

# Pelvic and Arterial Trauma



**DFIR`s årsmøde 2014**

**Korsør** 23th of May



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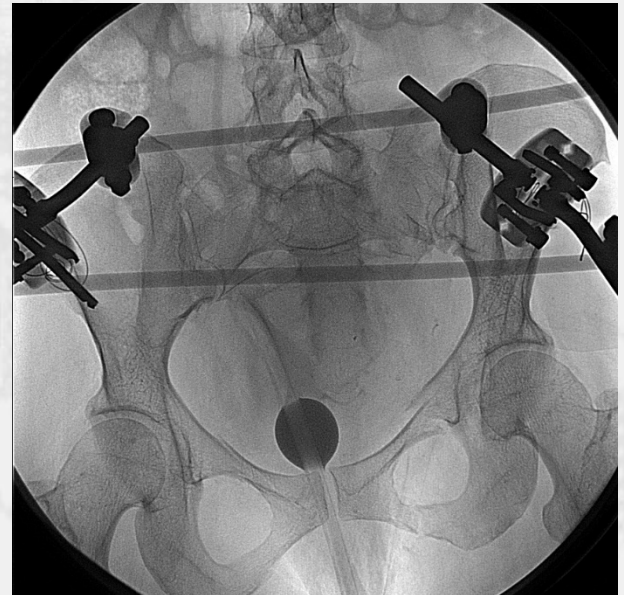
Madrid

# Pelvic Fracture

## Epidemiology

3 % of all fractures

- Motor Vehicle Acc.
- Run over pedestrians
- Falls
- Motorcycle
- Crush injuries
- Sports/recreations



# Pelvic Trauma



- **High mortality rate**
- Source of Massive Bleeding
  1. Rupture of veins/venous plexus
  2. Diffuse Bleeding from cancellous bone
  3. Rupture of arteries
  4. Combination
- Hemorrhage most common treatable cause of death

# Pelvic Trauma

Is hypotension related to the pelvic fracture itself ?

Bleeding from  
Abdomen

Visceral Injuries +

**DCL**

Bleeding from  
Pelvis

**Embolization**

External fixation

ICU, OR

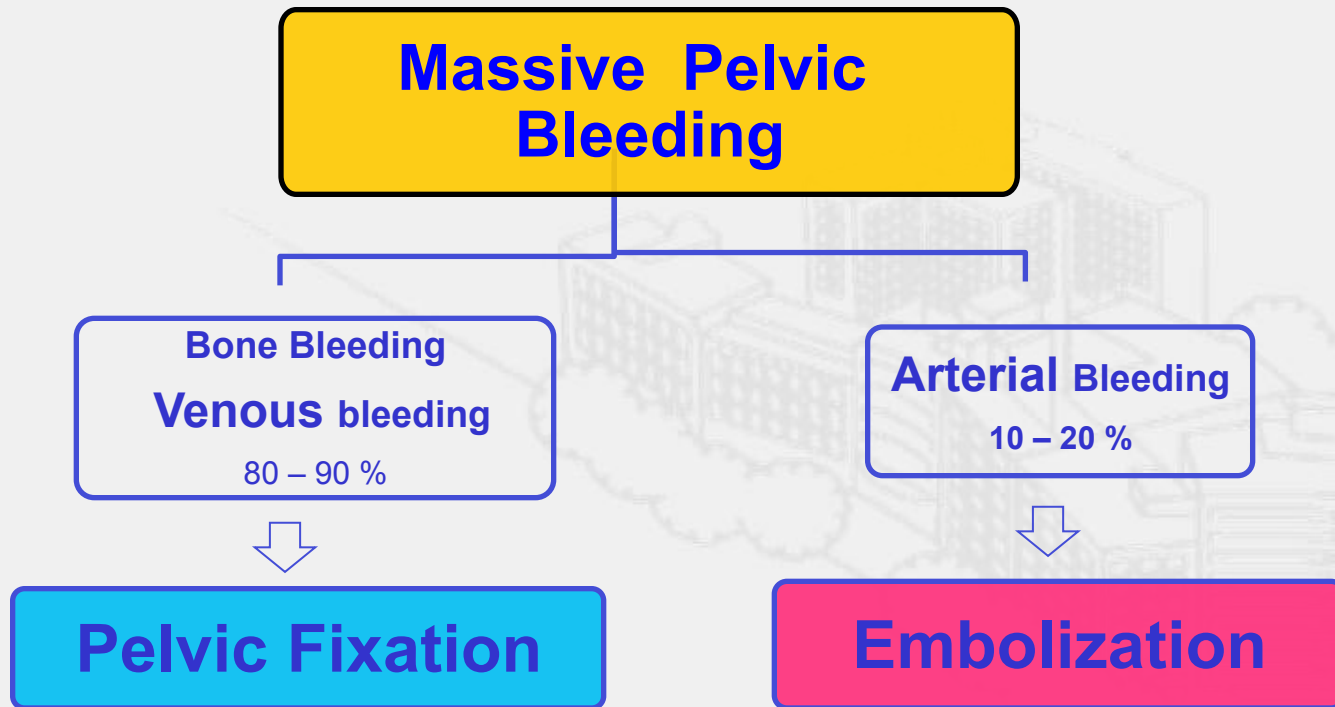
Internal Fixation

Re-embolization



# Pelvic Trauma

Arterial or venous bleeding?



# Pelvic Trauma

Hemodynamic status

- Stable
- Unstable



Patients responding to resuscitation can be scanned!

Source of hemorrhage → MDCT

CT whenever possible

1. Injuries screening
2. Predict the site of arterial injury
3. Tailored embolization

CT

F ast

A ccurate

S ensitive and S pecific

T otal body

E asy

R eproducible and R eviewable

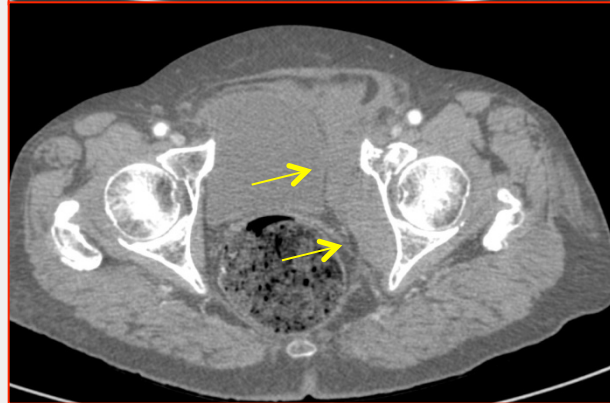
CT of the pelvis is an excellent screening tool to exclude pelvic hemorrhage

**Level II recommendation**

# MDCT

**MDCT is an independent predictor factor for survival**

*Wagner SH. Lancet 2009*



# FAST Ultrasound

## Focused Assessment with Sonography for Trauma

- Non specific
- Low sensitivity
- Low negative predictive value
- Best performed by experts

→ Perform if it does not delay CT

FAST US is not sensitive enough to exclude bleeding in the presence of pelvic fracture

**Level I recommendation**

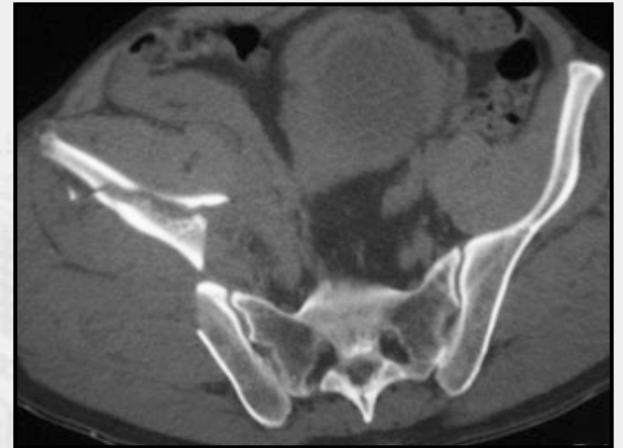
# Pelvic Trauma

## Why not surgery?

- **Increases bleeding risk**
- **Complex and obscure surgical field**
- **Iatrogenic complications**
- **Failure to control bleeding**

## Why Embolization ?

- **Better outcome**
- **Improves survival**



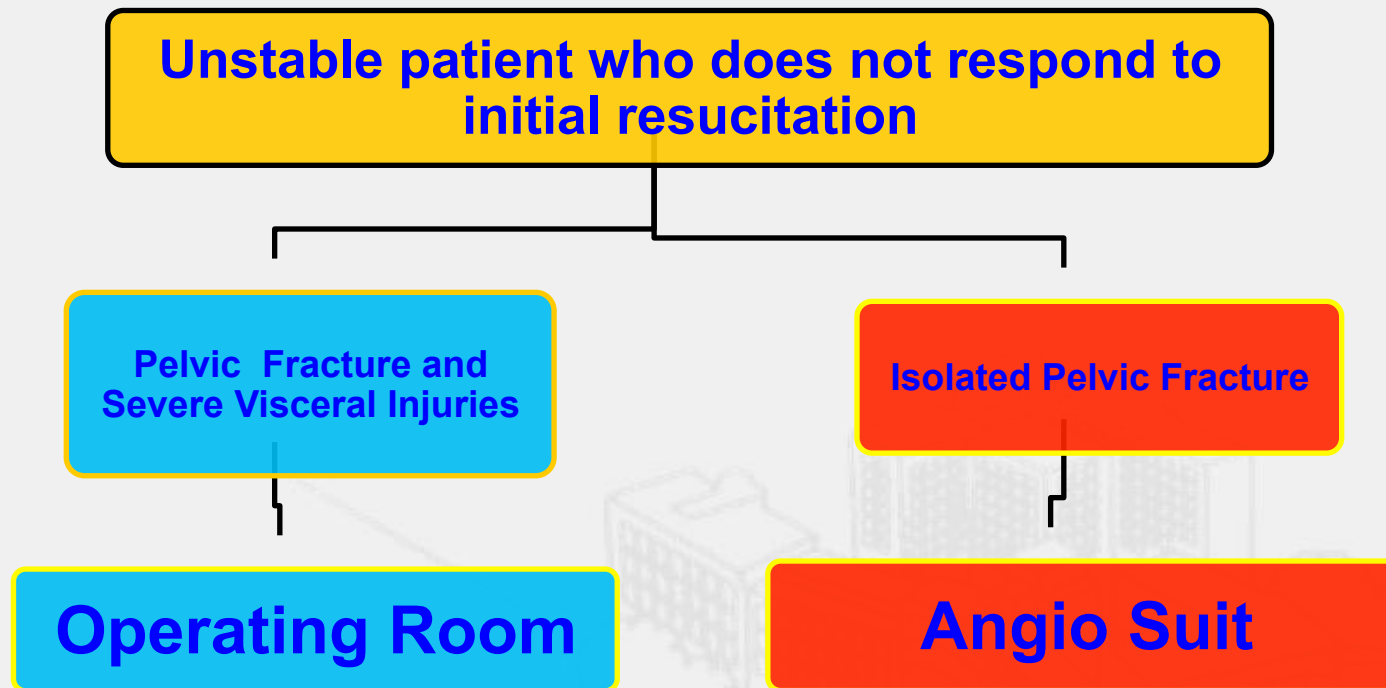


# Indications

## PELVIC TRAUMA with PELVIC ARTERIAL HEMORRHAGE

1. Hemodynamic instability
  2. Based on CT imaging
  3. Ongoing bleeding despite surgical intervention
  4. Slow but continuous bleeding in cases of NOM
- 

# Indications



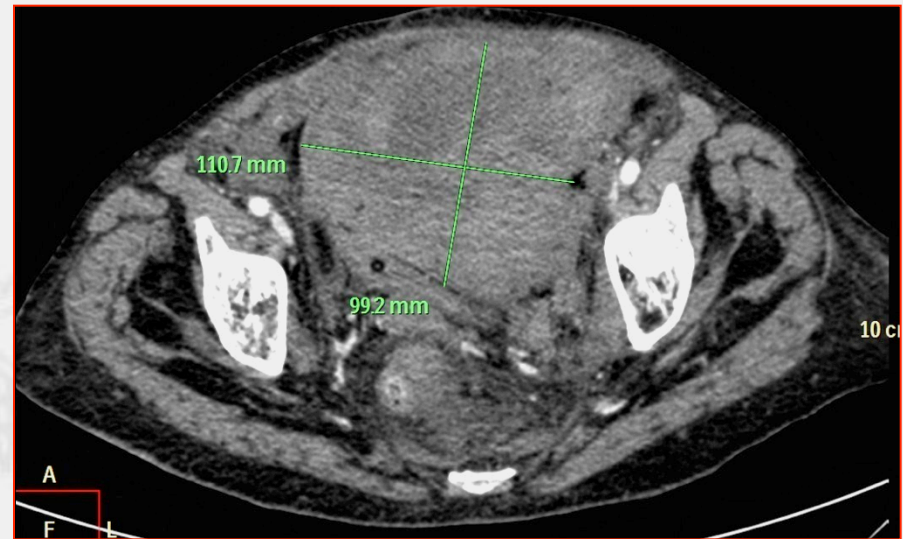
**CIRSE Guidelines for Treatment of Traumatic Hemorrhage:**

*Chakravety CVIR 2012; 35: 472 – 482*

• **Recommendation 13:** “Embolization should be used to manage arterial bleeding resulting of pelvic trauma and should precede treatment other than pelvic binder”

# Indications

Low Energy Pelvic Fractures in elderly people



- Stable Fracture
- Taking anticoagulants / antiplatelet

# Technique

- Pelvic Angiogram 4 – 5 F Pigtail
- Selective bilateral IIA Injection are mandatory
- Oblique views
- Film until venous return
- Look for multiple bleeders
- Massive Bleeding First

**Embolize as selectively as possible**

# Technique

## Source of bleeding

Post. Ring

Superior & Inferior Gluteal  
Iliolumbar  
Lateral Sacral






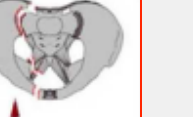

Acetab.

