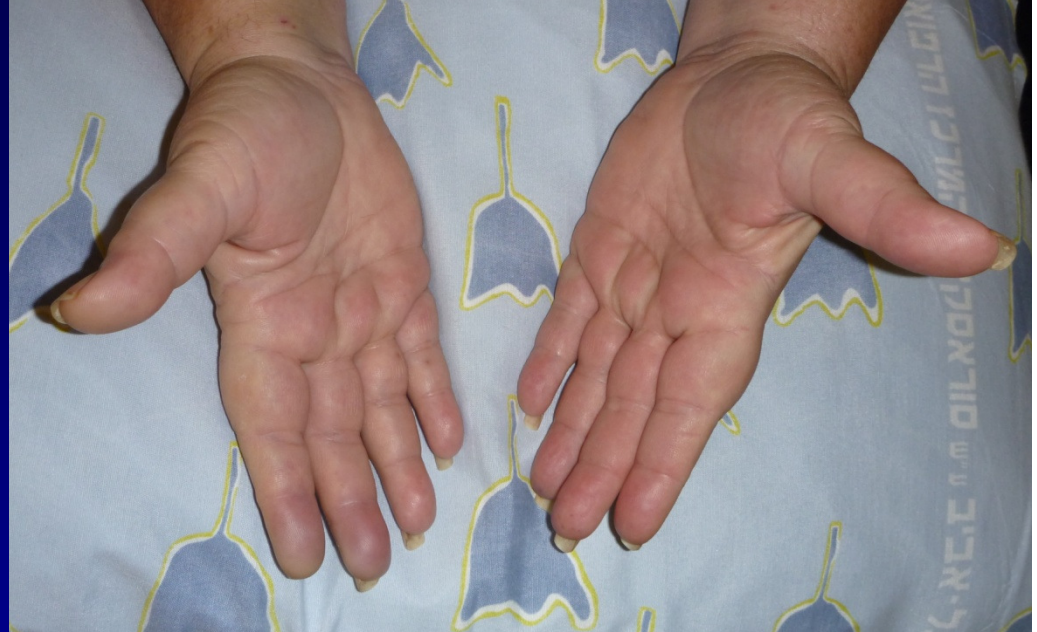
Physical exam reportedly normal, palpable radial pulse

⇒ required opiates

Doppler study

⇒ radial artery occlusion

Transradial Catheterization Complications:  
**Case Report (II)**



Vascular surgery consult: heparin, analgesia

Transradial Catheterization Complications:

**Case Report (II)**



**RAO  
can result in  
critical hand ischemia  
(i.e., tissue loss) despite  
dual palmar arch  
supply  
!!!**

**Transradial Catheterization Complications:**  
***What to Look for and How to Avoid Them***

**Why Use Access?**

**Anatomical Considerations**

**Classification and Incidence**

**Prevention and Management**

## Transradial Catheterization Complications: Prevention

### Case selection

- Age, gender
- Co-operative patient
- Palmar arch circulation

### Access

- Liberal anesthesia, analgesia & sedation
- Small caliber catheters
- Spasmolytic cocktail
- Hydrophilic sheaths
- Anticoagulation (i.v.=i.a., weight adjusted dose)

### Negotiation of upper extremity vasculature

- Avoid non-J-tipped 0.035" wires >> 0.014"
- Liberal fluoroscopic guidance
- Anticipate spasm and adverse anatomic features

### Hemostasis

- "Patent hemostasis"

**Transradial Catheterization Complications:  
Prevention - Case selection**

**Evaluation of palmar arch circulation**



## Transradial Catheterization Complications:

### Prevention: Palmar arch circulation

method [23]. The use of the Allen's test is controversial in the transradial catheterization community. It is a standard practice in our institution to perform the Allen's test as a part of a thorough examination for intact collateral circulation, however many high volume transradial operators have stopped using the Allen's test. Would you access the ulnar artery following no ipsilateral radial artery harvesting for CABG? There is no vascular complications.

