Perioperative Care of Our Cath Lab Patients:

Why what happens in the cath lab shouldn't stay in the cath lab

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Overview

Pre-Op Evaluation

- Consent
- CIN Prevention

Vascular Access

- Complication prevention and management
- Femoral vs. Radial

Overview

Pre-Op Evaluation

- Consent
- CIN Prevention

Procedure Related Complications of Cardiac Catheterization

	Diagnostic Catheterization-Only Patients Without STEMI (n=1,091,557)	PCI Patients Without STEMI (n=787,980)	PCI Patients With STEMI (n=153,268)
Complications (%)			
Any adverse event	1.35	4.53	12.4
Cardiogenic shock	0.24	0.47	3.87
Heart failure	0.38	0.59	3.46
Pericardial tamponade	0.03	0.07	0.15
Cerebrovascular accident/stroke	0.17	0.17	0.56
% of total strokes that are hemorrhagic	9.16	15.6	19.7
New requirement for dialysis	0.14	0.19	0.63
In-hospital mortality			
Risk-adjusted (median)			5.2
Non-risk-adjusted	0.72	0.65	
Non-risk-adjusted, excluding CABG patients	0.60	0.62	
CABG performed during admission	7.47	0.81	
CABG status			
Salvage/emergency	0.01 / 0.27	0.01 / 0.17	0.05 / 0.87
Urgent/elective	5.27 / 1.92	0.47 / 0.16	2.08 / 0.43
CABG indication			
PCI failure without clinical deterioration		0.26	0.58
PCI complication		0.14	0.22
Bleeding Complications (%)			
Any bleeding event within 72 hours of procedure	0.49	1.40	3.85
Any other vascular complication requiring treatment	0.15	0.44	0.62
Red blood cells/whole blood transfusion	N/A	2.07	5.61

J Am Coll Cardiol. 2012 Nov 13;60(20):2017-31

Informed Consent

- Overall risk of serious life threatening complication of death, myocardial infarction, or stroke is < 0.1%.
- Informed Consent
  - Risks, benefits, alternatives
  - Ultimately the responsibility of the operator
  - If PCI is a possible outcome, this should be included in the consent
  - Not required to include all risks

Informed Consent

- Ultimately, it is the responsibility of the operator to ensure this is done.

Contrast Induced Nephropathy

- CIN is a rise in serum Cr ≥ 0.5 mg/dL or 25% increase above baseline.
- Differential includes hypotension, renal atheroemboli, acute interstitial nephritis
- Time course
  - Rise in Cr occurs in 24-48 hours
  - Peaks at 3-5 days
  - Resolves over one week

Contrast Induced Nephropathy

- CIN is associated with adverse outcomes
  - 5 to 20 fold increase risk of early events
    - In-hospital MI
    - Target vessel occlusion
    - Prolonged hospital stay
    - Early mortality
  - Long term adverse associations include 11-fold increase in ESRD, re-hospitalization, and 3-4 times increased risk of mortality

JAMA 1996;275:1489-94.
Circulation 2011;123:409-16.
Circulation 2002;105:2259-64.

Risk factors for Contrast-Induced Nephropathy

Patient Factors	Procedural Factors
Chronic kidney disease	Volume of contrast
Congestive heart failure	Use of intra-aortic balloon pump
Age greater than 70 years old	Urgent or emergent procedure
Hypotension (at time of procedure)	Repeat contrast exposure within 72 hours
History of hypertension	Hyperosmolar contrast
Anemia	
Diabetes mellitus	
Nephrotoxic medications	
Female gender	

Predictive Model of CIN

Risk Factors	Integer Score
Hypotension	5
IABP	5
CHF	5
Age >75 y/o	4
Anemia	3
Diabetes	3
Contrast Media Volume	1 for each 100 cc^3
Serum creatinine >1.5 mg/dl *OR* **eGFR <60 ml/min/1.73 m^2**	4 2 for 40-60 4 for 20-40 6 for <20

Add All Scores

Add All Scores

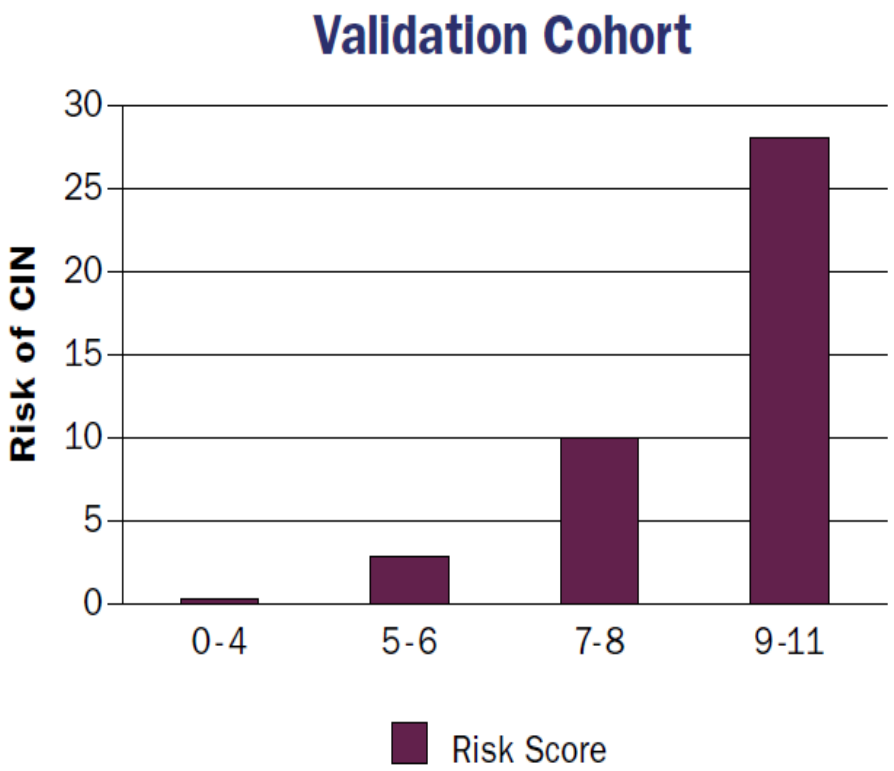
Risk Score

Risk Score	Risk of CIN	Risk of Dialysis
≤5	7.5%	0.04%
6-10	14%	0.12%
11-16	26.1%	1.09%
≥16	57.3%	12.6%

JACC 2004; 44: 1393-9

Alternative Model of CIN

Characteristic	Score
Creatinine clearance <60 ml/min	2
Intra-aortic balloon pump	2
Urgent/emergency procedure	2
Diabetes mellitus	1
Congestive heart failure	1
Hypertension	1
Peripheral vascular disease	1
Contrast >260 ml	1



Am J Cardiol 2004; 93:1515-19
Ann Int Med; 150:170-7

Preventing Contrast-Induced Nephropathy

- Identify risks
  - Higher risk – eGFR < 60 mL/min/1.73m*m
  - Diabetes
- Manage medications
  - Hold nephrotoxic drugs (e.g., NSAIDS)
- Management intravascular volume
  - Hydrate with normal saline pre-cath
  - LVEDP guided post cath hydration
- Radiographic contrast
  - Minimize contrast volume
  - Use either low-osmolar or iso-osmolar contrast
- Follow-up: Obtain 48 hour creatinine

Bashore JACC 2012; 59: 2221-305

Preventing Contrast-Induced Nephropathy

CIN Prevention: Pre-Cath Hydration

sodium chloride 0.9 % bolus 3 mL/kg

3 mL/kg, Intravenous, Administer over 60 Minutes, ONCE, Today at 0900, For 1 dose
Pre-procedural hydration= administer 3ml/kg for ONE HOUR PRIOR to procedure. Intra-procedural hydration= As approved by interventional cardiologist, use LVEDP-guided hydration for fluid administration throughout procedure Maximum dose = 300 mL
Pre-Procedure(Cath), Sign & Hold