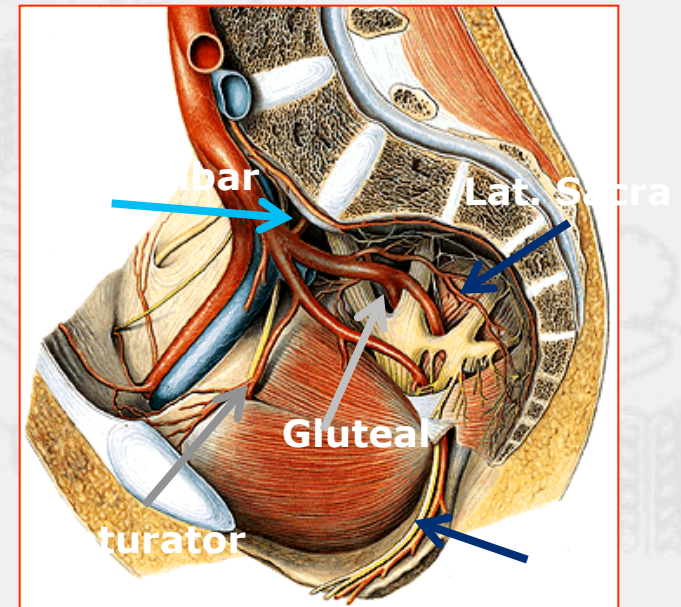
Obturator  
Inferior Gluteal

Ant. Ring

Internal Pudendal  
Obturator


## Pelvic Fracture Classification

Lateral Compression			
	LC-I	LC-II	LC-III
Anterior-Posterior Compression			
	AP-I	AP-II	AP-III
Vertical Shear			
	VS		



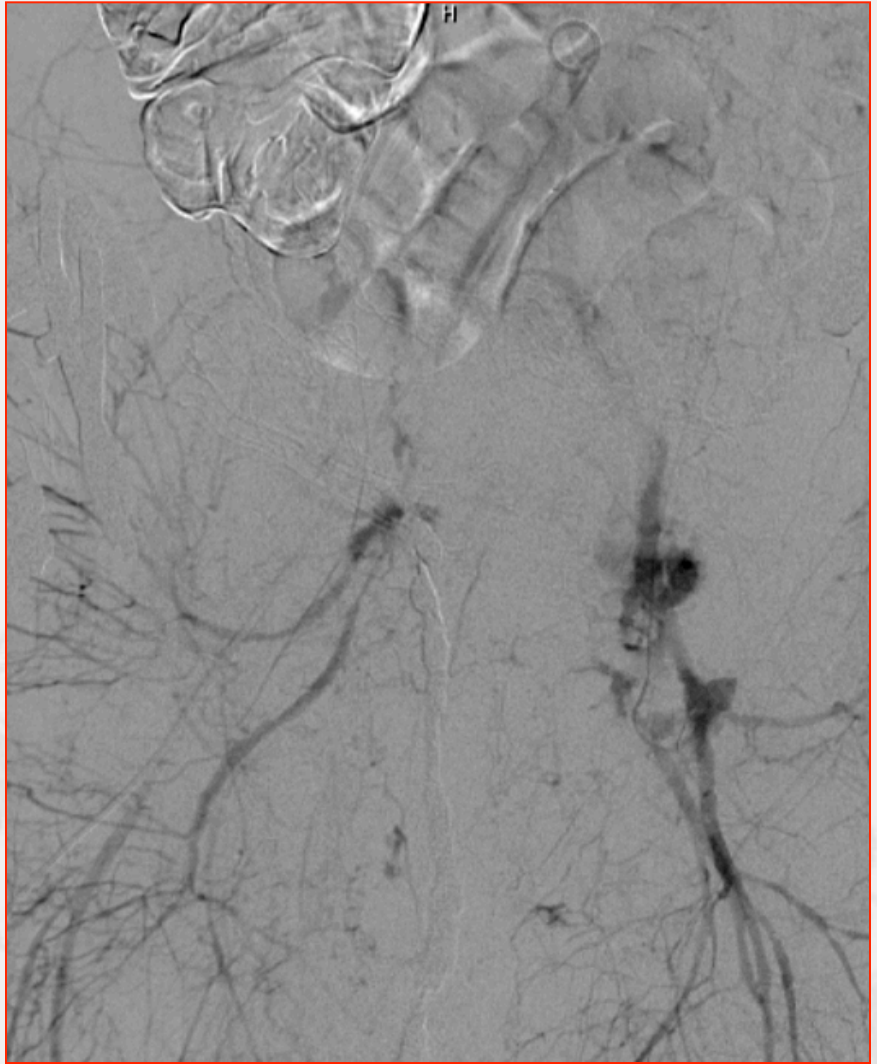
# Technique

## Angiographic Evidence of Arterial Trauma

1. Frank extravasation
  2. Vessel truncation (cut-off sign)
  3. Branch vessel dissection
  4. Spasm, intimal injuries
  5. Pseudoaneurysm & AVF
- 



# Pelvic Trauma



# Technique

“Cut-off ” Sign

- Treat like Active Bleeding



# Technique

## Embolization Agents

- 1. Gelfoam (torpedos/slurry)**
2. Coils
3. Particles
4. Glue (NBCA)
5. EVOH ( Onyx® )



# Embolization technique

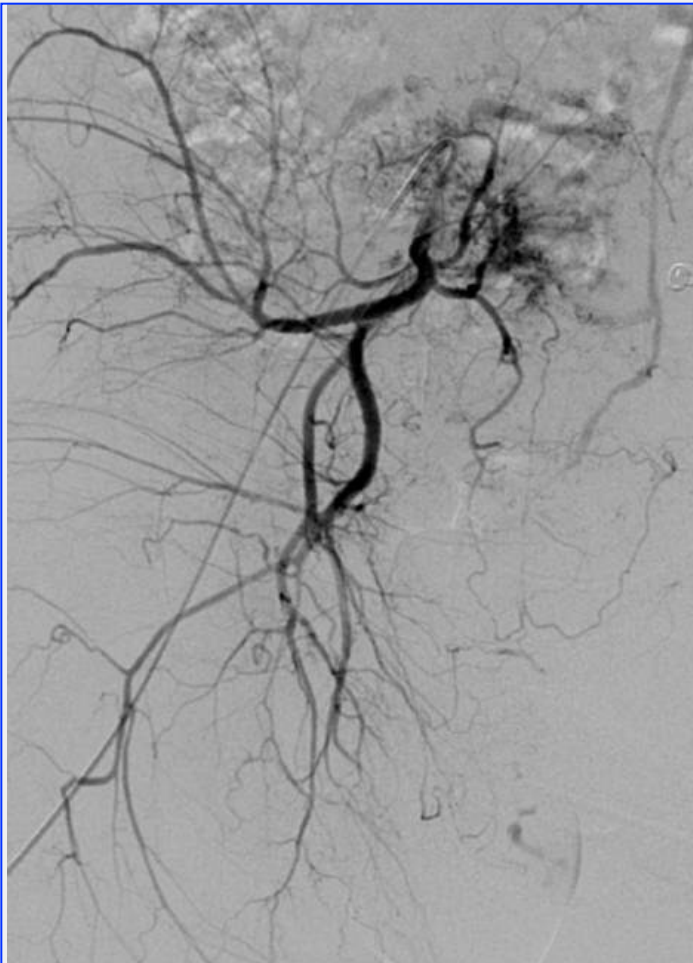
## Gelfoam

- Reversible
- Diffuse bleeding
- Trombogenic
- 15 -30% rebleeding
- Torpedoes/slurry



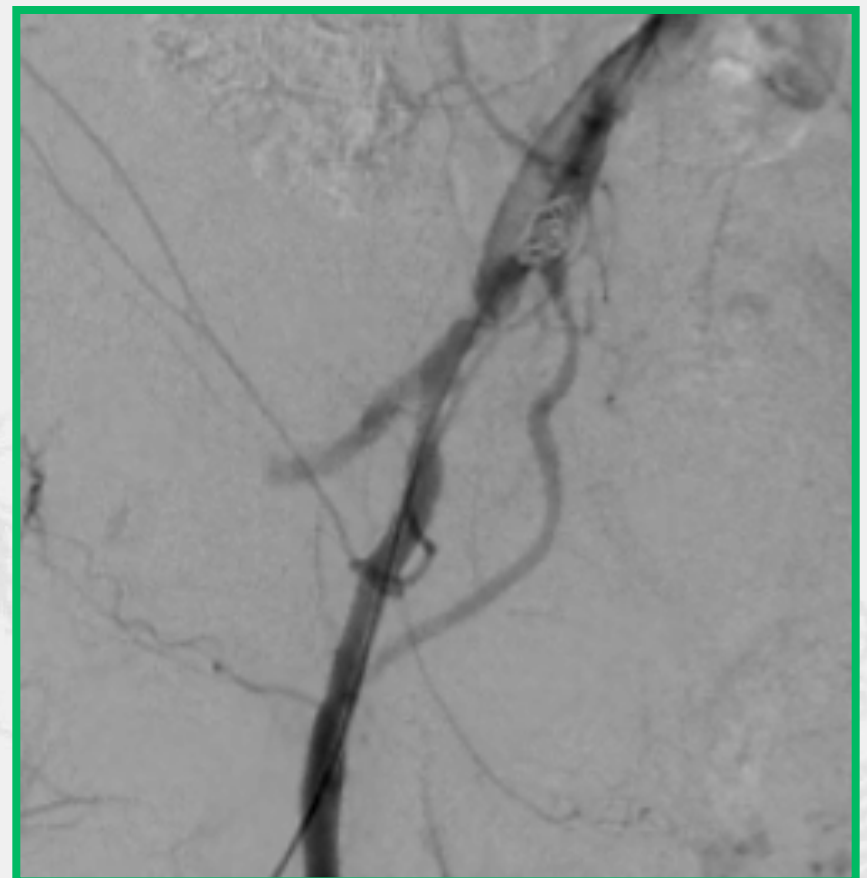
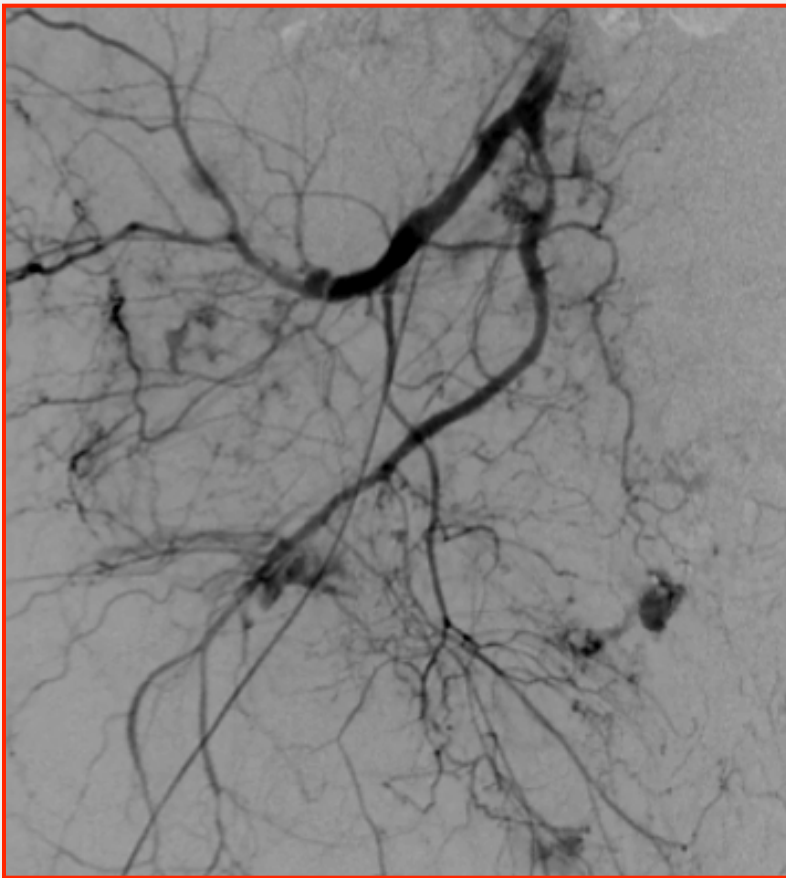
# Technique