**Just Test It!!!**



# Transradial Catheterization Complications: Prevention: Palmar arch circulation

## Barbeau Test

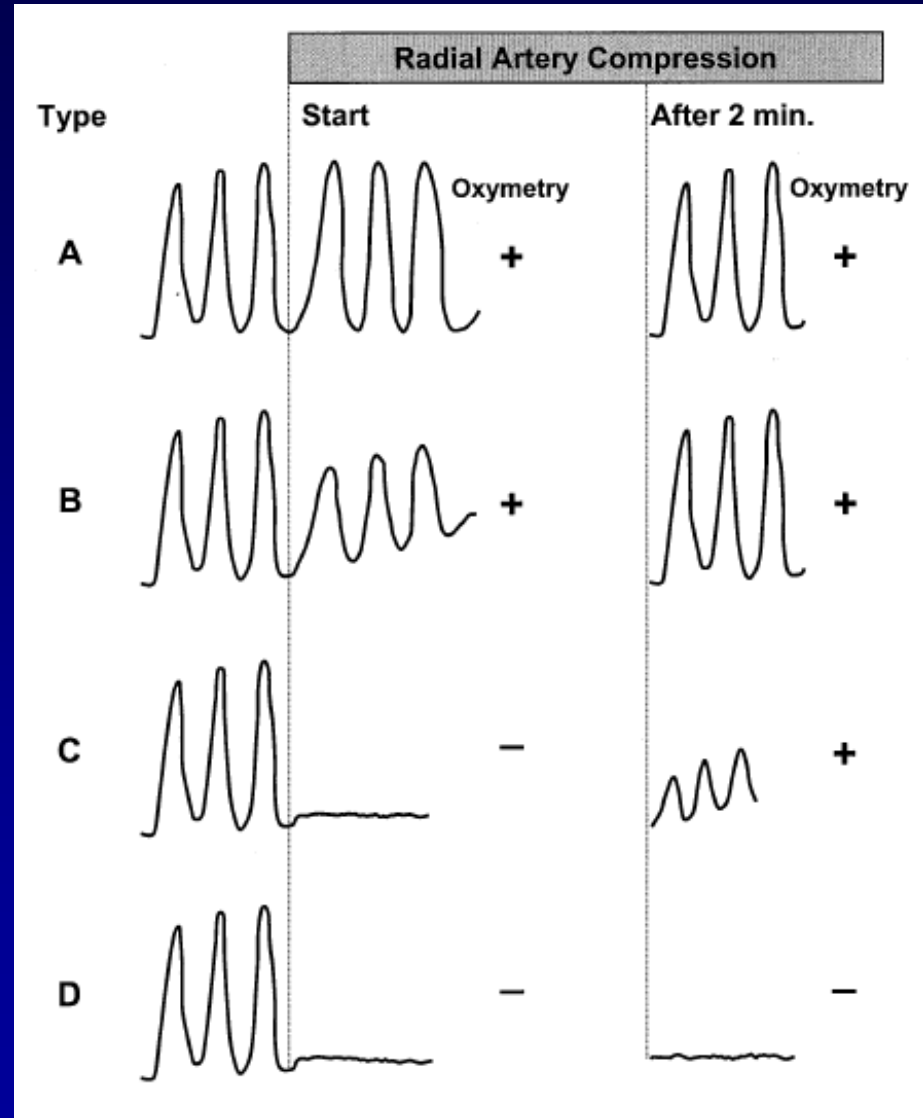
Barbeau et al. AHJ 2004

**2 separate series:**

**n=1, 010**

**n=7, 049**

**No cases of acute hand  
ischemia**



**Transradial Catheterization Complications:**  
**Prevention - Access**

**Access site management**

Transradial Catheterization Complications:

**Prevention: Access**

- Local anesthesia, liberal analgesia & sedation
- Small caliber catheters
- Spasmolytic cocktail
- **Hydrophilic sheaths**
- Anticoagulation

***Hydrophilic sheath use reduces radial spasm***

**Rathore et al. JACC Cardiovasc Interv 2010**

***Route of heparin administration has no impact on radial occlusion rates (i.v.=i.a.)***

**Pancholy SB et al. AJC 2009**

## Transradial Catheterization Complications:

# Prevention: Access

*Hydrophilic sheath use reduces radial spasm*

Rathore et al. JACC Cardiovasc Interv 2010

Variables	Coated (n = 397)	Uncoated (n = 393)	p Value
Operator RAS	75 (19.0)	155 (39.9)	<0.001
Patient discomfort	60 (15.1)	112 (28.5)	<0.001
Local complication			
Large hematoma	3 (0.8)	14 (3.7)	0.006
Noncoronary dissection	1 (0.3)	2 (0.5)	1.00
RAO at discharge	35 (8.9)	28 (10.0)	0.624
Late complication (n = 625)	315	310	
Abscess	9 (2.8)	0 (0)	
Infection	11 (3.5)	1 (0.3)	0.0001
Pseudoaneurysm	1 (0.3)	0 (0)	0.570
RAO at follow-up (n = 625)	24 (7.6)	19 (6.1)	0.436