Preventing Contrast-Induced Nephropathy

CIN Prevention: Post-Cath Hydration

▼ IV Fluids

▼ ** FOR LHC/PCI ONLY **

** Contraindicated for ESRD/Dialysis patients **

- ○ Post-Procedure fluids not indicated
  No Post Cath Procedure Fluids
- ○ LVEDP less than 13 - 0.9% NaCl at 5 ml/kg/hr for 2 HOURS POST PROCEDURE
  5 mL/kg/hr, Intravenous, Continuous, for 2 hours, For LVEDP less than 13 Maximum dose = 500 mL/hr based on maximum dosing weight of 100 kg
- ○ LVEDP less than 13 - 0.9% NaCl at 5 ml/kg/hr for 4 HOURS POST PROCEDURE
  5 mL/kg/hr, Intravenous, Continuous, for 4 hours, For LVEDP less than 13 Maximum dose = 500 mL/hr based on maximum dosing weight of 100 kg
- ○ LVEDP 13 to 18 - 0.9% NaCl at 3 ml/kg/hr for 2 HOURS POST PROCEDURE
  3 mL/kg/hr, Intravenous, Continuous, for 2 hours, For LVEDP 13-18 Maximum dose = 300 mL/hr based on maximum dosing weight of 100 kg
- ○ LVEDP 13 to 18 - 0.9% NaCl at 3 ml/kg/hr for 4 HOURS POST PROCEDURE
  3 mL/kg/hr, Intravenous, Continuous, for 4 hours, For LVEDP 13-18 Maximum dose = 300 mL/hr based on maximum dosing weight of 100 kg
- ○ LVEDP greater than 18 or LVEDP not obtained - 0.9% NaCl at 1.5 ml/kg/hr for 2 HOURS POST PROCEDURE
  1.5 mL/kg/hr, Intravenous, Continuous, for 2 hours, For LVEDP greater than 18 or LVEDP not obtained Maximum dose = 150 mL/hr based on maximum dosing weight of 100 kg
- ○ LVEDP greater than 18 or LVEDP not obtained - 0.9% NaCl at 1.5 ml/kg/hr for 4 HOURS POST PROCEDURE
  1.5 mL/kg/hr, Intravenous, Continuous, for 4 hours, For LVEDP greater than 18 or LVEDP not obtained Maximum dose = 150 mL/hr based on maximum dosing weight of 100 kg

Overview

Pre-Op Evaluation

- Consent
- CIN Prevention

Vascular Access

- Complication prevention and management
- Femoral vs. Radial

Preventing Access Complications

- Step 1

Recognize that vascular access is taken for granted, under-investigated, and over-represented in complications.

Image: https://www.researchgate.net/figure/224830285_fig1_Fig-1-Large-right-groin-and-forearm-hematomas

Most common: hematoma
Most lethal: retroperitoneal hemorrhage

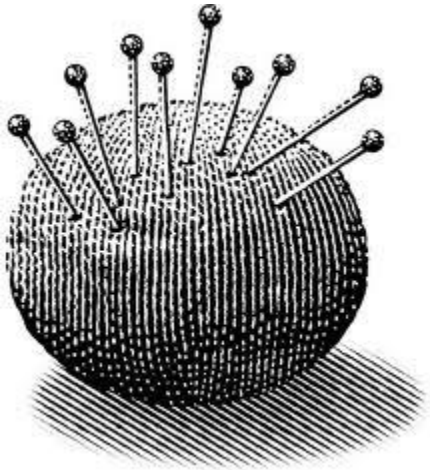
Local complications of FA access: 2-10%

- **Hematoma (1-12%)**
- **Pseudoaneurysm (1-6%)**
- **AV fistula (<1%)**
- **Vessel laceration (<1%)**
  - **Free bleeding**
- **Intimal dissection**
  - **Ante- or retro-grade**
- **Acute vessel closure (<1%)**
  - **Thrombosis (small artery lumen)**
- **Retroperitoneal hemorrhage (0.2 – 0.9%)**
- **Thickening of the perivascular tissues**
- **Neural damage**
- **Infection**
- **Venous thrombosis**
- **Pericatheter clot**