Gelfoam alone



# Technique

Gelfoam & coils





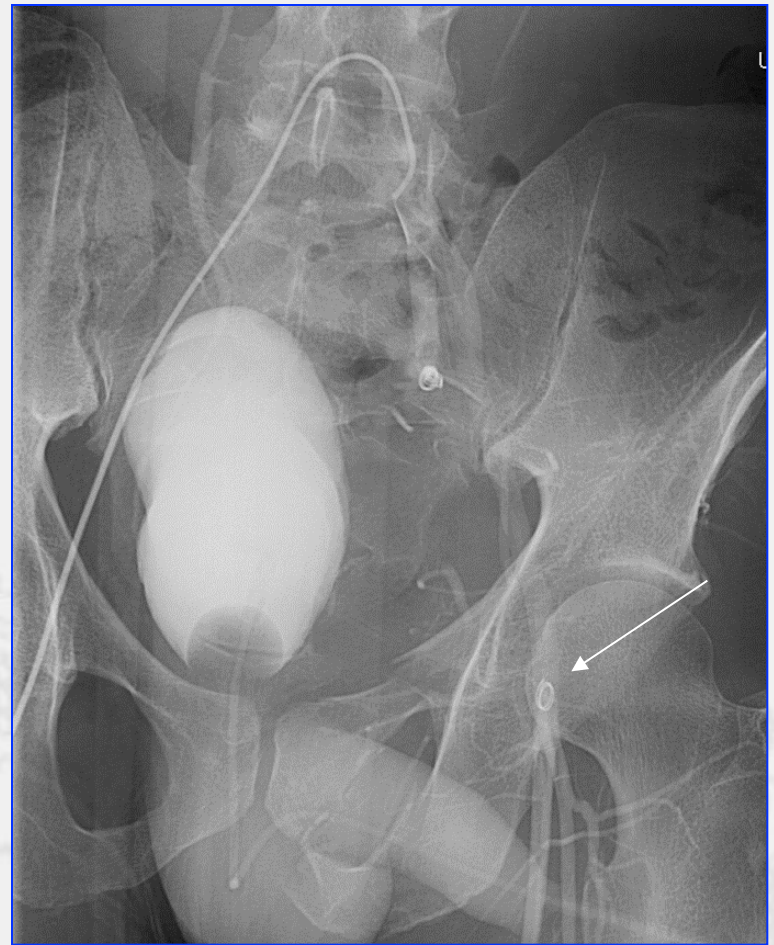
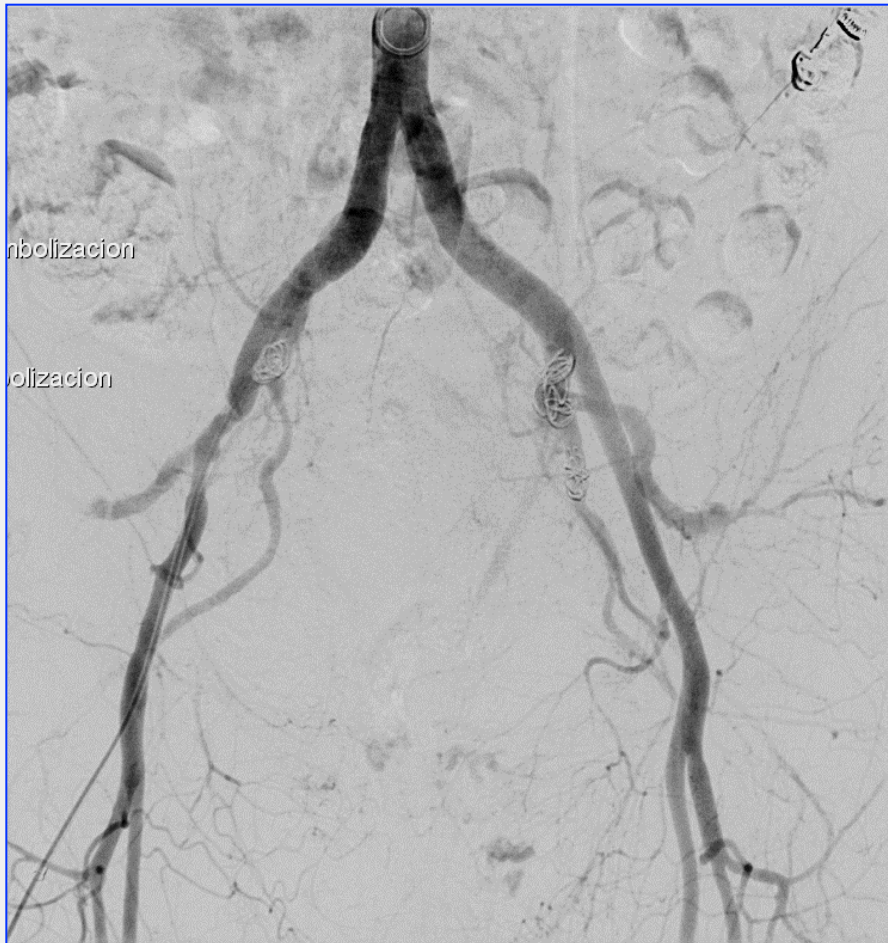
# Embolization technique

## Coils

- Produce proximal occlusion
- Single vessel
- Fibered
- mechanical + thrombogenic
- Irreversible
- Packing



coils



# Technique

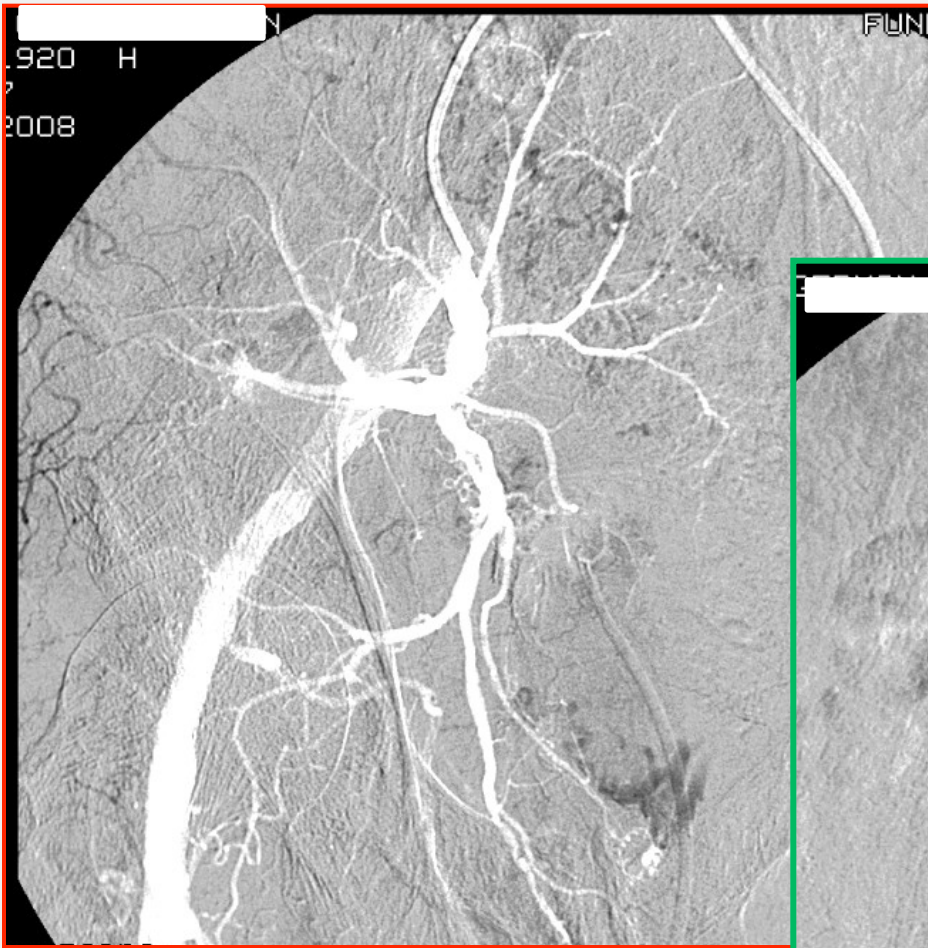
## Liquid Embolics:

Glue & EVOH (ethylene vinyl alcohol)

- For selective branch embolization
- Produce proximal & distal occlusion
- Irreversible
- Better Results than Gelfoam

Coagulopathy or cumarin treatment

# Pelvic Trauma

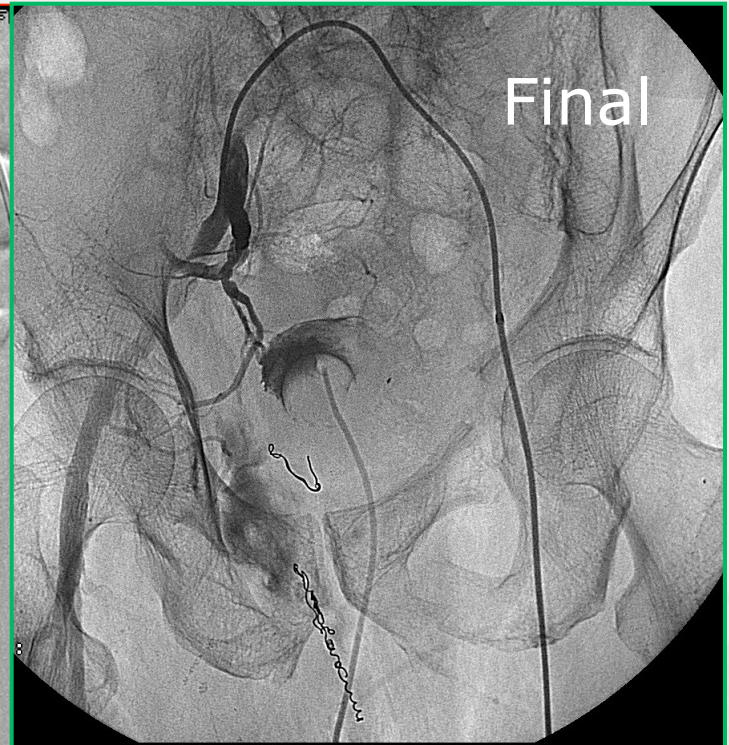
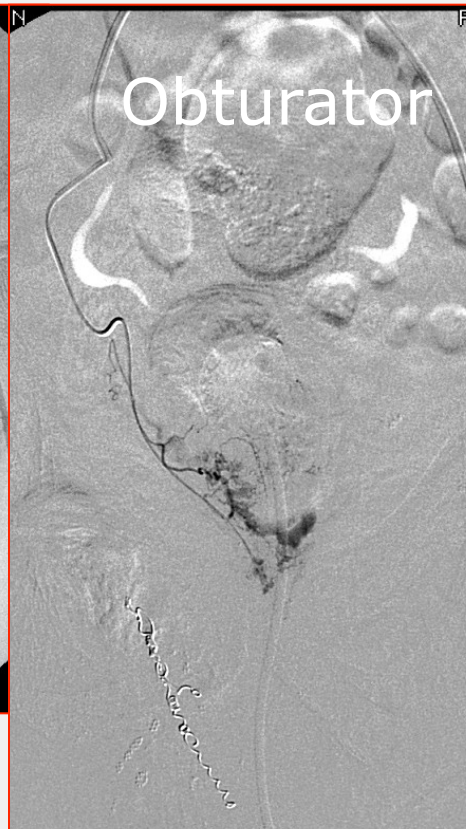
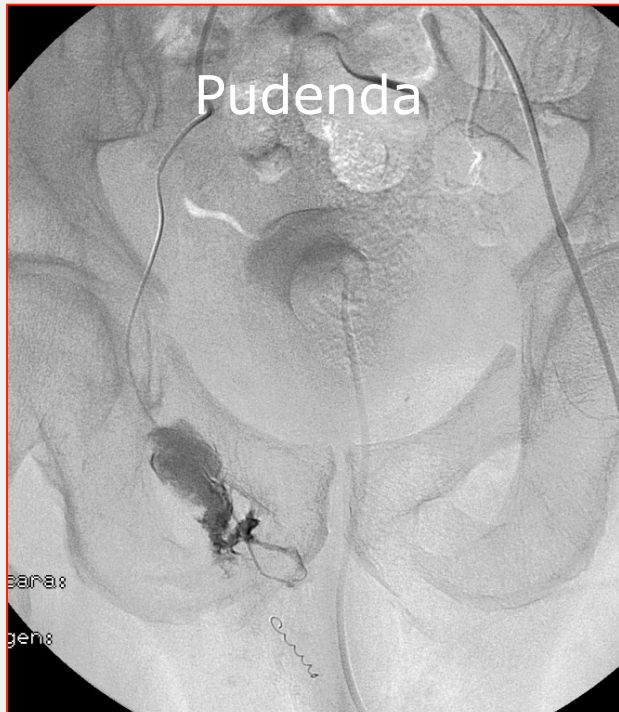