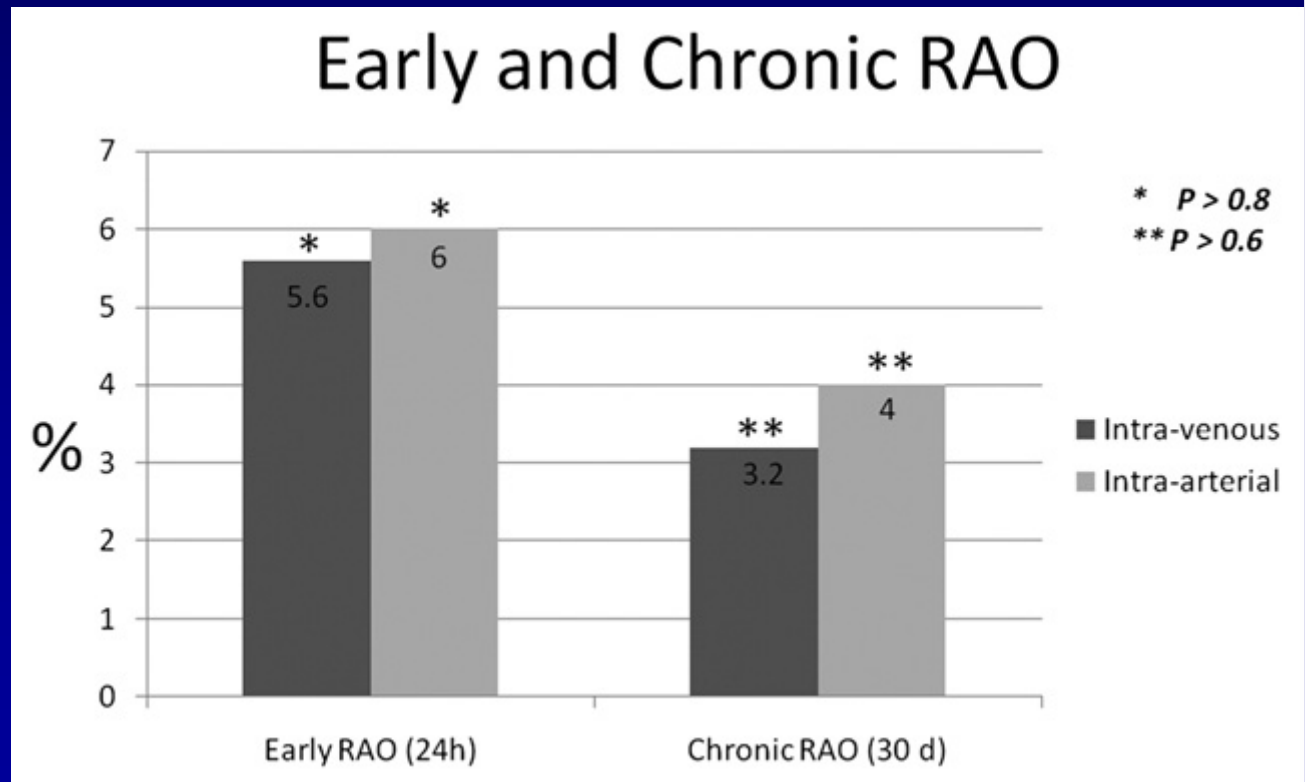
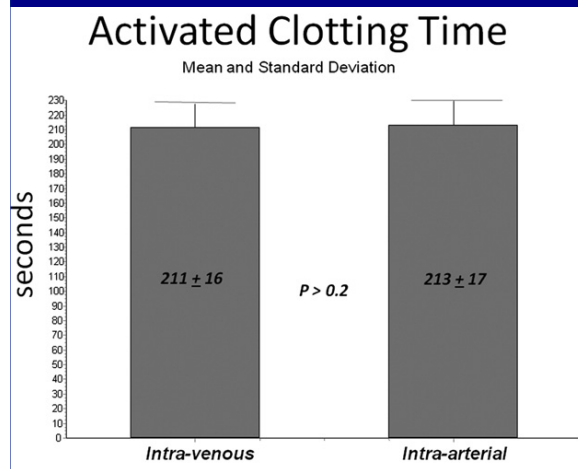
## Transradial Catheterization Complications:

# Prevention: Access

***Route of heparin administration has no impact on radial occlusion rates***

Pancholy SB et al. AJC 2009

n=500



Transradial Catheterization Complications:  
**Prevention –**  
**Negotiation of upper extremity vasculature**

**“Easy does it”**

Transradial Catheterization Complications:

## Prevention: Upper Extremity Vessel Negotiation

- Minimize use of non-”J-tipped” 0.035” wires
- Fluoroscopic guidance/road mapping
- Anticipate spasm/adverse anatomy