Complication rate has been persistent over many decades

Usual Approach

- **Keep poking until you get a gusher**

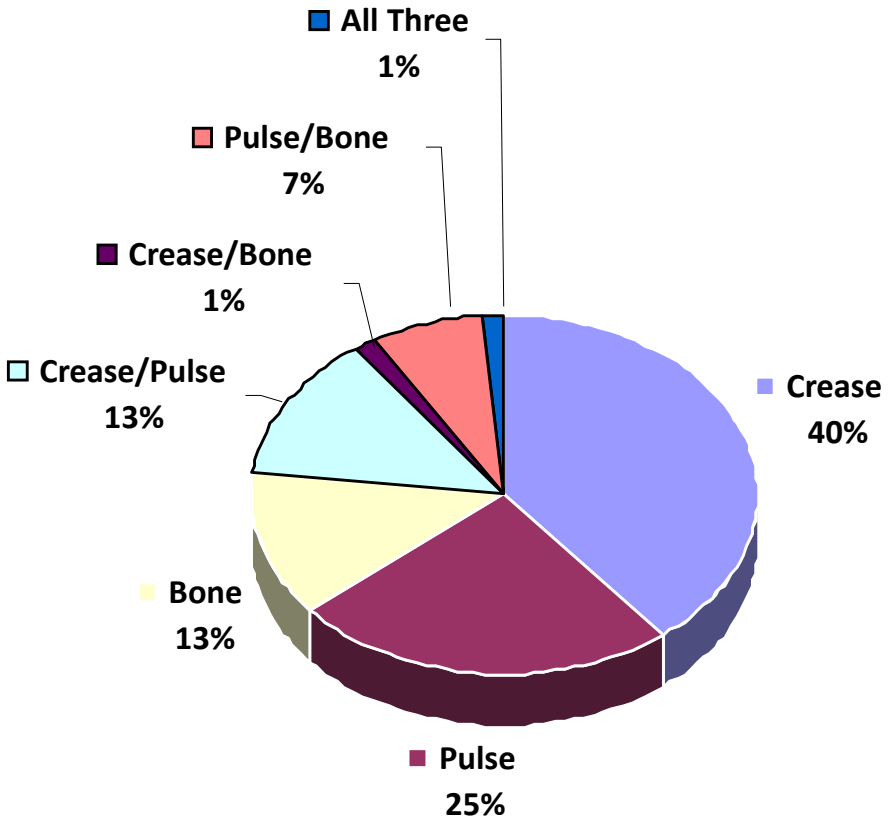


Landmarks Used for Femoral Puncture

Skin Crease

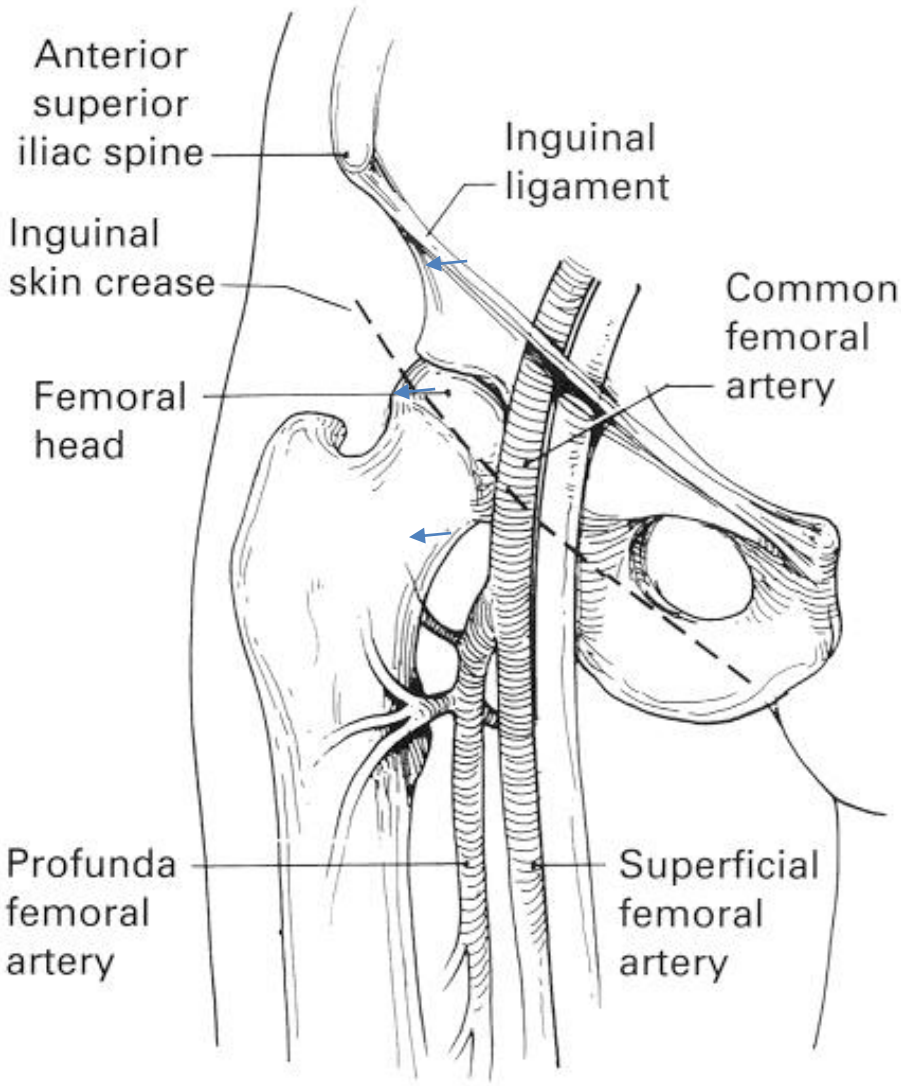
Maximum Pulse

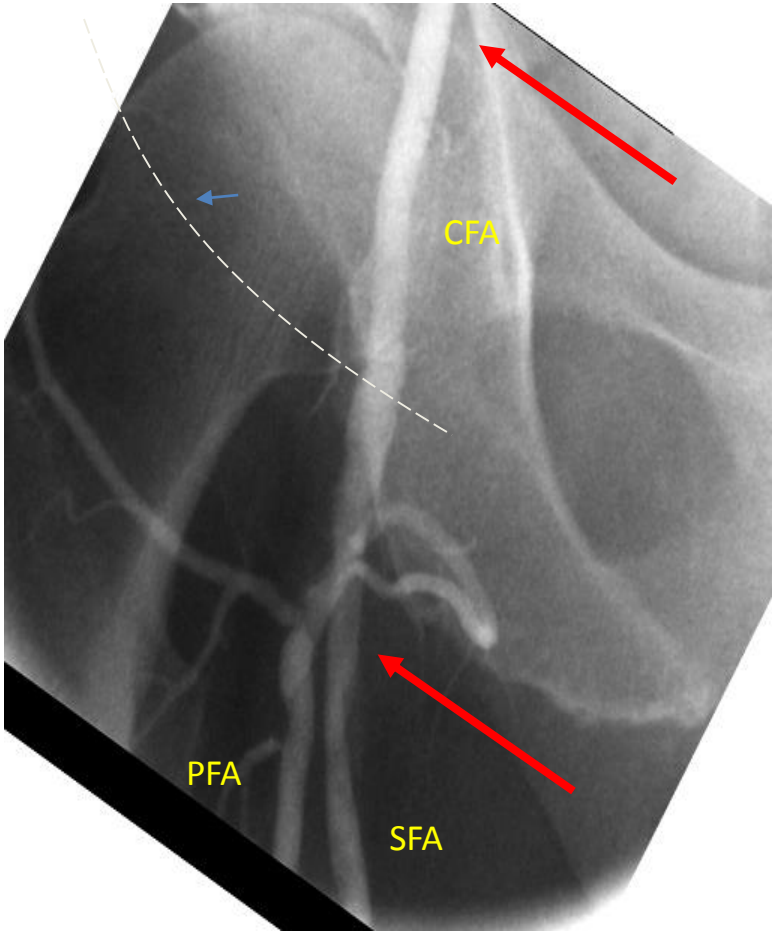
Bony Landmarks

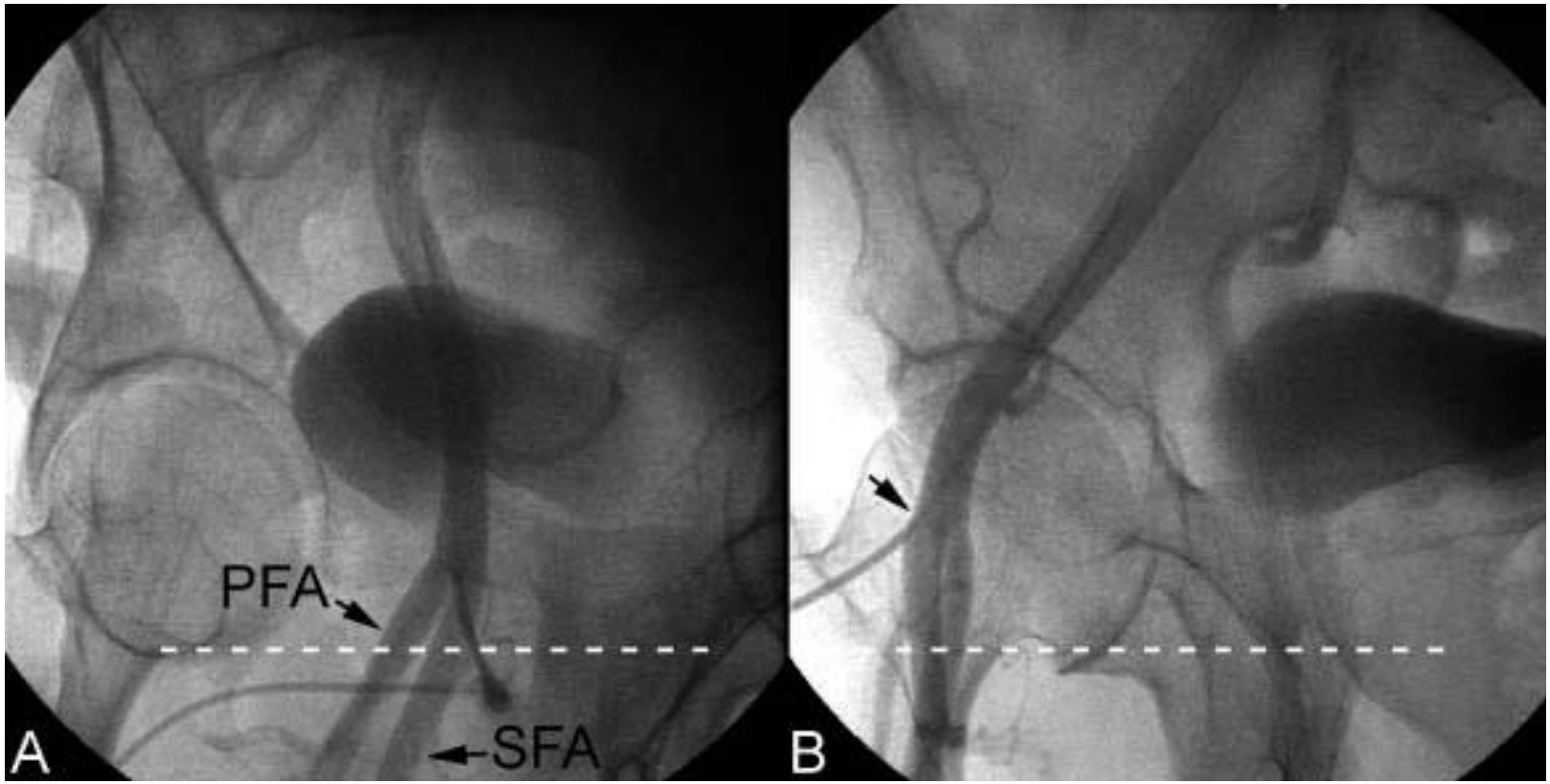


Grier D. *Br J Radiol* 1990;63:602.