Particles  
> 500  $\mu$  beads



# Technique

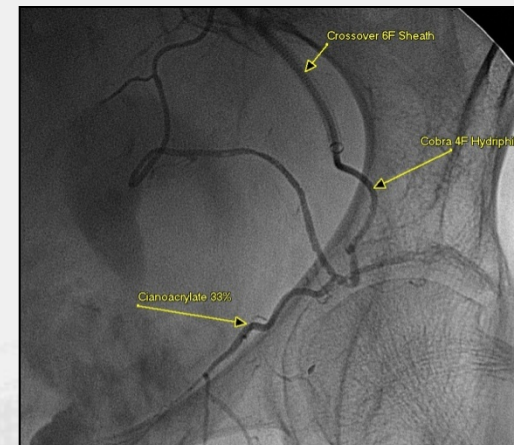
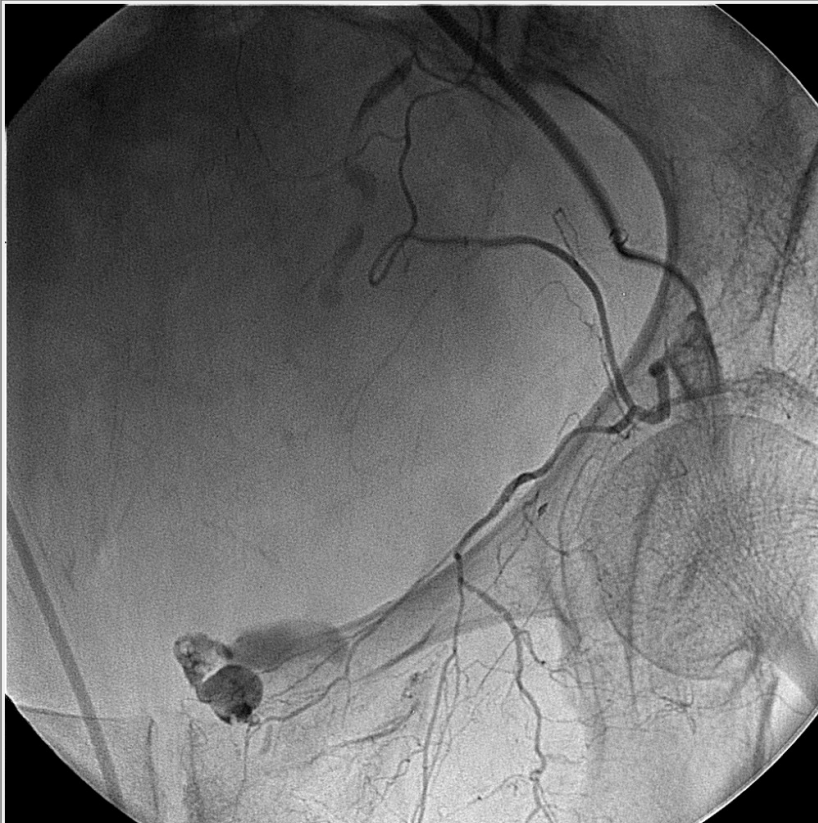
## Microcatheter



## Technique

- Aberrant Obturator : Corona Mortis
- Lumbar & Epigastric and Circunflex

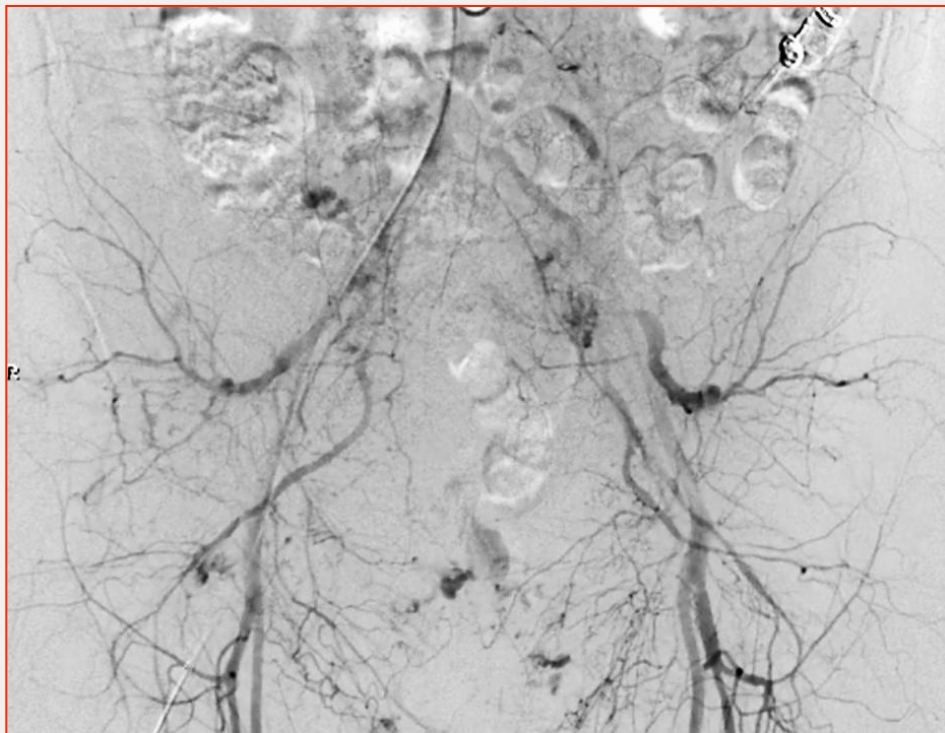
### Anomalous arterial vasculature





# Technique

## Bilateral Embolization



# Results

Achieve hemostasis: 85 – 97 %

4,6% to 24,3% repeat embolization

Survival rate: Variable



# Complications

Embo. related Complications

**5 – 6 %**

Embo. VS No Embo. without Significant Differences

*Velmahos J Trauma 2002  
Travis T JVIR 2008  
Richard H SIR 2010*

## Short - Term

- Hip, buttock, perineal or thigh infection
- Urinary retention
- Gluteal necrosis
- Skin breakdown
- Bladder necrosis
- Bowel infarction
- Rabdomyolysis

## Long - Term

- Sciatic or sacral plexus palsies
- Gluteal claudication
- Impotence

# Take Home Points

Image early with CT whenever possible

First answer two questions:

Abdominal or pelvic bleeding ?  
Venous or arterial source ?

24 – Hour IR care

Embolize as selectively as time permits

Bilateral nonselective IIA embolization may be justified







# Arterial Trauma

```
graph TD; A[Arterial Trauma] -.-> B[Ischemic]; A -.-> C[Hemorrhagic]; B --> D[Surgical repair]; C --> E[Endovascular repair  
Surgical repair];
```

The diagram is a flowchart titled 'Arterial Trauma' in a blue rounded rectangle. A dotted green line branches from the title to two categories: 'Ischemic' in a dark blue rounded rectangle and 'Hemorrhagic' in a red rounded rectangle. From 'Ischemic', a solid green arrow points down to 'Surgical repair' in a dark blue rounded rectangle. From 'Hemorrhagic', a solid green arrow points down to a red rounded rectangle containing 'Endovascular repair' and 'Surgical repair' stacked vertically. The background features a faint, light-colored illustration of a city skyline.

Ischemic



Surgical  
repair

Hemorrhagic



Endovascular repair  
Surgical repair

# Arterial Trauma

Source of Massive Bleeding

High mortality rate

Cause of potentially preventable deaths





# Arterial Trauma: Types of Injuries

## Polytrauma

- Motor Vehicle Acc.
- Run over pedestrians
- Falls
- At workplace
- Motorcycle
- Crush injuries
- Sports/recreations

## Iatrogenic

- From radiology
- From surgery
- From endoscopy

## Bloody crimes

- Stab wounds
- Gunshots

## Anticoagulant Overdose

# Treatment options

1. Amount of bleeding
2. Speed of bleeding
3. Hemodynamic status
4. Type of vessel
5. Type of arterial Injury
6. Size of artery



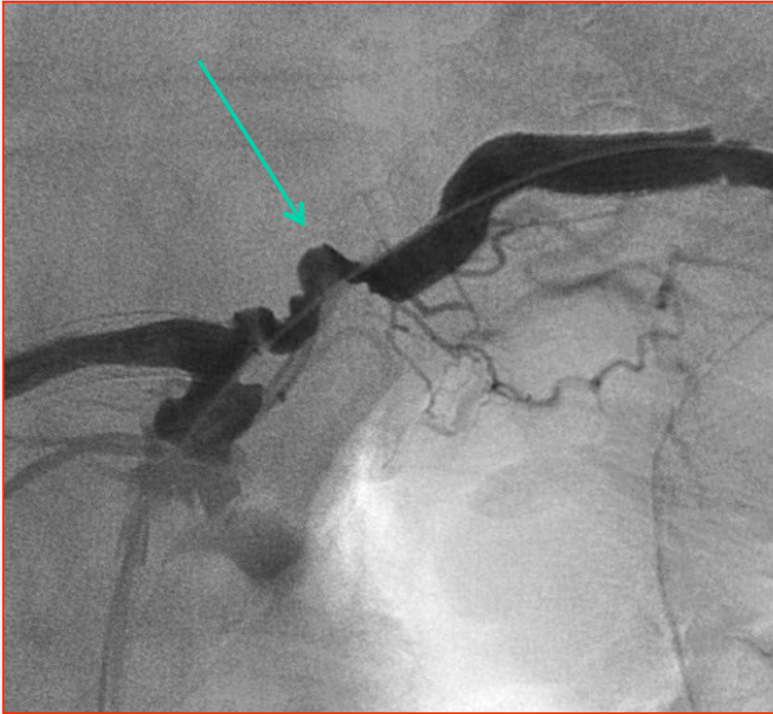
# Range of Arterial Injuries

- **Blunt**

1. Vessel spasm/strain
2. Dissection / intimal flap
3. Mural hematoma
4. Pseudoaneurysm

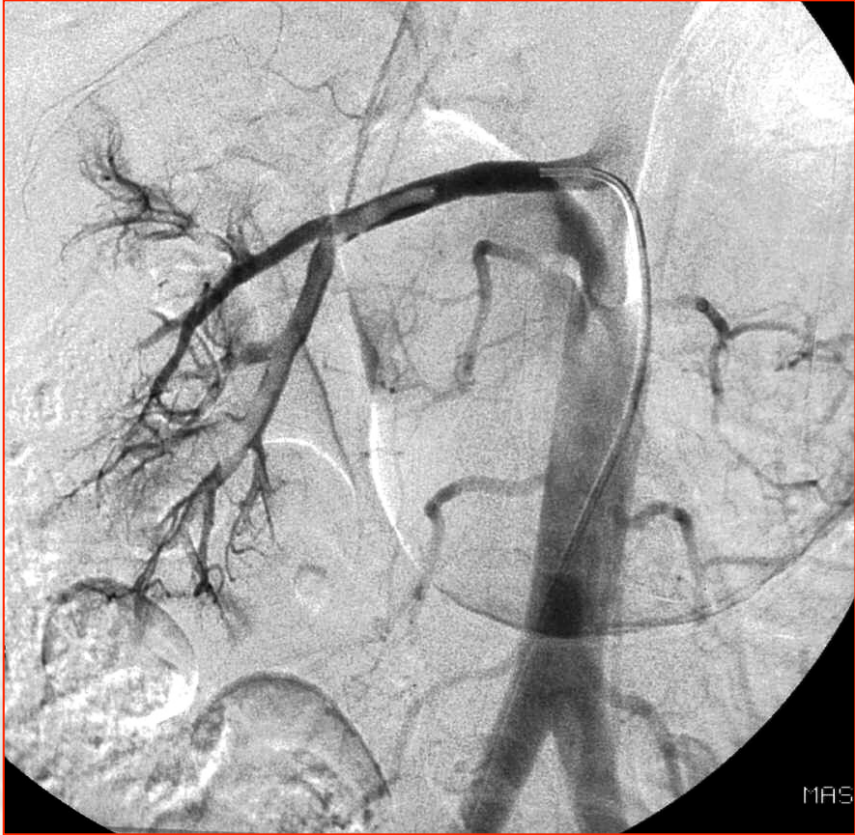
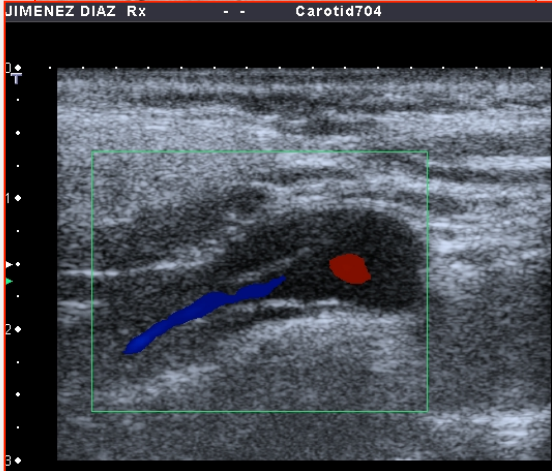
- **Penetrating**