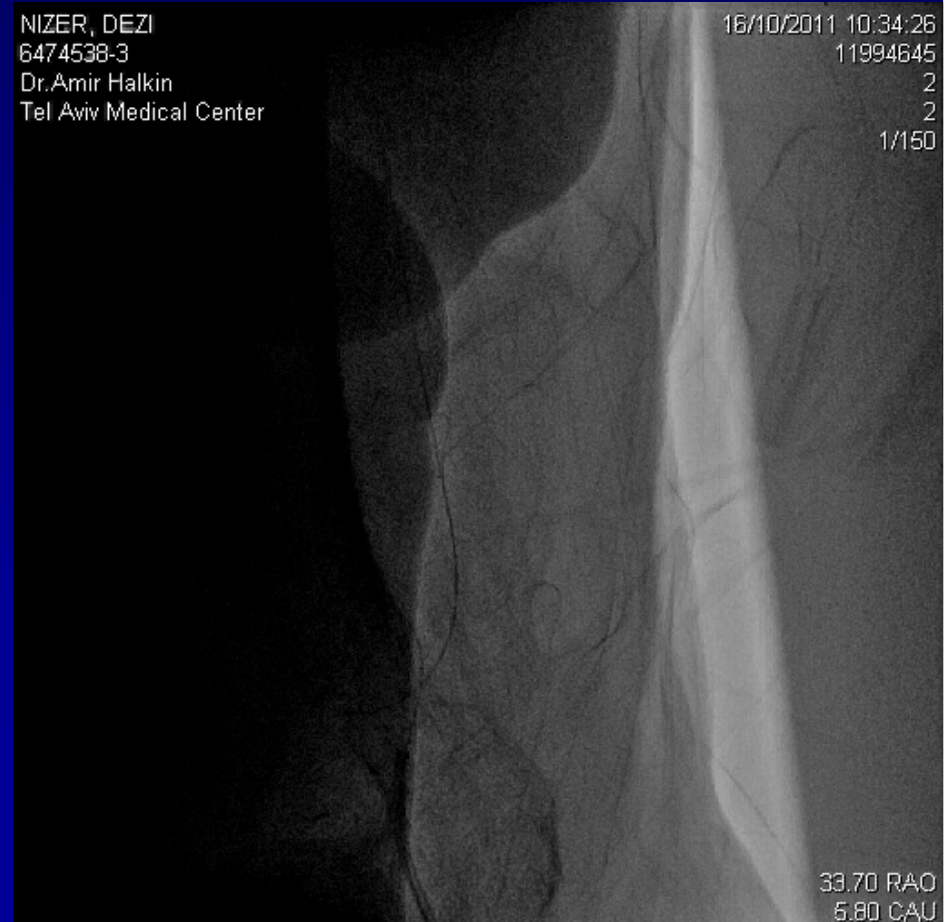
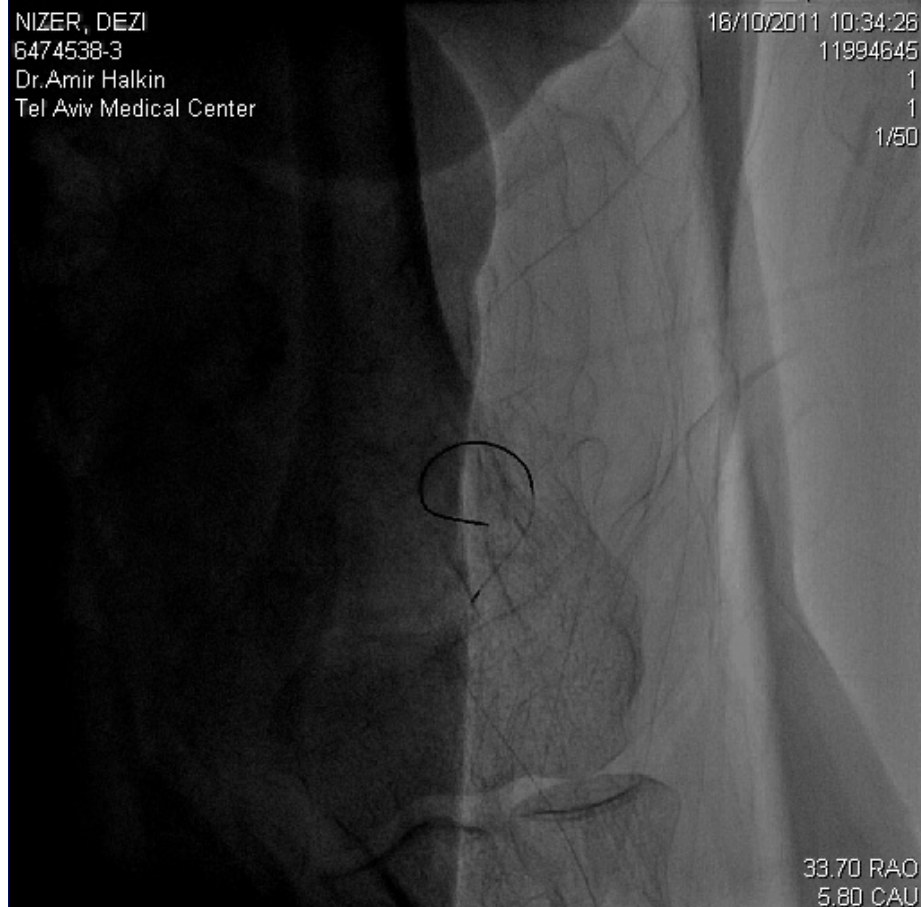