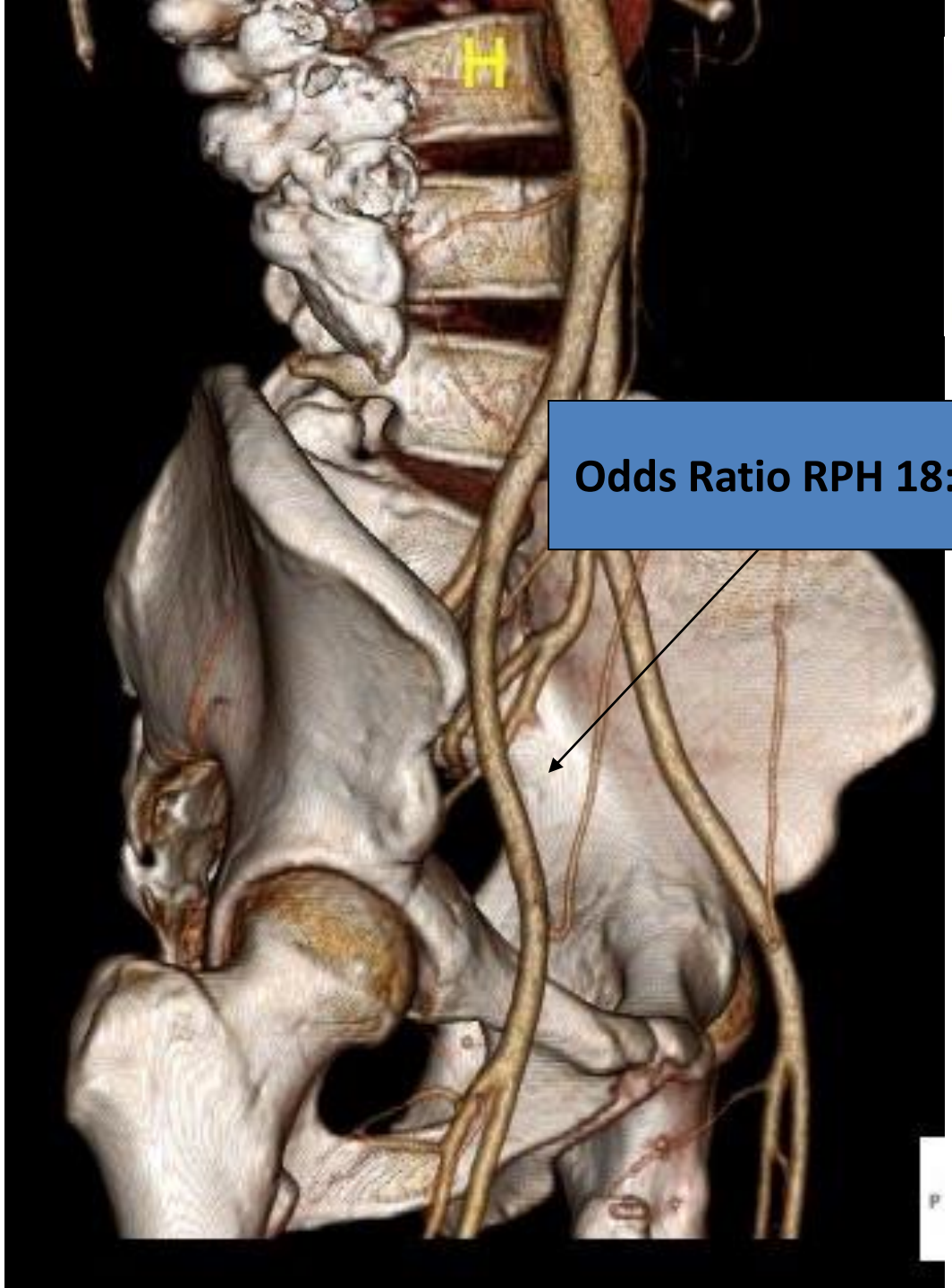
This is NOT Normal Anatomy



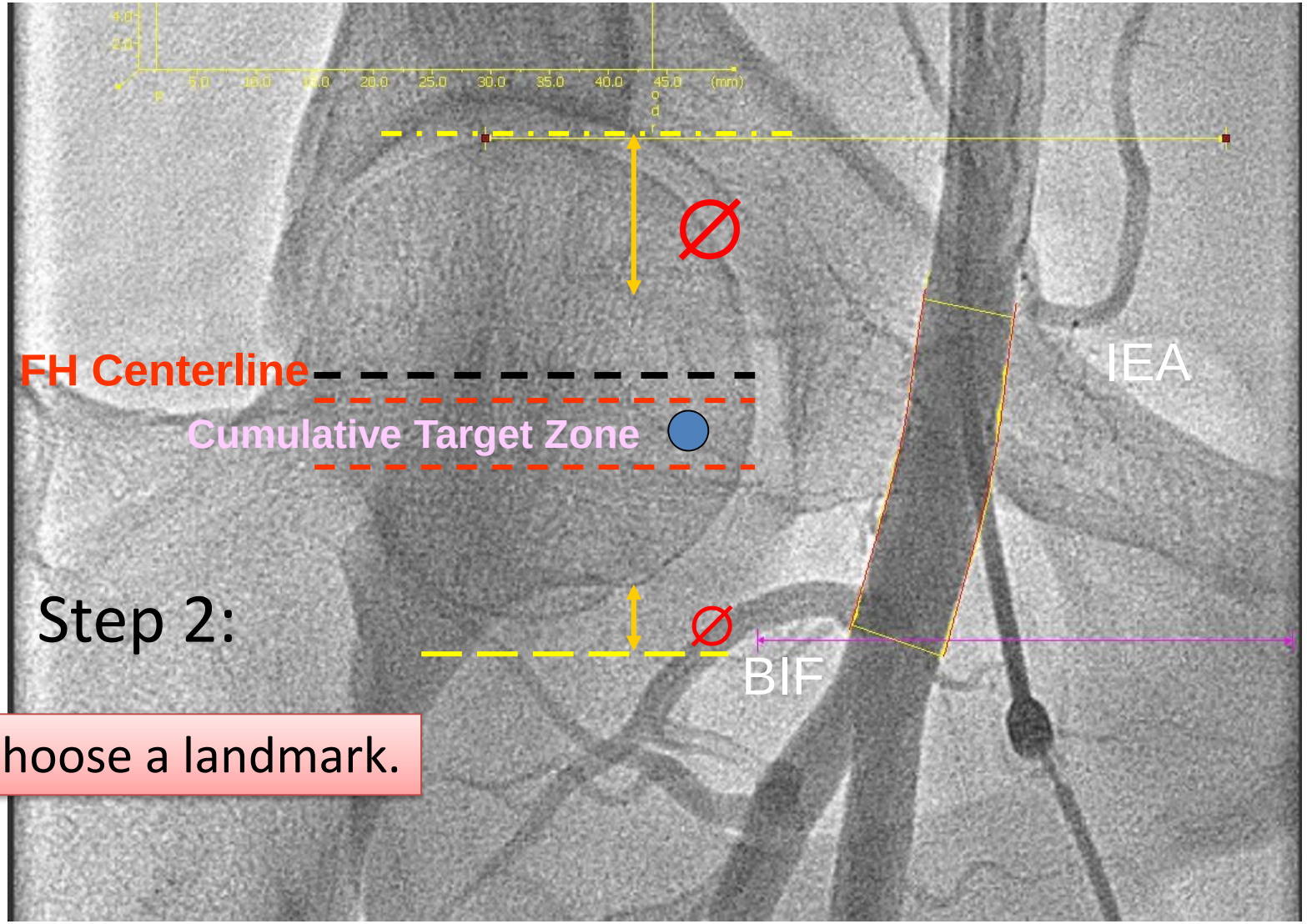




Clinical Cardiology 34(11):700-2 · November 2011


H
Odds Ratio RPH 18:1

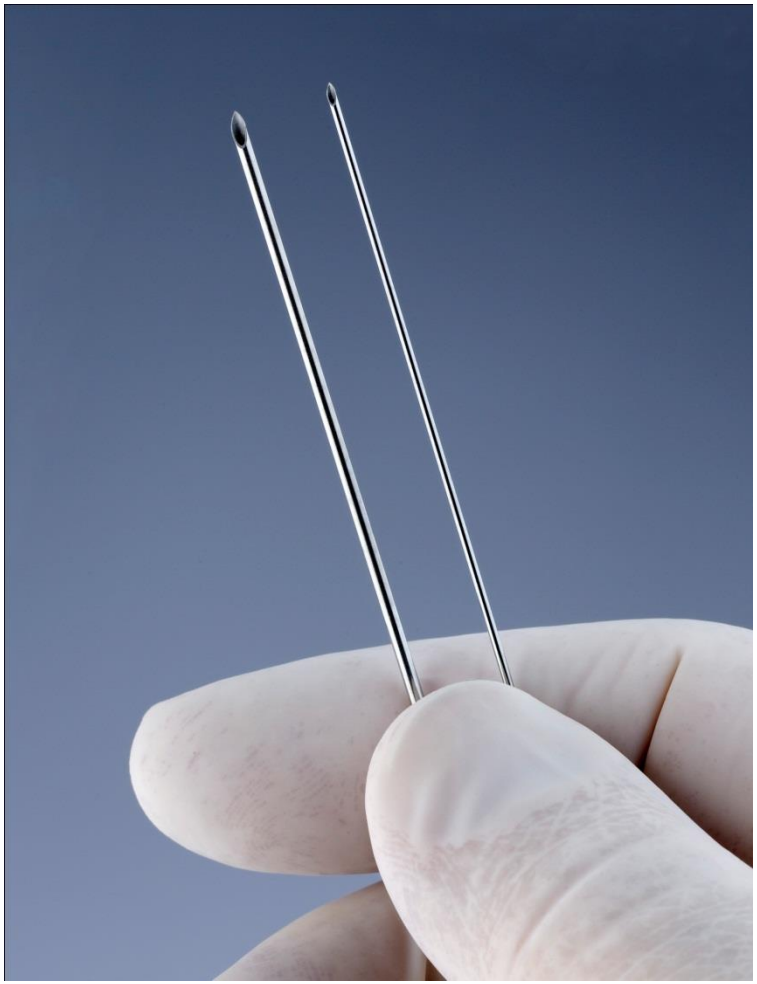
Preventing Access Complications

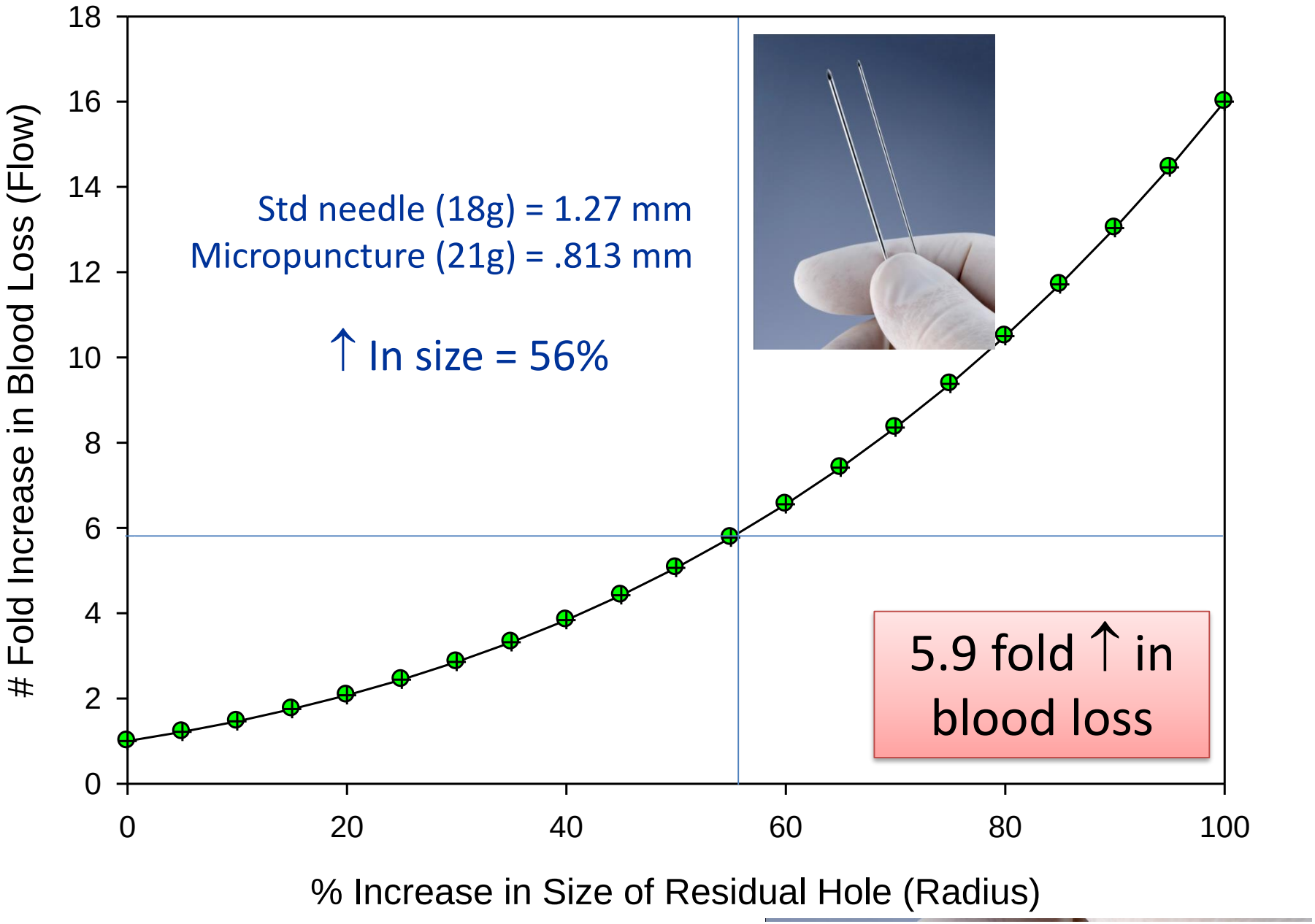


Preventing Access Complications

- Step 3

Micropuncture




Std needle (18g) = 1.27 mm
Micropuncture (21g) = .813 mm
↑ In size = 56%
5.9 fold ↑ in blood loss
Fold Increase in Blood Loss (Flow)
% Increase in Size of Residual Hole (Radius)
0
2
4
6
8
10
12
14
16
18
0
20
40
60
80
100

Preventing Access Complications

- Step 4

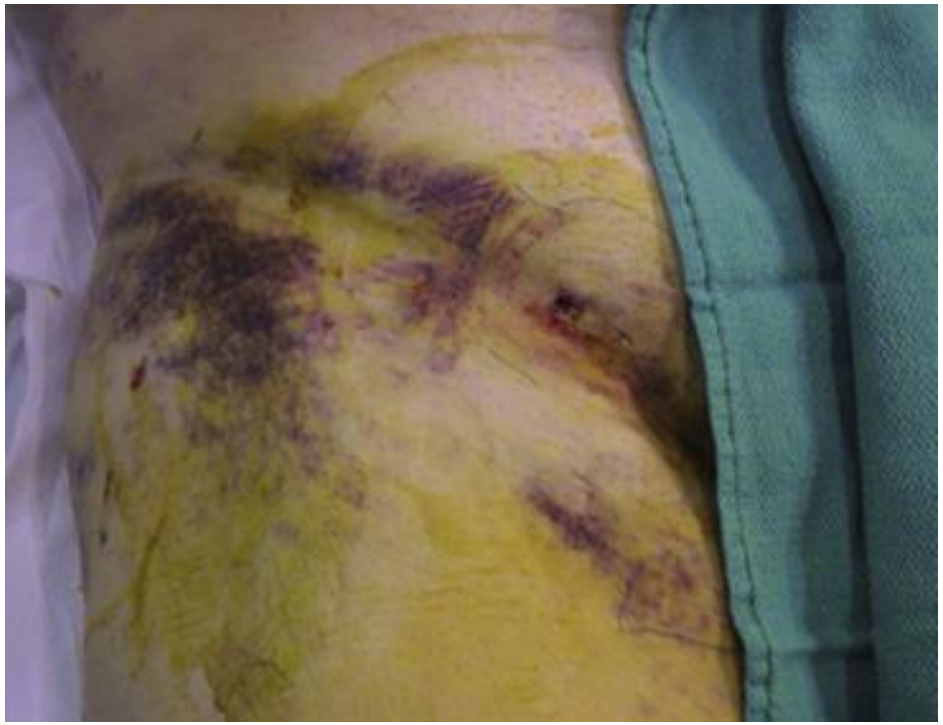
Good Closure

- Hold time
  - 15 minutes diagnostic
  - 30 minutes intervention
  - Bedrest 6 hours
- Hold location
  - Proximal
  - Over palpable pulse

Preventing Access Complications

Risk Factors for Bleeding

Risk Factor	Odds Ratio
Age >75 vs. <55	2.59
Heparin use postprocedure	2.46
Severe renal impairment	2.25
Age 65–74 vs. <55	2.18
Female patient	1.64
Closure device use	1.58
Sheath size 7F–8 F vs. <6	1.53
GP IIb/IIIa use	1.39
Longer procedure duration	1.2



http://clinicalgate.com/complications-of-percutaneous-coronary-interventions/

Adapted from Doyle B, Ting HH, Bell MR, et al. Major femoral bleeding complications after PCI. JACC Cardiovasc Interv2008;1(2):202–209

Preventing Access Complications

Access Complication	Incidence (%)
Pseudoaneurysm	61.2
Hematoma	11.2
Arteriovenous fistula	10.2
External bleeding	6.1
Retroperitoneal hematoma	5.1
Arterial thrombosis	3.1
Groin abscess	2.0
Mycotic aneurysm	1.0

Femoral Access Complications Requiring Interventions

Data from Lumsden AB, Peden EK, Bush RL, Lin PH. Complications of endovascular procedures at the target site. In: Ouriel K, Katzen BT, Rosenfield K, editors. Complications in endovascular therapy. New York: Taylor & Francis; 2006. p. 29–53.