5. AV Fistula
6. Laceration / cut
7. Complete transection
8. Active bleeding



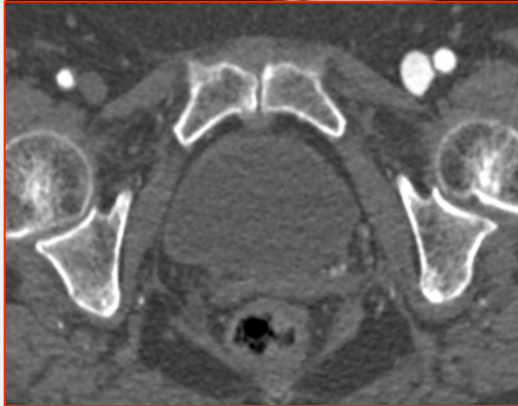
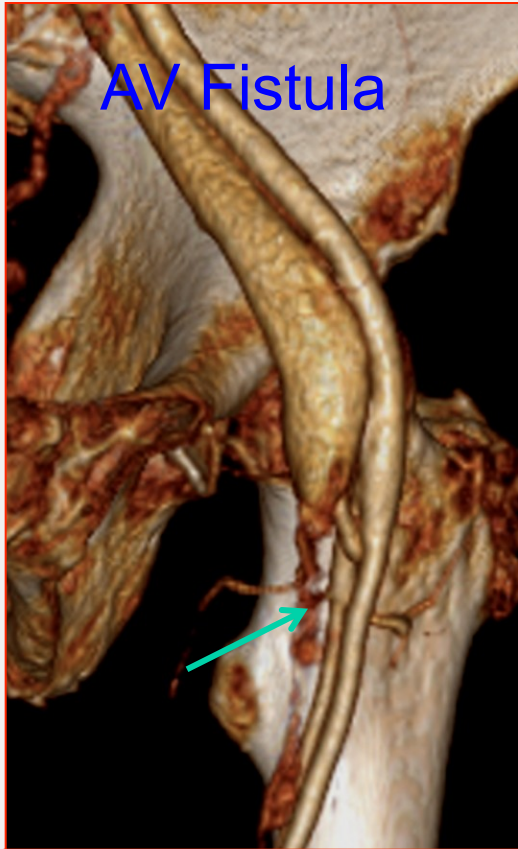
Vessel spasm/strain

# Arterial Trauma

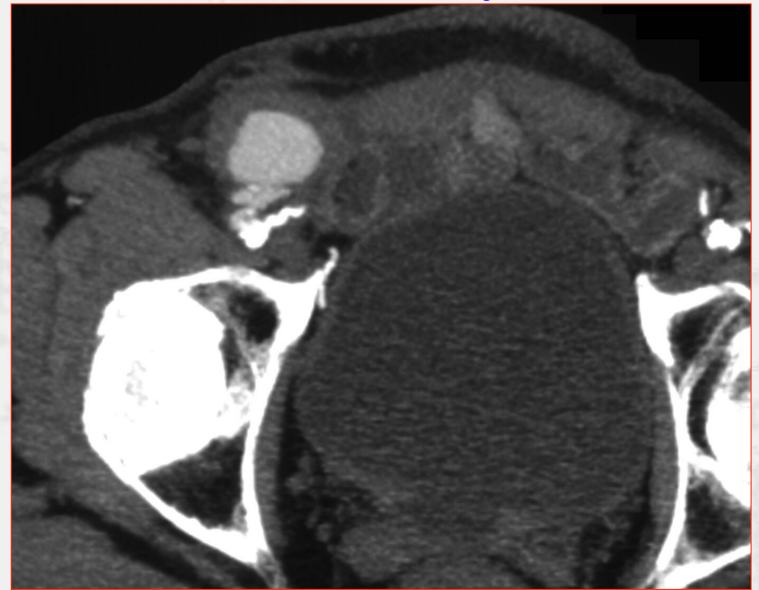


Dissection / intimal flap





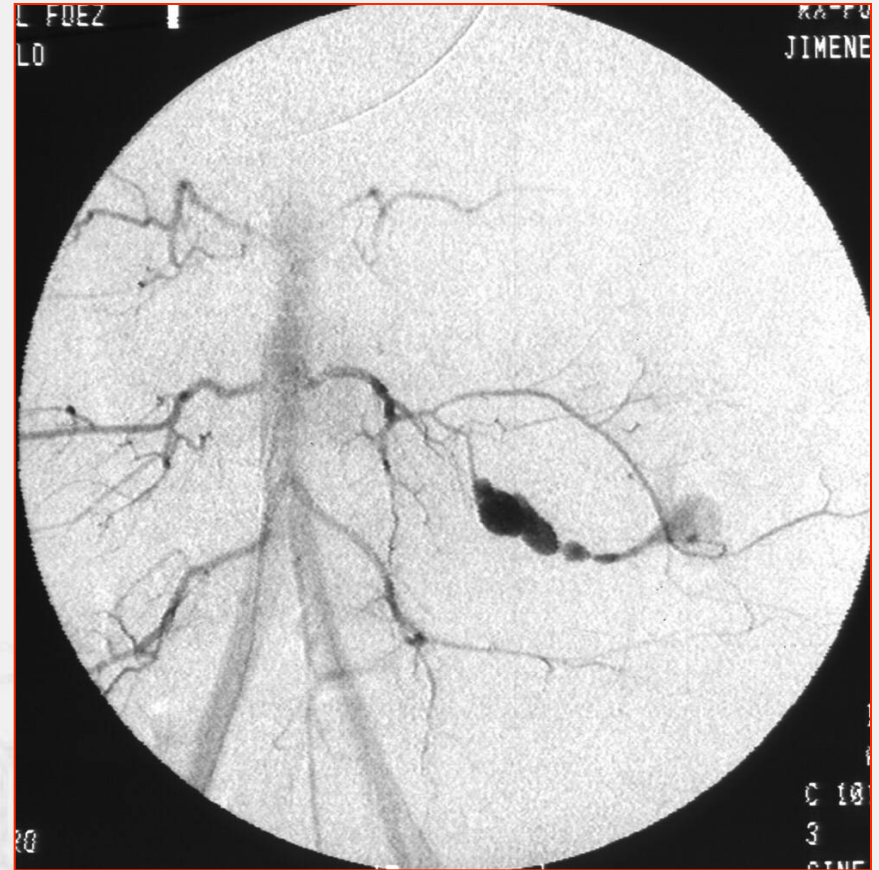
Pseudoaneurysms



# Arterial Trauma



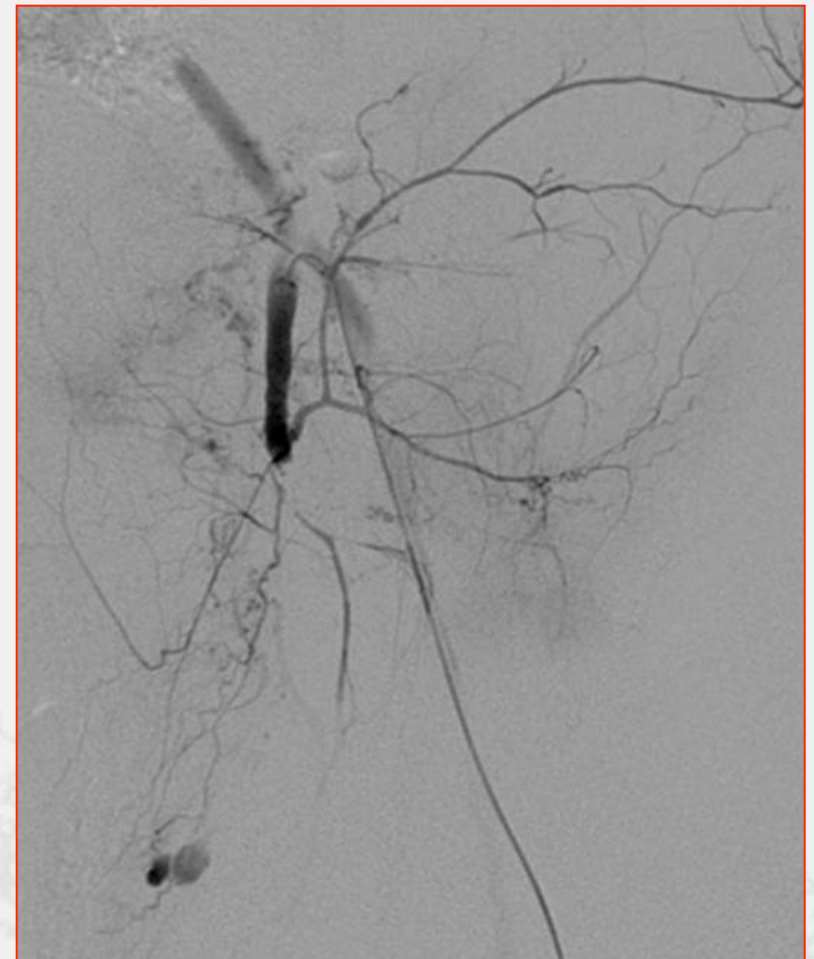
Arterial tear



Laceration / cut


Active bleeding





Complete transection

# Management of Arterial Trauma

1. Surgery
  2. Embolisation
  3. Cover stents / Stent grafts
  4. Thrombin injection
  5. Combination of all
- 



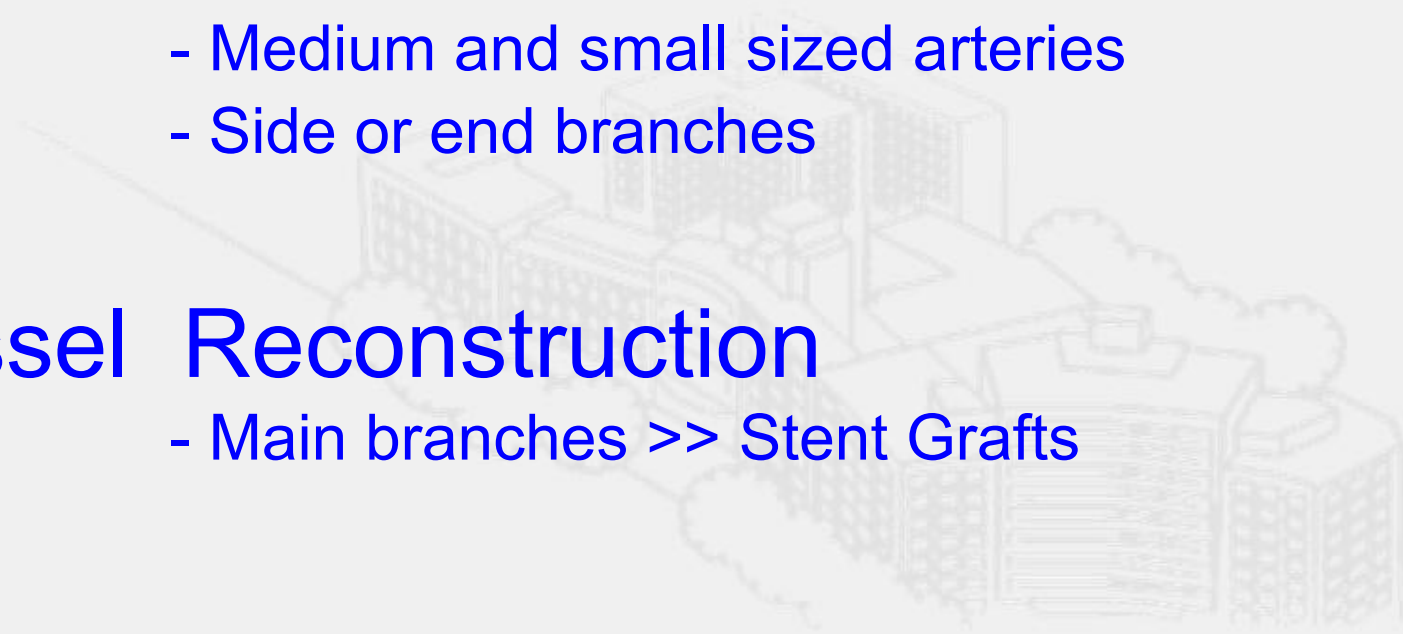
# Endovascular treatment of Arterial Trauma