## Transradial Catheterization Complications:

# Prevention: Upper Extremity Vessel Negotiation

- Minimize use of non-”J-tipped” 0.035” wires
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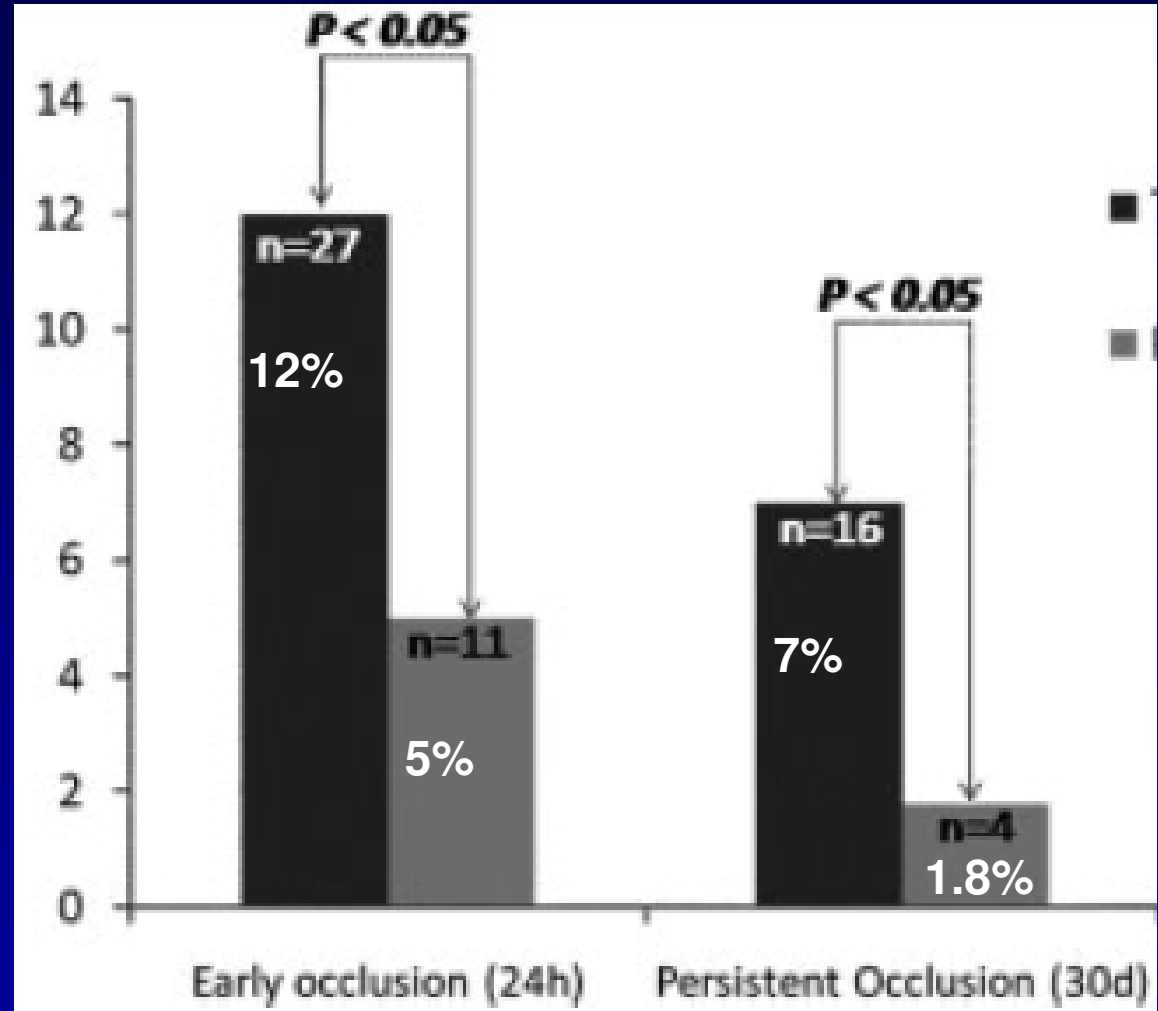
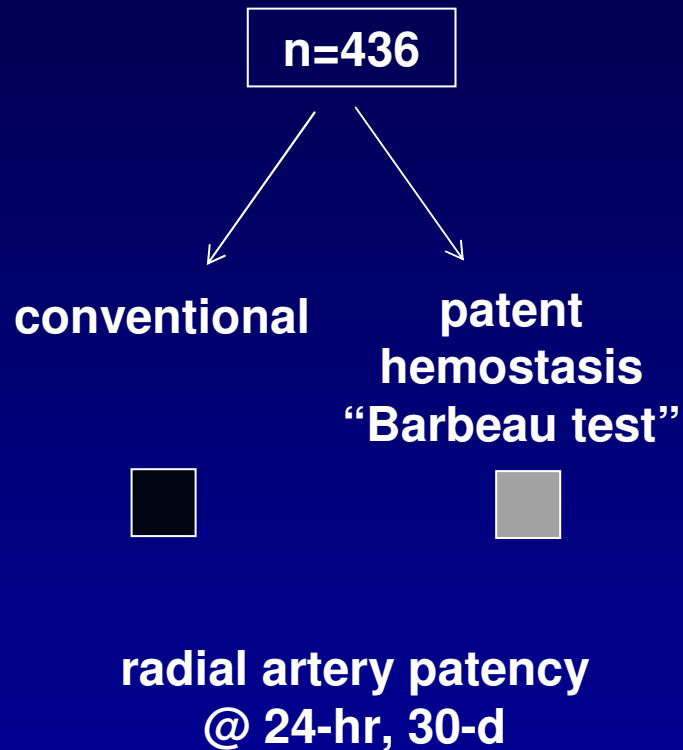