Preventing Access Complications

Pseudoaneurysms

Procedural Factors

Catheterization of both artery and vein

Cannulation of the superficial femoral or profunda femoris rather than common femoral

Inadequate compression post procedure

More anticoagulation used

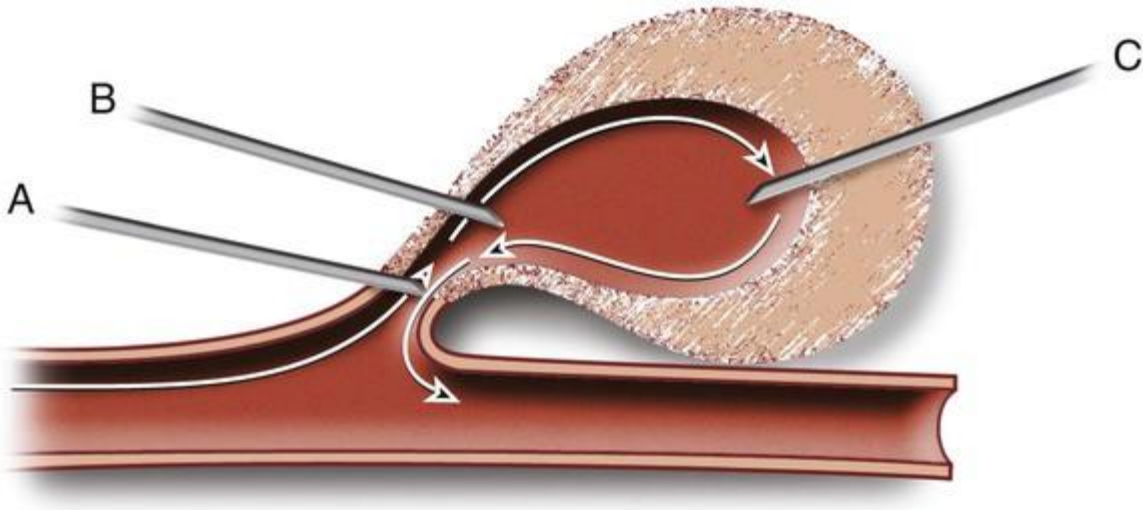
Patient Factors

Obesity

Hemodialysis

Calcified arteries

- Low puncture site
- Inadequate pressure
- Experience of sheath-puller



http://radiologykey.com/management-of-postcatheterization-pseudoaneurysms/

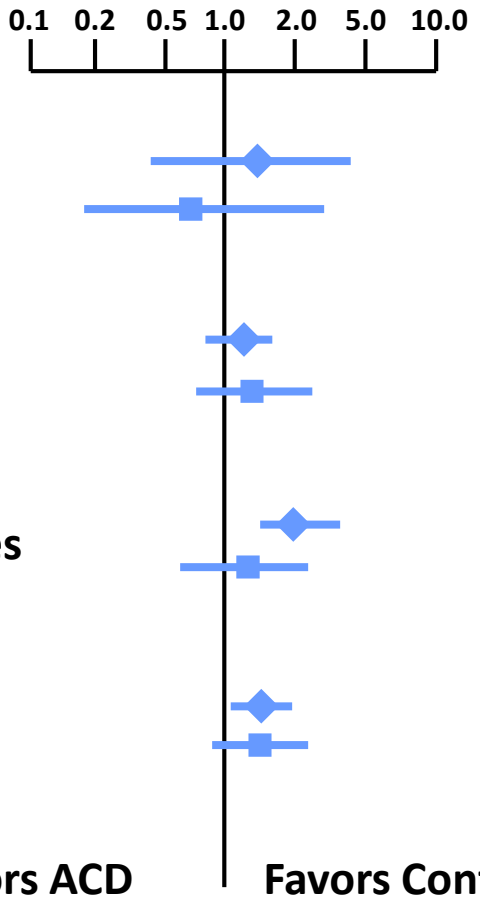
Preventing Access Complications

- Step 4

Closure Devices?

- Patient comfort and convenience
  - Early hemostasis
  - Early ambulation
- Decreased complications?
  - NO!

Meta-analysis of Closure Devices



	OR (95% CI)	Heterogeneity test P-value
Dx studies	1.44 [0.43, 4.82]† 0.66 [0.18/, 2.38]*	0.0003 0.16
PCI studies	1.11 [0.94, 1.33]* 1.35 [0.87, 2.11]*	0.22 0.15
Both Dx+PCI studies	1.83[1.15,2.90]† 1.15 [0.67, 1.98]*	0.001 0.43
All studies	1.34 [1.01, 1.79]† 1.30 [0.90,1.87]*	<0.0001 0.19

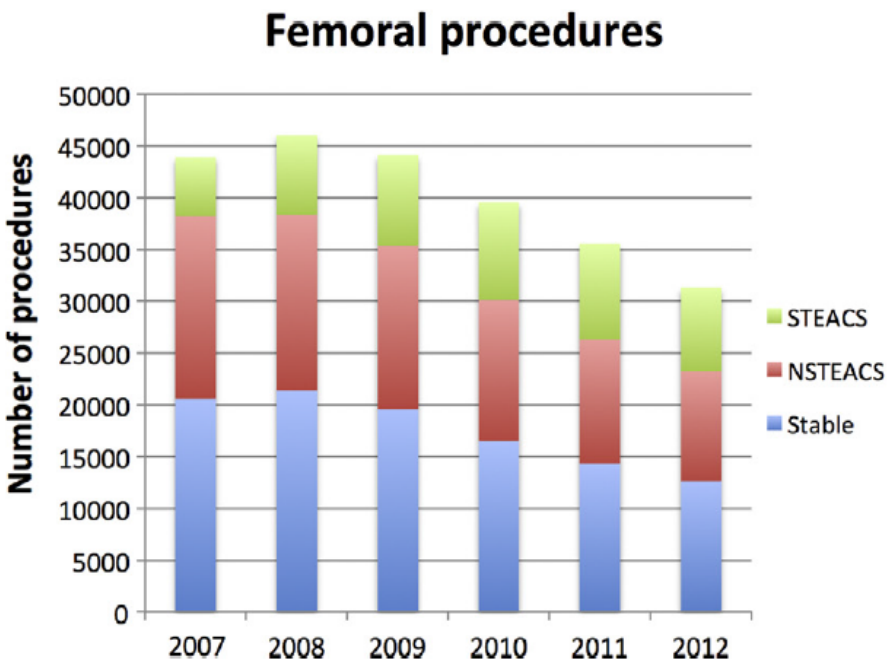
ACC/AHA Class III indication to **lower** complication rates

Nikolsky et al. *JACC* 2004.

Preventing Access Complications

1. Don’t take access for granted
2. Access the common femoral over the femoral head
3. Use micropuncture
4. Quality hemostasis/closure
5. GO RADIAL!

Registry Data: Transradial PCI in the UK



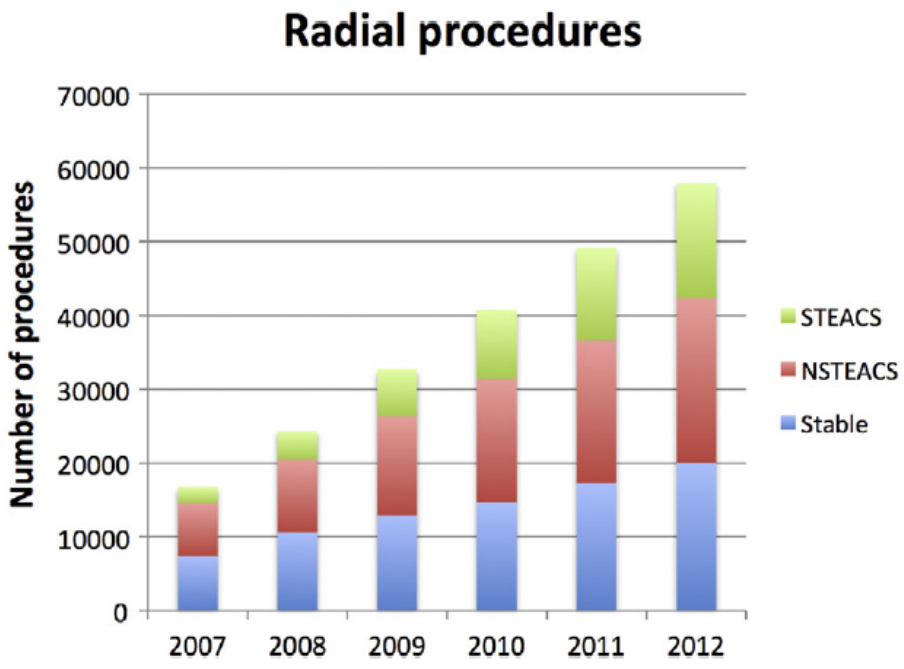


FIGURE 1 **Use of Access Site for PCI Between 2007 and 2012**

Numbers of procedures using femoral or radial access and indication for percutaneous coronary intervention (PCI) in the United Kingdom between 2007 and 2012. NSTEACS = non-ST-segment elevation acute coronary syndrome; STEACS = ST-segment elevation acute coronary syndrome.