- Embolization

- Medium and small sized arteries
- Side or end branches

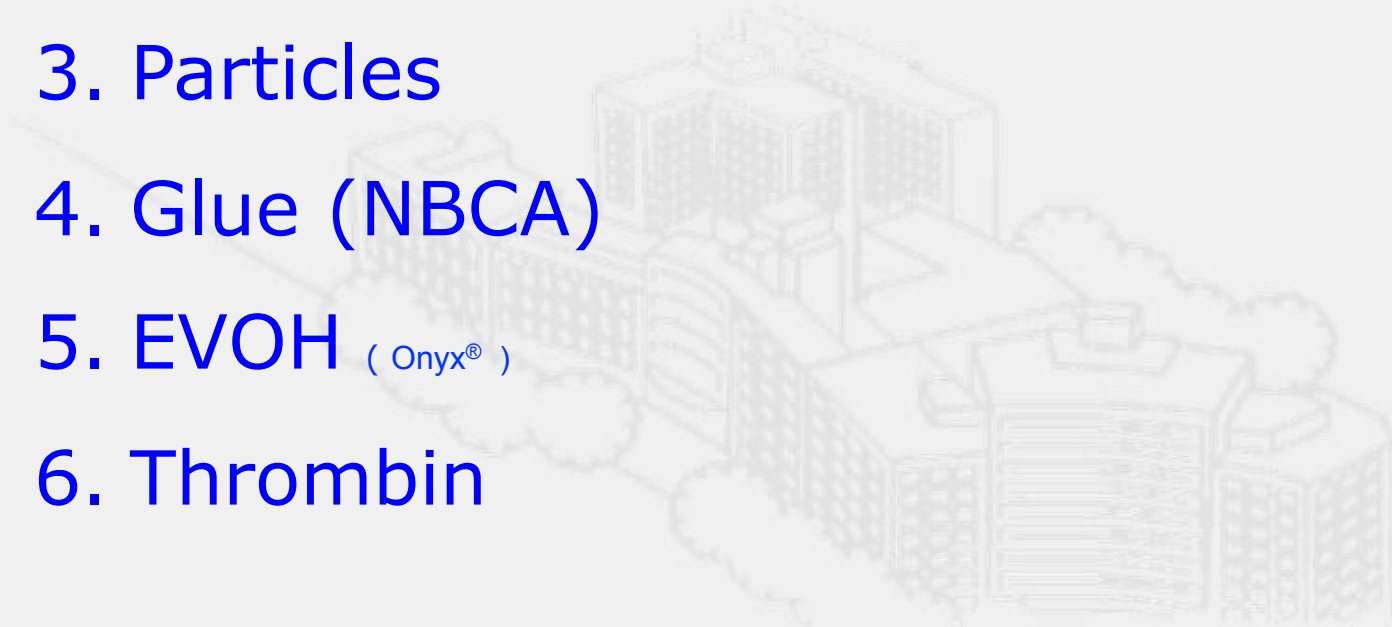
- Vessel Reconstruction

- Main branches >> Stent Grafts



# Embolization Agents

1. Gelfoam
2. Coils & Plugs
3. Particles
4. Glue (NBCA)
5. EVOH ( Onyx® )
6. Thrombin

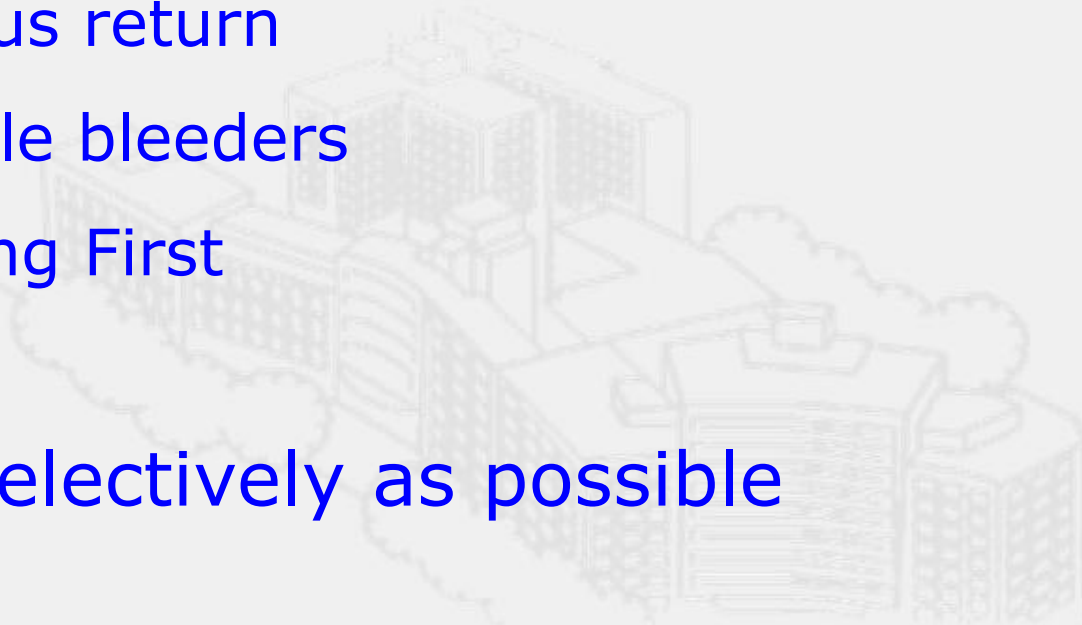




# Embolization technique

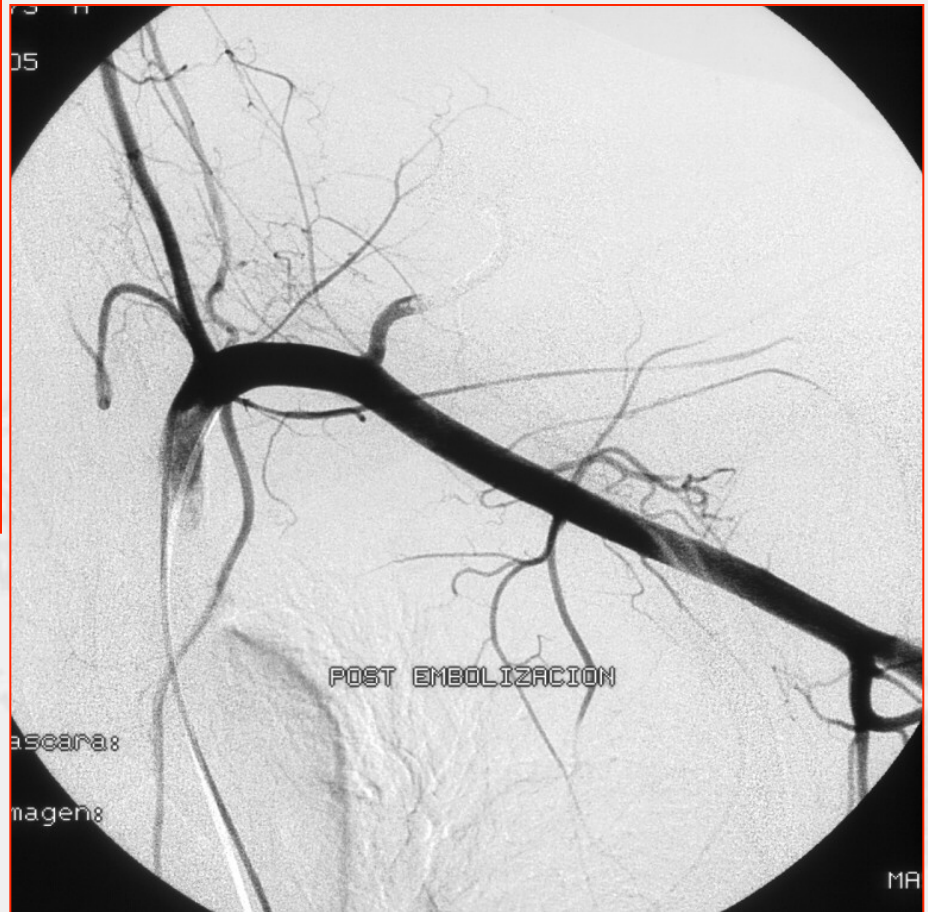
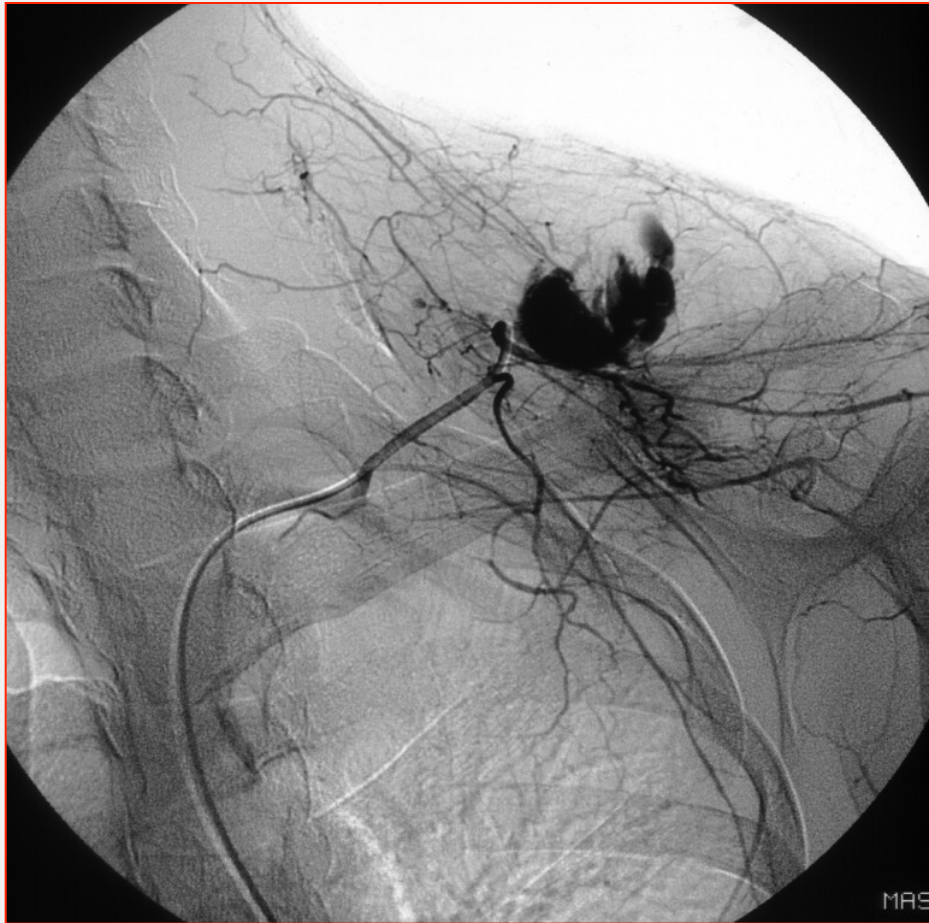
- **Selective Injection** are mandatory
- Oblique views
- Film until venous return
- Look for multiple bleeders
- Massive Bleeding First

Embolize as selectively as possible



# Arterial Trauma

Glue



# Arterial Trauma

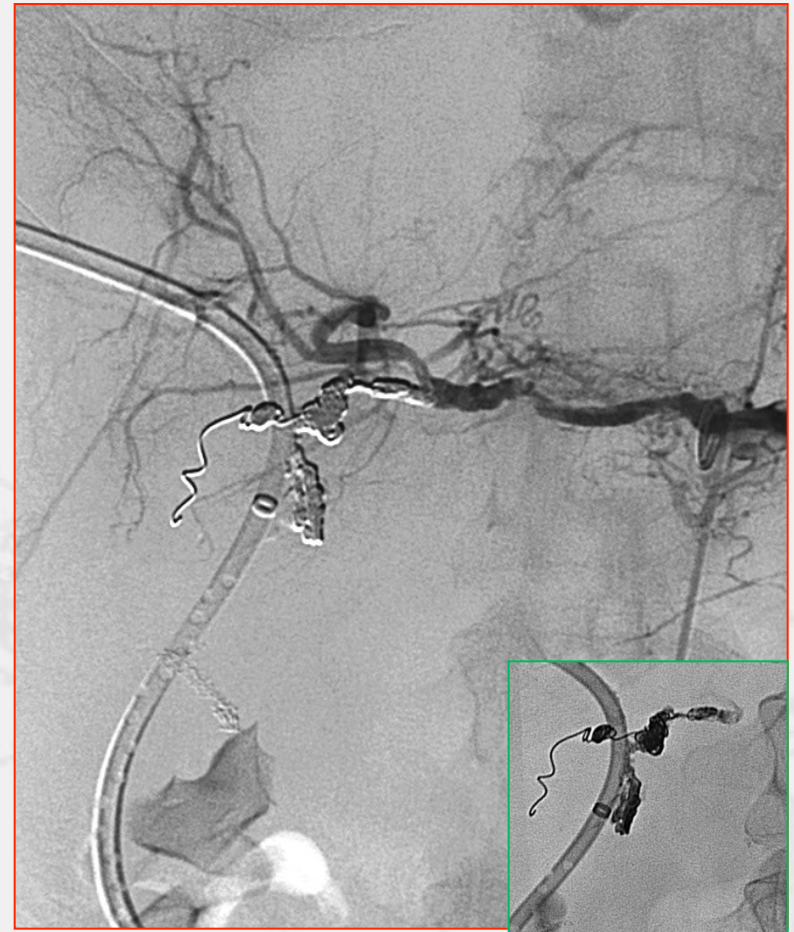
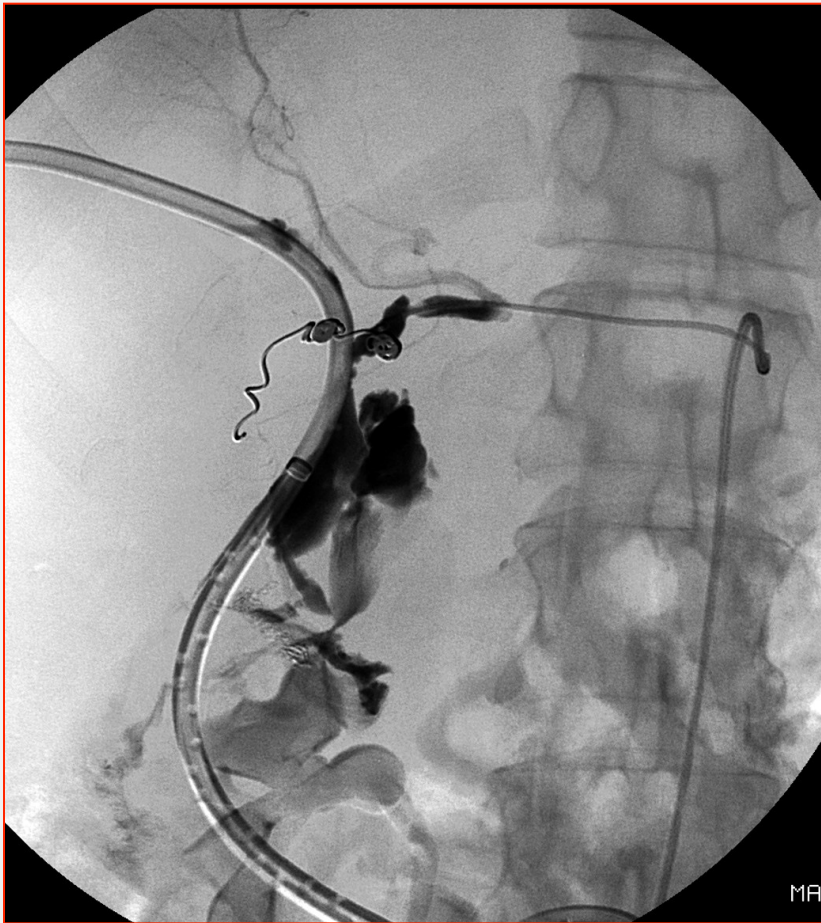
EVOH