Transradial Catheterization Complications:  
Prevention – Radial artery occlusion

**Patent Hemostasis**

# Prevention: Patent hemostasis

Pancholy et al. PROPHET. CCI 2008



***"Patent hemostasis" reduces risk of radial occlusion***

## Transradial Catheterization Complications: Prevention and Management

Event	Prevention/Management
Radial artery occlusion	<ul style="list-style-type: none"> <li>•Anticoagulation</li> <li>•Patent hemostasis</li> </ul>
Nonocclusive radian artery iniury	<ul style="list-style-type: none"> <li>•Careful evaluation prior to harvesting for CABG</li> </ul>
Hand	<p><b><u>Prevention:</u></b></p> <ul style="list-style-type: none"> <li>•Verify functionality of dual palmar arch supply (<i>Allen, Barbeau tests</i>)</li> <li>•Technique and dedicated devices</li> <li>•Patent hemostasis</li> </ul>
Radial	
Perforation	<ul style="list-style-type: none"> <li>•Early detection</li> </ul>
Pseudoaneurysm	<ul style="list-style-type: none"> <li>•Compression</li> <li>•Thrombin injection</li> </ul>
AV fistula	<ul style="list-style-type: none"> <li>•Surgery</li> </ul>
Sterile granuloma	<ul style="list-style-type: none"> <li>•Removal of hydrophillic coating</li> </ul>
Nerve damage	<ul style="list-style-type: none"> <li>•Supportive care</li> </ul>

Transradial Catheterization Complications:

## **Prevention and Management of Critical Hand Ischemia**

**What should be done when radial occlusion is detected?**

**Recognize the potential consequences  
Avoid nihilism**

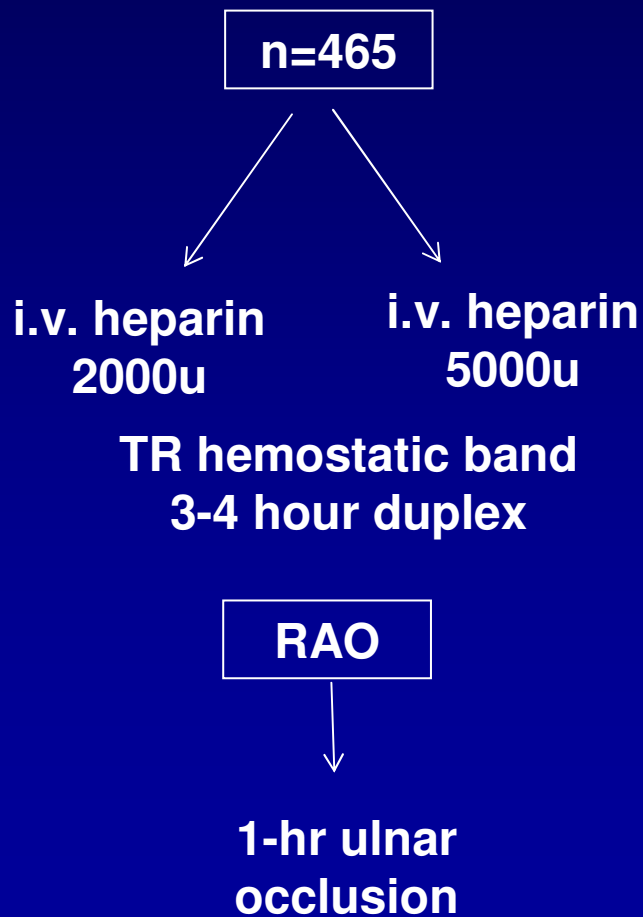
**Ulnar artery compression for radial artery occlusions**