Katib et al. JACC Intv 2015.

Transradial Use for STEMI in the US

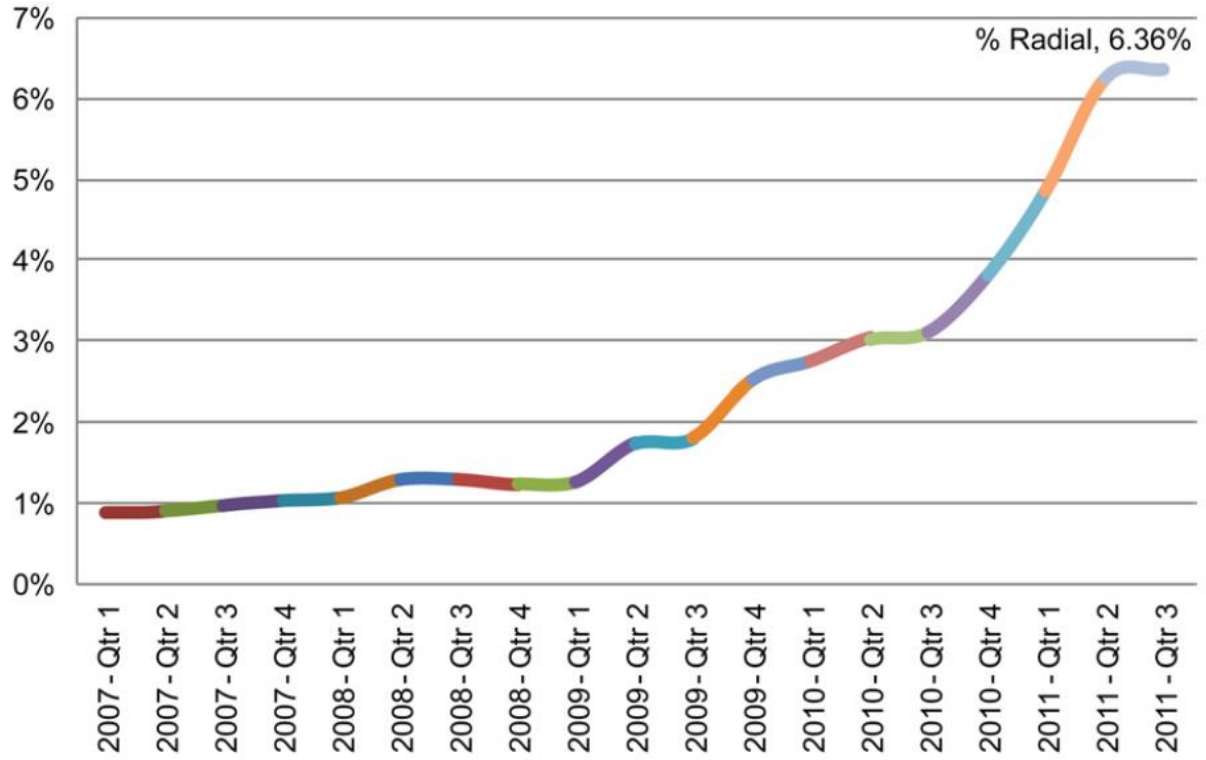
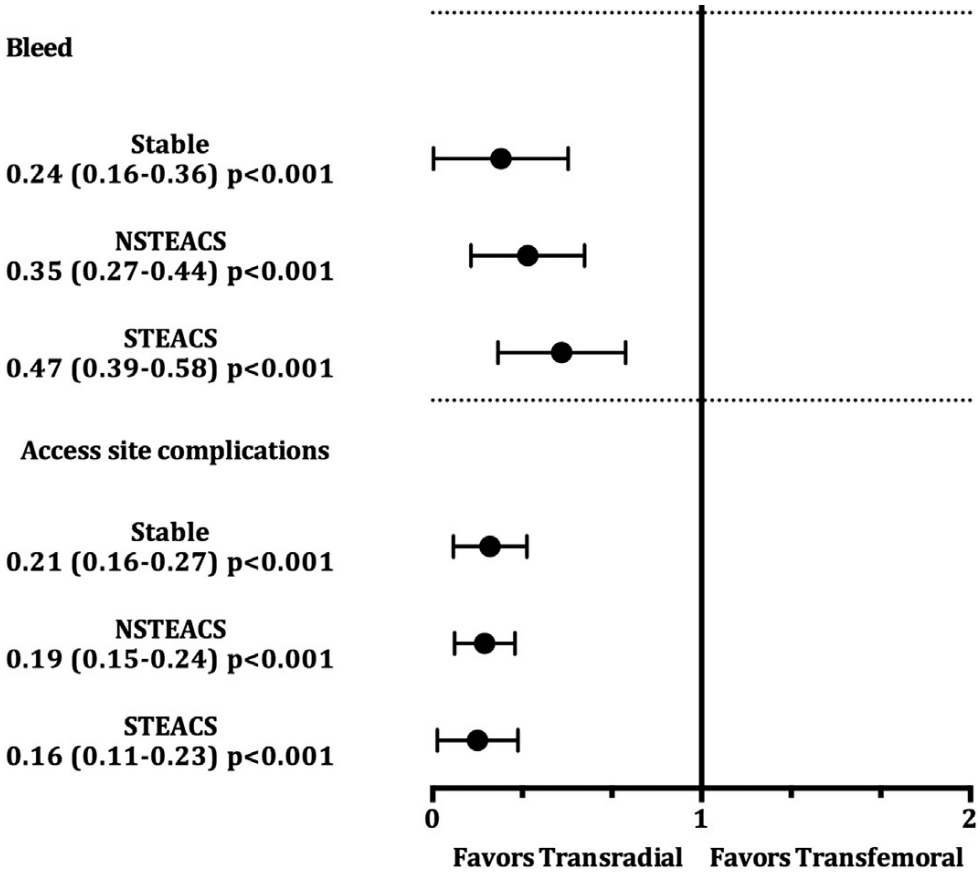
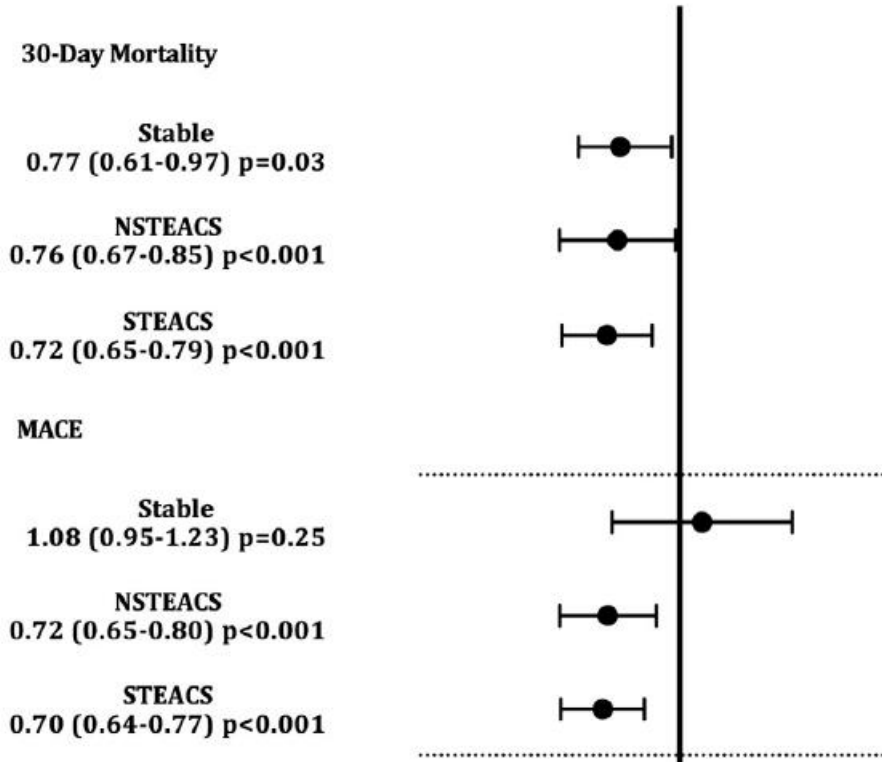


Figure 3 **Temporal Trend in Use of TRI for STEMI PCI from 2007 to 2011**

Baklanov, et al. JACC 2013.