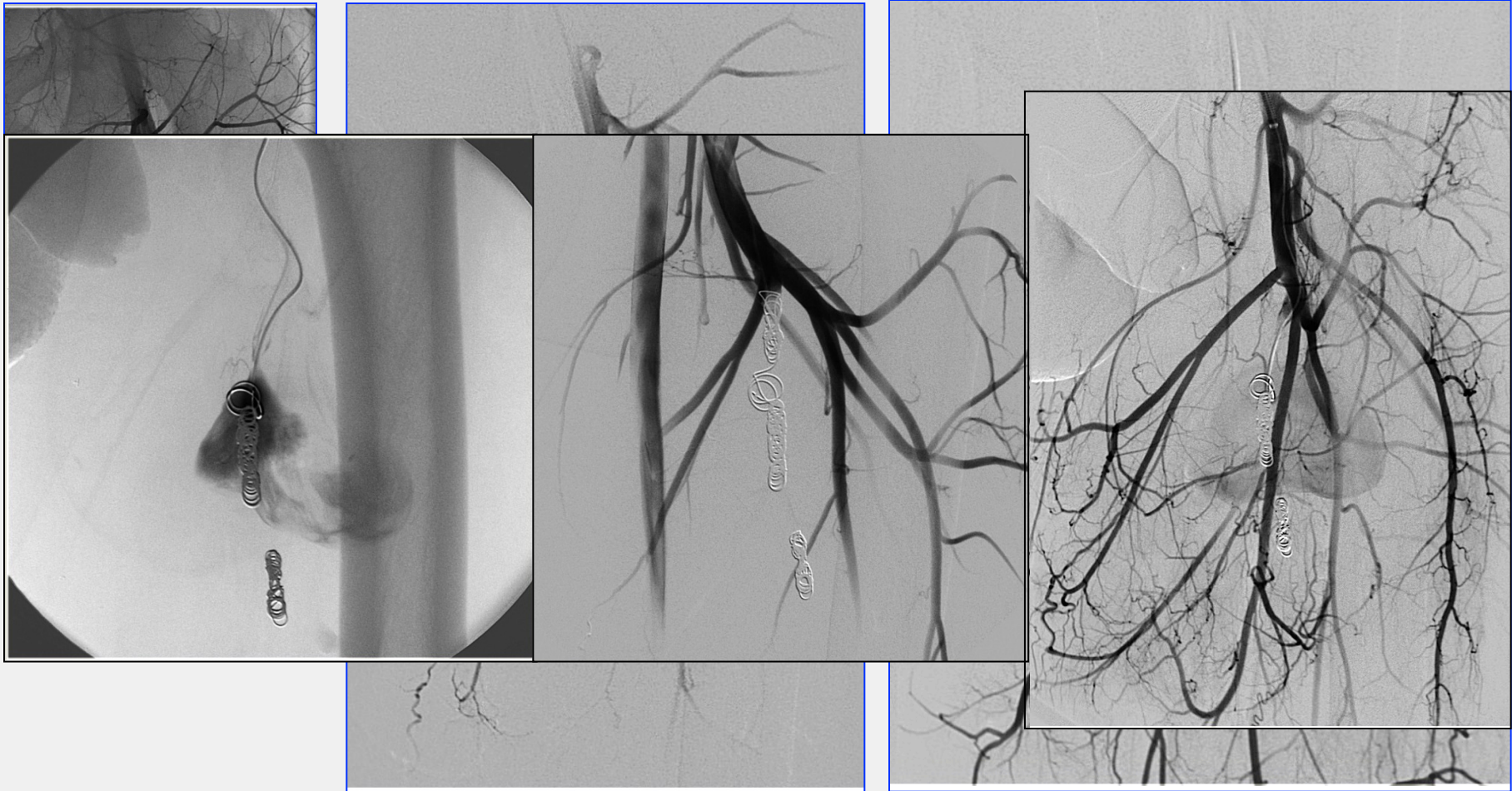
Embolization technique

Combination of agents



Embolization  
Technique

Collateral Vessels and  
Anatomical variants





# Vessels reconstruction

## Surgical Repair

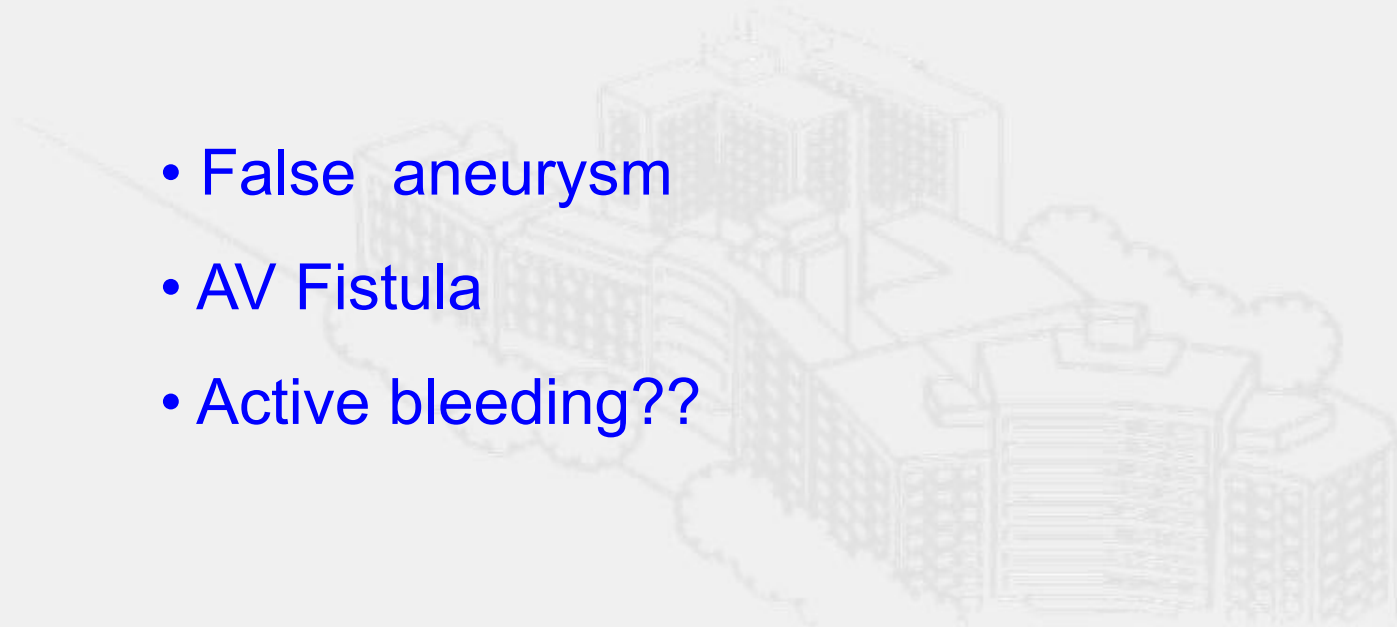
- Up to world war II amputation rate was 50%
- **Surgery is still the treatment of choice**
- Current amputation rate 8%
- Autologous vein if possible

# Stent grafts

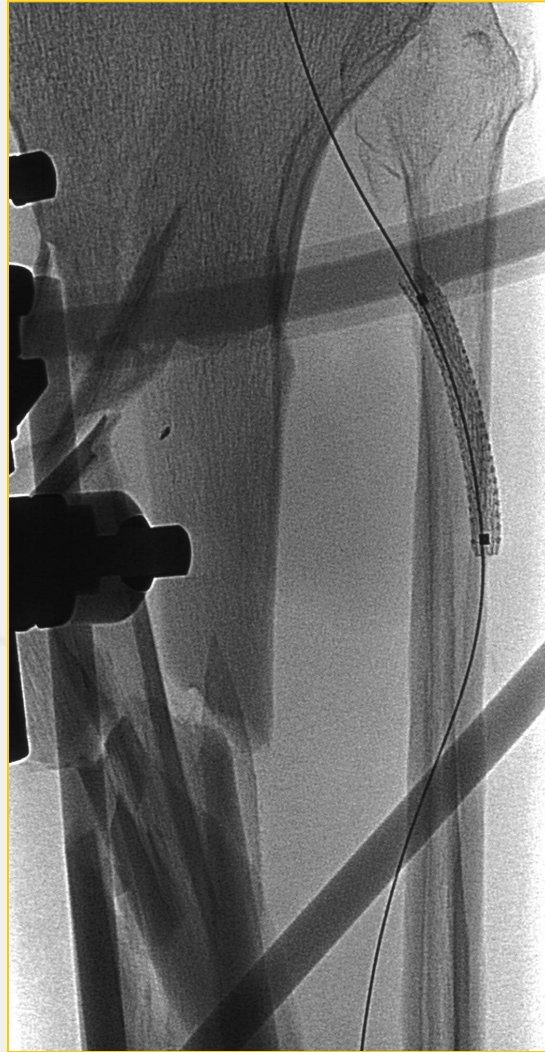
Endovascular way of vessels reconstruction

For selected cases:

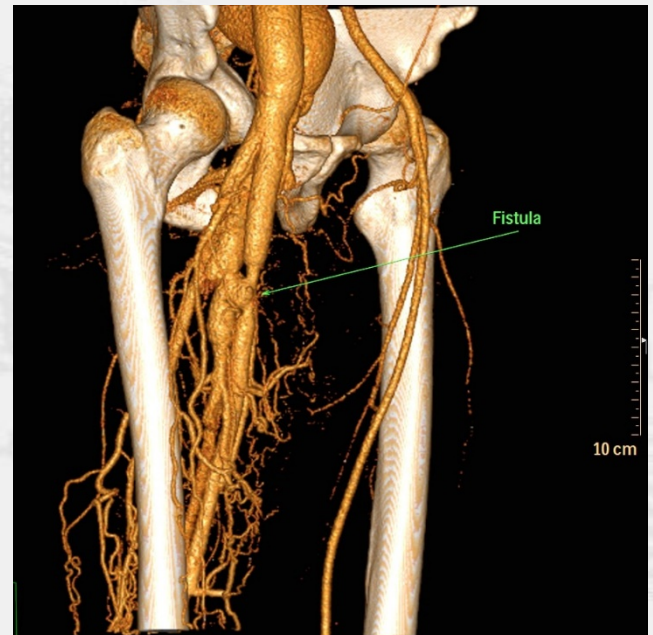
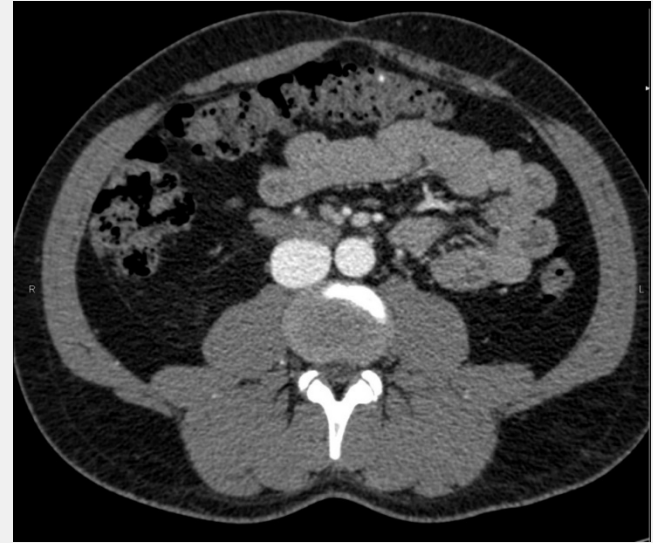
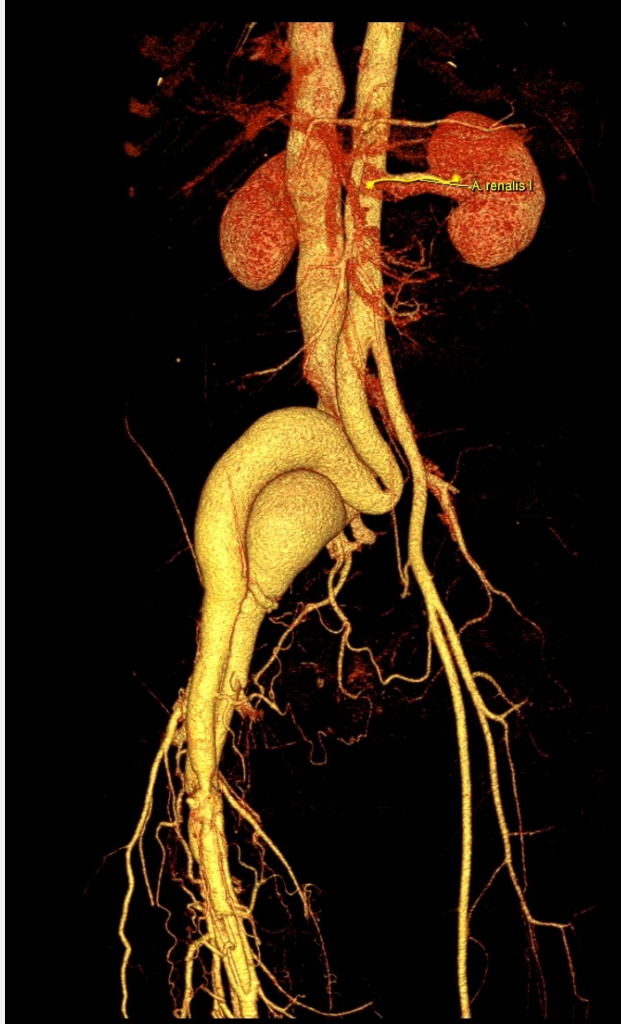
- False aneurysm
- AV Fistula
- Active bleeding??