**Early angiography and intervention for CHI**

Transradial Catheterization Complications:  
**Prevention of Hand ischemia**

***Ulnar compression can resolve early radial occlusion***

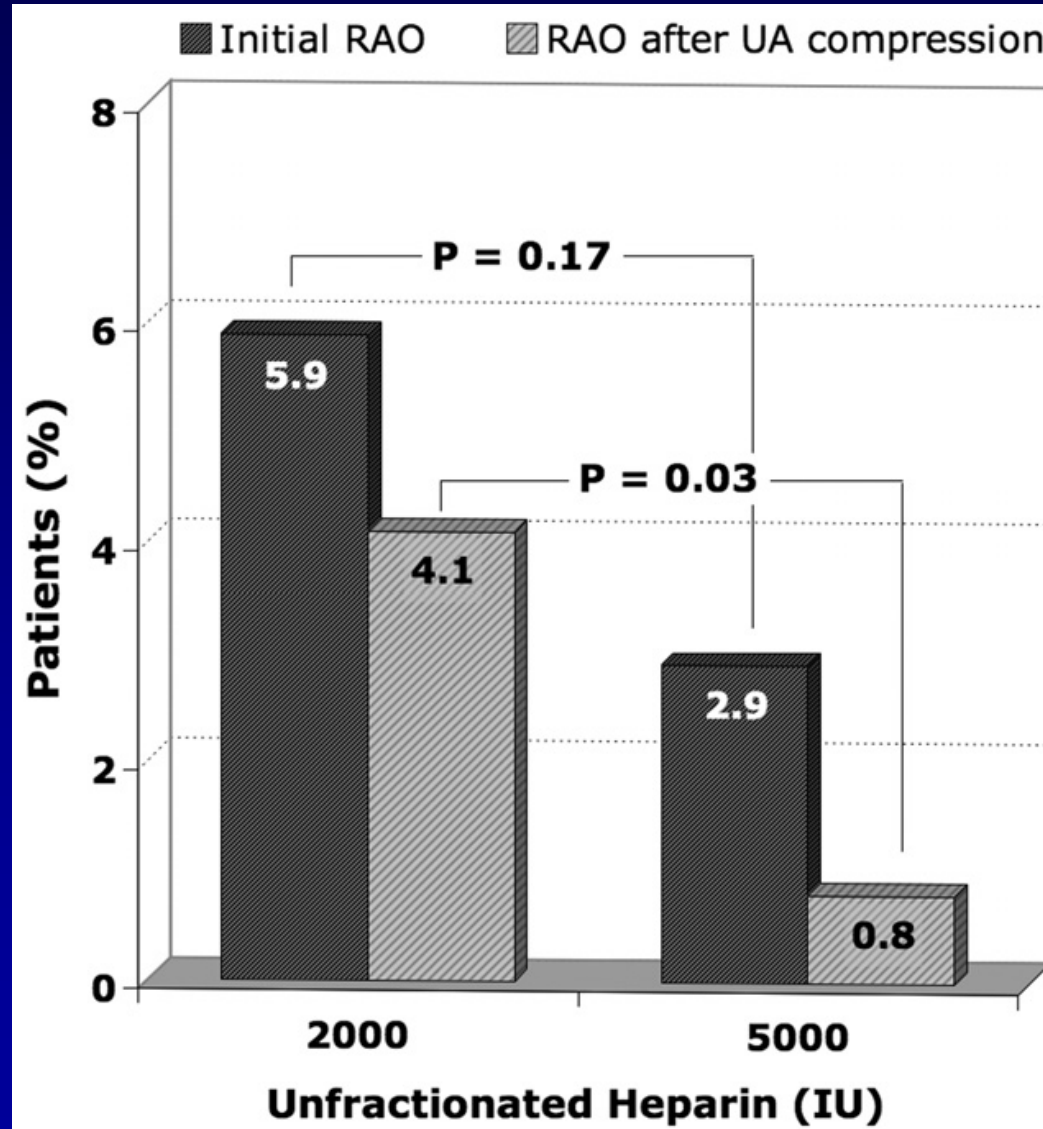
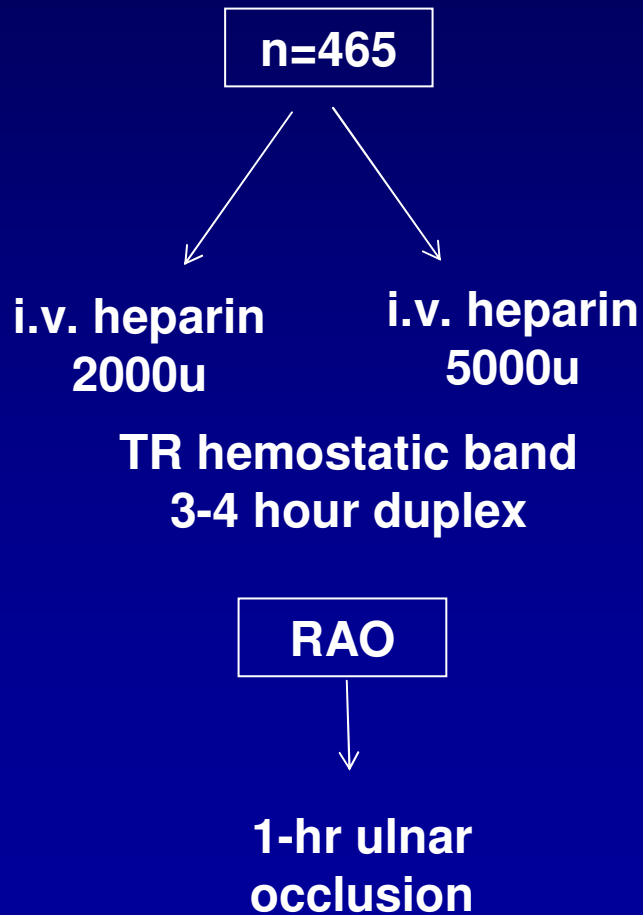
Berant et al. AJC 2011