Large Associated Benefit

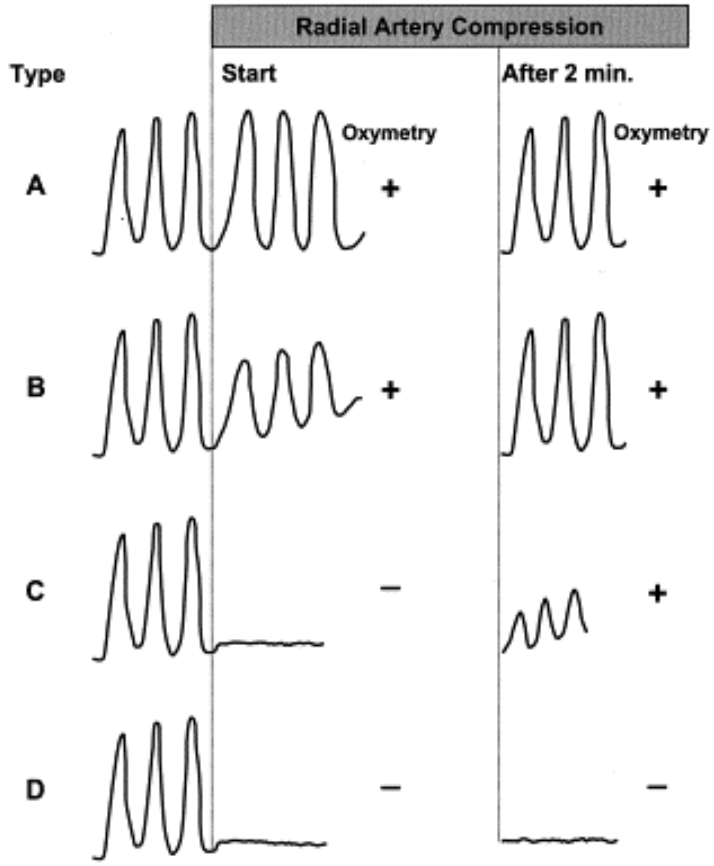




Katib et al. JACC Intv 2015.

Oximetry + Plethysmography

The clamp sensor is applied to the thumb



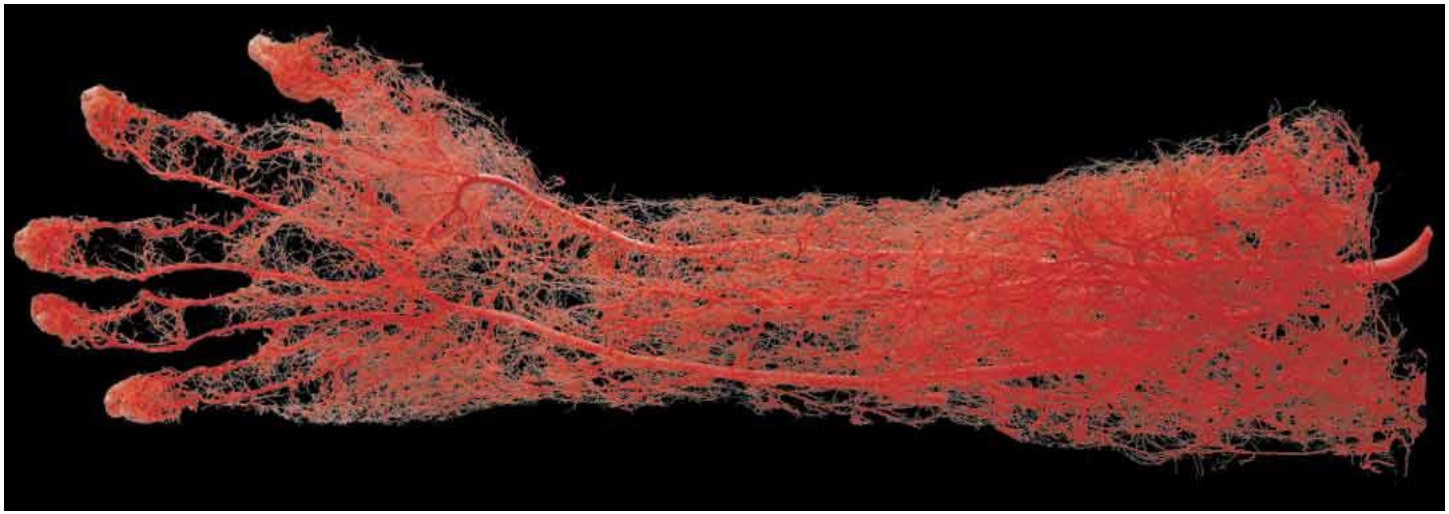
A	No damping of pulse tracing immediately after radial artery compression	15%
B	Damping of pulse tracing	75%
C	Loss of pulse tracing followed by recovery of pulse tracing within 2 minutes	5%
D	Loss of pulse tracing without recovery within 2 minutes.	5%

n=1,010 patients

Barbeau et al. Am Heart J 2004;147:489–93

Arm is very well collateralized

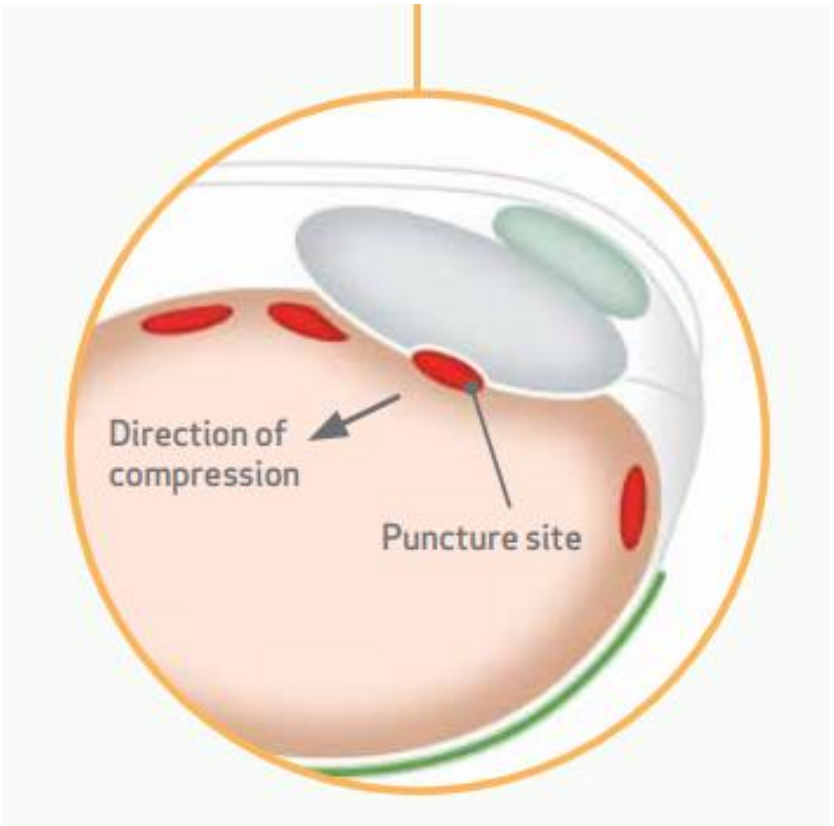
- *No correlation to hand ischemia & arterial lines*[1]
- Extensive radial CABG experience without ischemia
- Radial harvest with abnormal Allen's Test is possible[2]



Theoretical fears from an abnormal Allens Test is a poor excuse for a real risk of groin complications

1. J Trauma 2006;206:468-70
2. Surg Today 2006;36(9):790-2

TR band management



https://www.terumois.com/products/closure/tr-band.html

https://www.terumois.com/content/dam/terumopublic/products/Vascular-Access-Managment-Brochure.pdf

TR band management

- All patients with radial access will have TR band and stabilization device (armboard)
- TR band deflation 1-2 hours after diagnostic cath and 2-4 hours for interventional cath
- Deflate air by 3 ml every 15 minutes until band is deflated
  - If bleeding occurs, re-inflate band in 3 mL increments until bleeding stops
- Armboard for 24 hours or until discharge, whichever first

Hematoma or Swelling on Return to Room?

Hematoma or Swelling on Return to Room?

Managing a Perforation

- Early recognition
- Wrap potential bleeding site
- Wrap forearm swelling not related to hemostasis device at any time

Conclusions

- Consent is a critical part of the procedure
- Think ahead to avoid contrast induced nephropathy
- Access is taken for granted, and is over-represented in complications
- Radial access decreases bleeding, and mortality