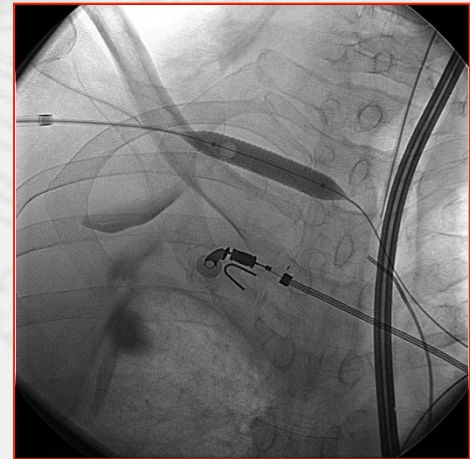
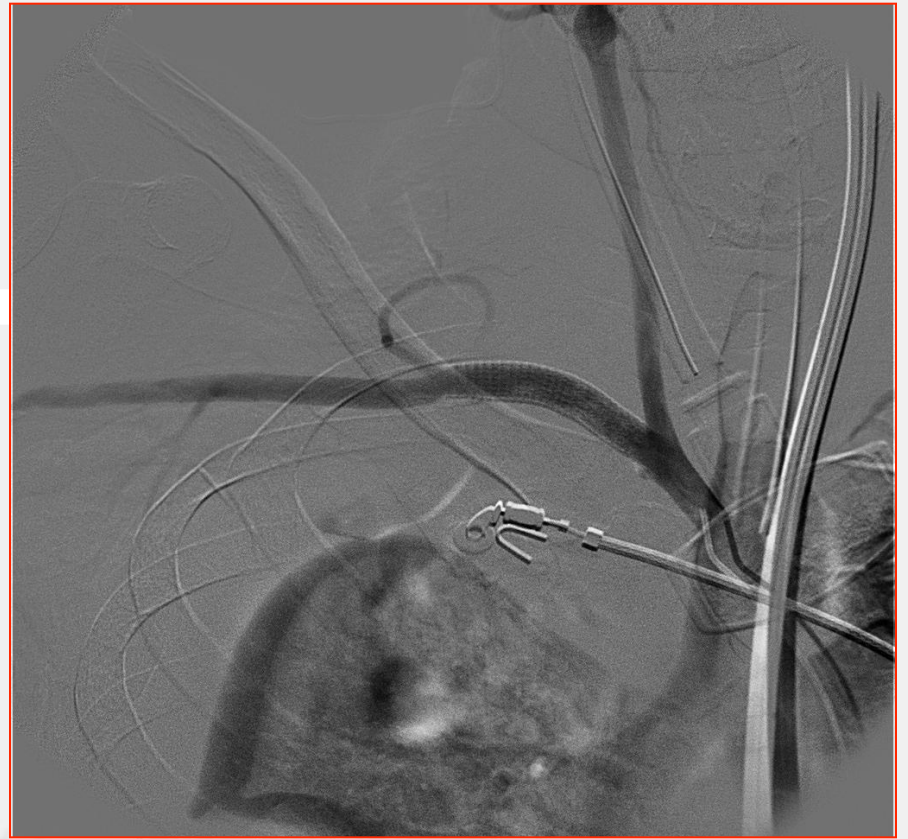
False aneurysm



AV Fistula

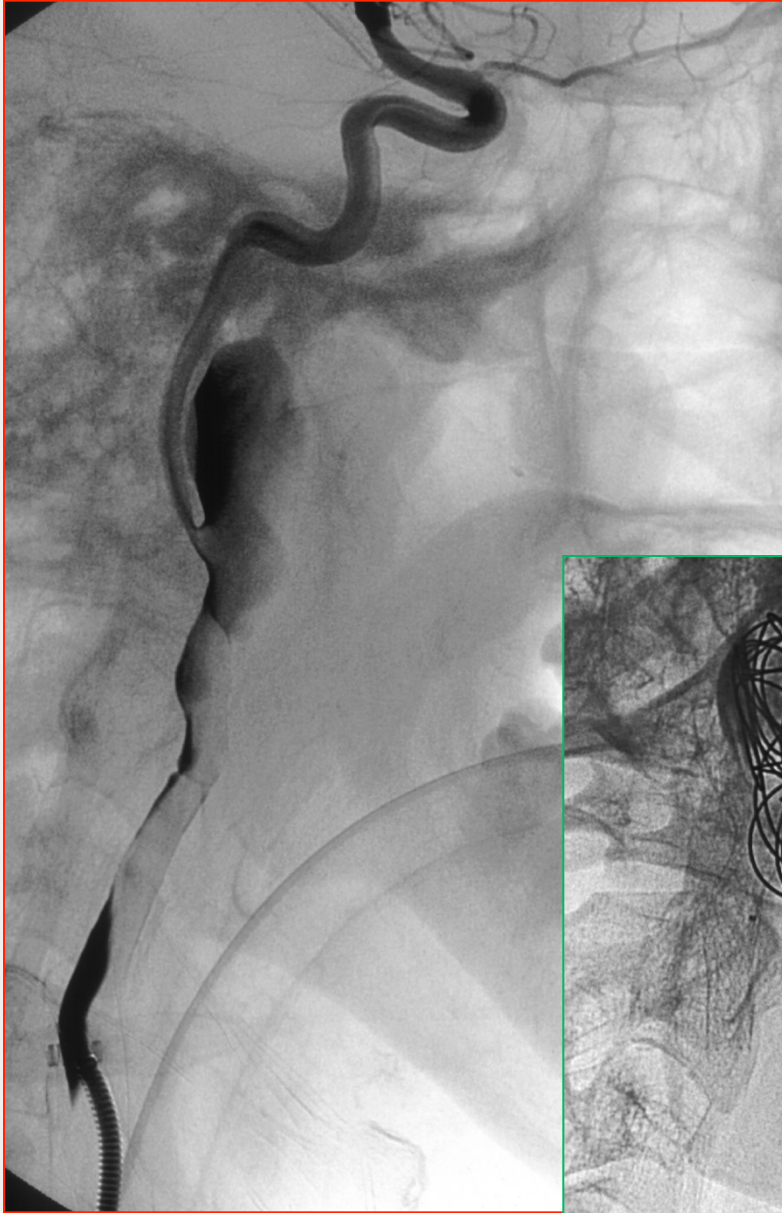








# Arterial Trauma



# Descending Thoracic Aorta

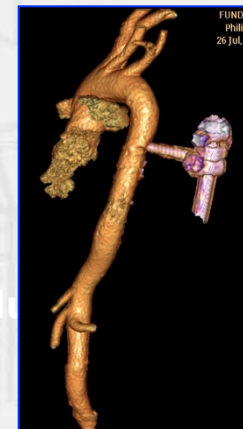
## 1.- Blunt Injury (transection)

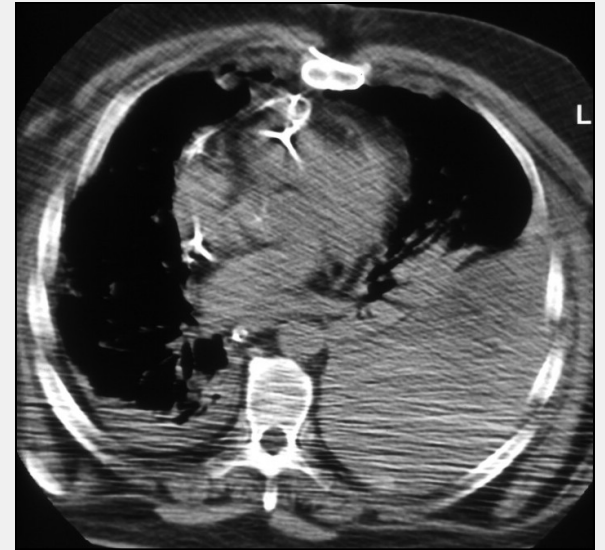
- Endovascular: Stent grafts

## 2.- Penetrating Injuries (stab, gunshot wounds)

- Open Surgery




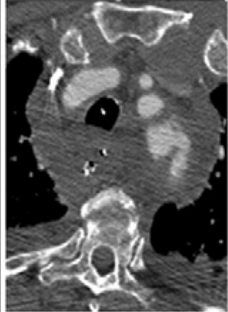
*Radiology* 1997; 205: 657-662  
*J. Trauma* 2006; 60: 765-771







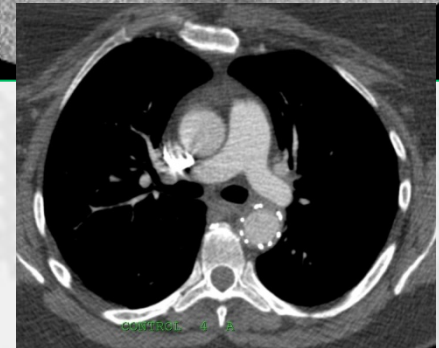
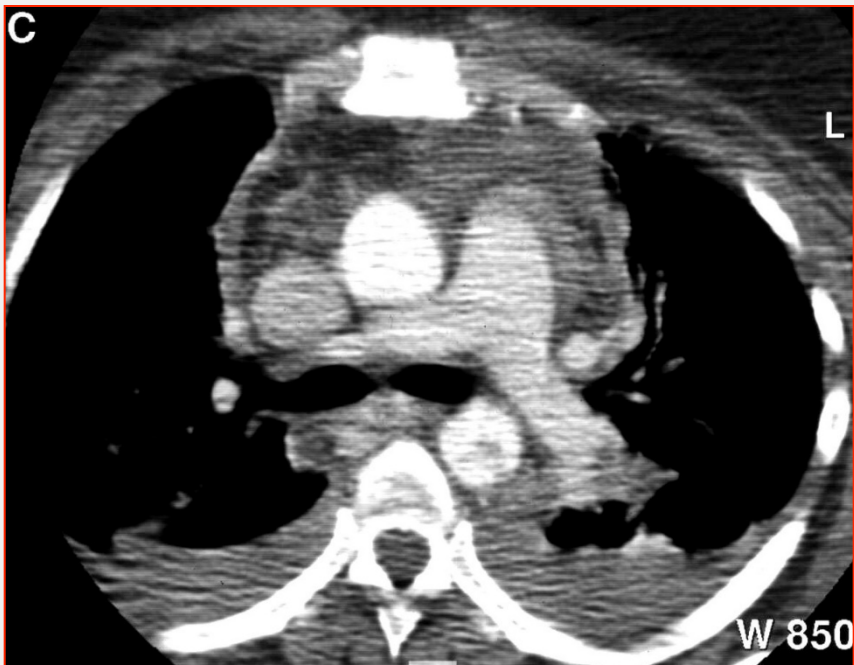
# Thoracic Aorta transection: When to treat

<i>Type of Aortic Injury</i>	<i>Definition</i>	<i>Example</i>	<i>Type of Aortic Injury</i>	<i>Definition</i>	<i>Example</i>
<b>Intimal Tear</b>	No aortic external contour abnormality: tear and/or associated thrombus is <10mm		<b>Pseudoaneurysm</b>	Aortic external contour abnormality: contained	
<b>Large Intimal Flap</b>	No aortic external contour abnormality: tear and/or associated thrombus is >10mm		<b>Rupture</b>	Aortic external contour abnormality: not contained, free rupture	

*J Vasc Surg 2012 ;55:47-54.*

- Intimal tear
- Abnormal external AO contour
- Free rupture





# Summary

Ischemic arterial trauma  
Unstable patients  
Severe arterial tissue loss

Surgery

Bleeding from :  
- Medium and small sized arteries  
- Side or end branches

Embolization

Bleeding from focal arterial tear/hole  
- Pseudoaneurysm  
- AV fistula

Cover stents

Thoracic aortic transection

Stent grafts

# Pelvic and Arterial Trauma



**DFIR`s årsmøde 2014**

**Korsør** 23th of May



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