Transradial Catheterization Complications:  
**Prevention of Hand ischemia**

***Ulnar compression can resolve early radial occlusion***

Berant et al. AJC 2011

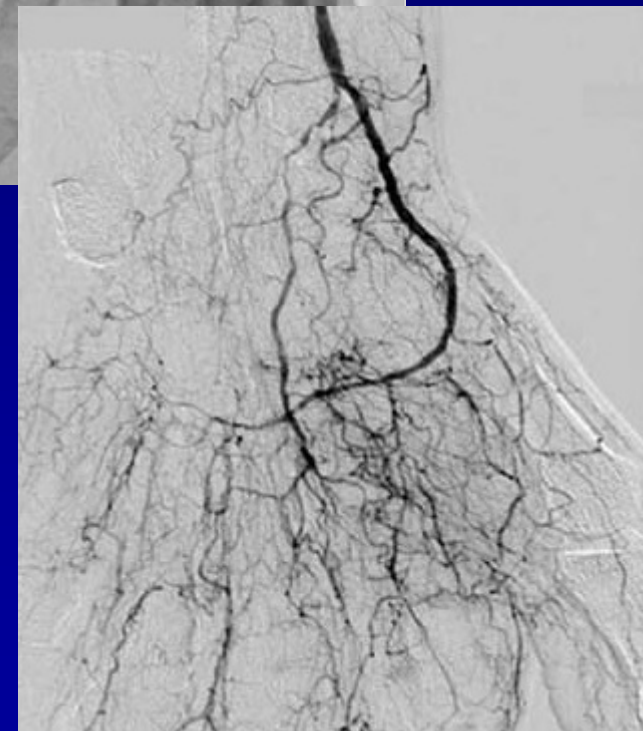
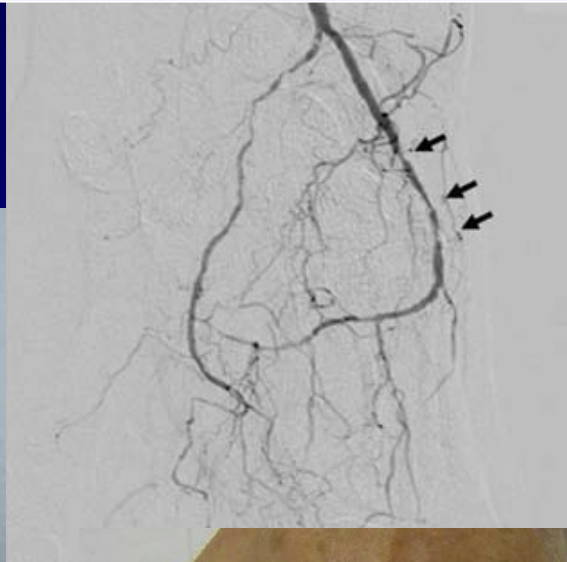


Transradial Catheterization Complications:

## Management of Hand ischemia

*Early angiography and intervention for critical hand ischemia*

Kawarada et al. CCI 2010





## Transradial Catheterization Complications:

# Summary

**TRC enhances patient comfort and is likely to reduce the rates of minor vascular complications (vs. TFC)**

**Though generally very safe, serious potential complications of TRC should be recognized**

**Most complications are easily avoided by simple preventive measures (case selection, technique and dedicated devices, patent hemostasis)**

**Early detection and intervention should may prevent permanent radial occlusion and critical hand ischemia**



