

CO₂ Digital Subtraction Angiography in Dialysis: Do's and Don'ts

Daniel Simon, MD

Chief Medical Officer
Vascular Management Associates
New Brunswick NJ

Director Peripheral Interventions
Maryland Cardiology Associates
Greenbelt Maryland



19th Annual Conference

2018

May 30 - June 01

THE PERIPHERAL EVENT OF THE YEAR



Disclosures

Speaker's Bureau:

- Abbott Vascular
- Terumo

Consultant:

- Terumo
- Phillips
- Acumen LLC
- MIG Partnership LLC

Stockholder:

- Control Rad Systems

Medical/Scientific Boards:

- Control Rad Systems

Unbreakable Rules of Dialysis

- **#1 – Every catheter will occlude or become infected.**
- **# 2- Every Graft will stenose, occlude, fail, or become infected.**
- **# 3- Every Fistula will stenose, occlude, or fail.**
 - Infection is less likely.
- **#4 – Transplants don't last forever.**

Unbreakable Rules of Carbon Dioxide

- **Rule #1 – Don't intentionally inject CO₂ into the neurovasculature.**
 - Learned empirically
 - Brain and Spinal Cord do not mix well with Carbon Dioxide

End Stage Renal Disease – Carbon Dioxide

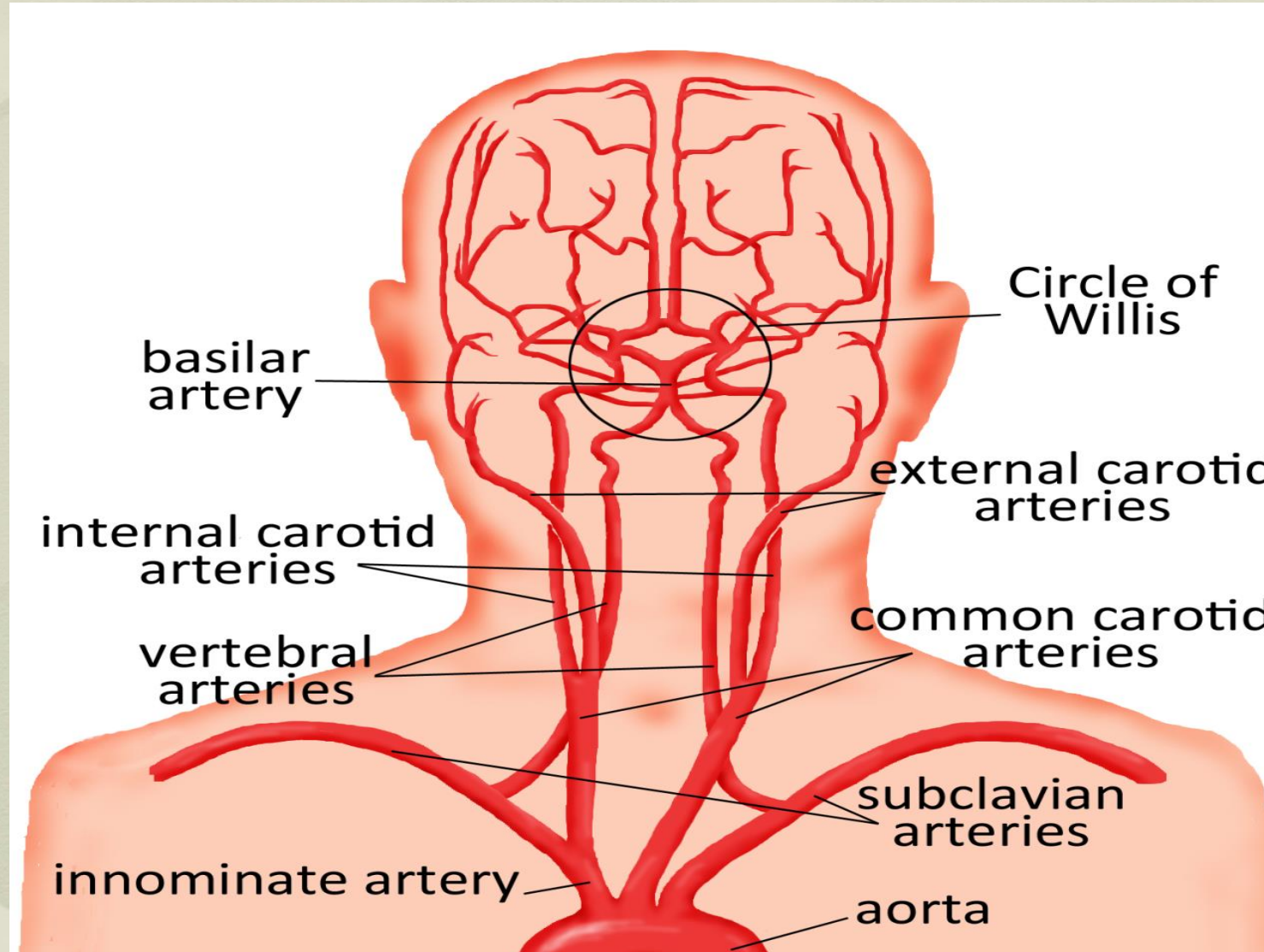
- **CO₂ – Brain/Brainstem has been known to cause seizures**
- **CO₂- spinal artery has been known to cause paralysis**
 - **Sporadic in frequency**

• J Vasc Surg. 2012 Dec;56(6):1717-20. doi: 10.1016/j.jvs.2012.06.075. Epub 2012 Oct 23

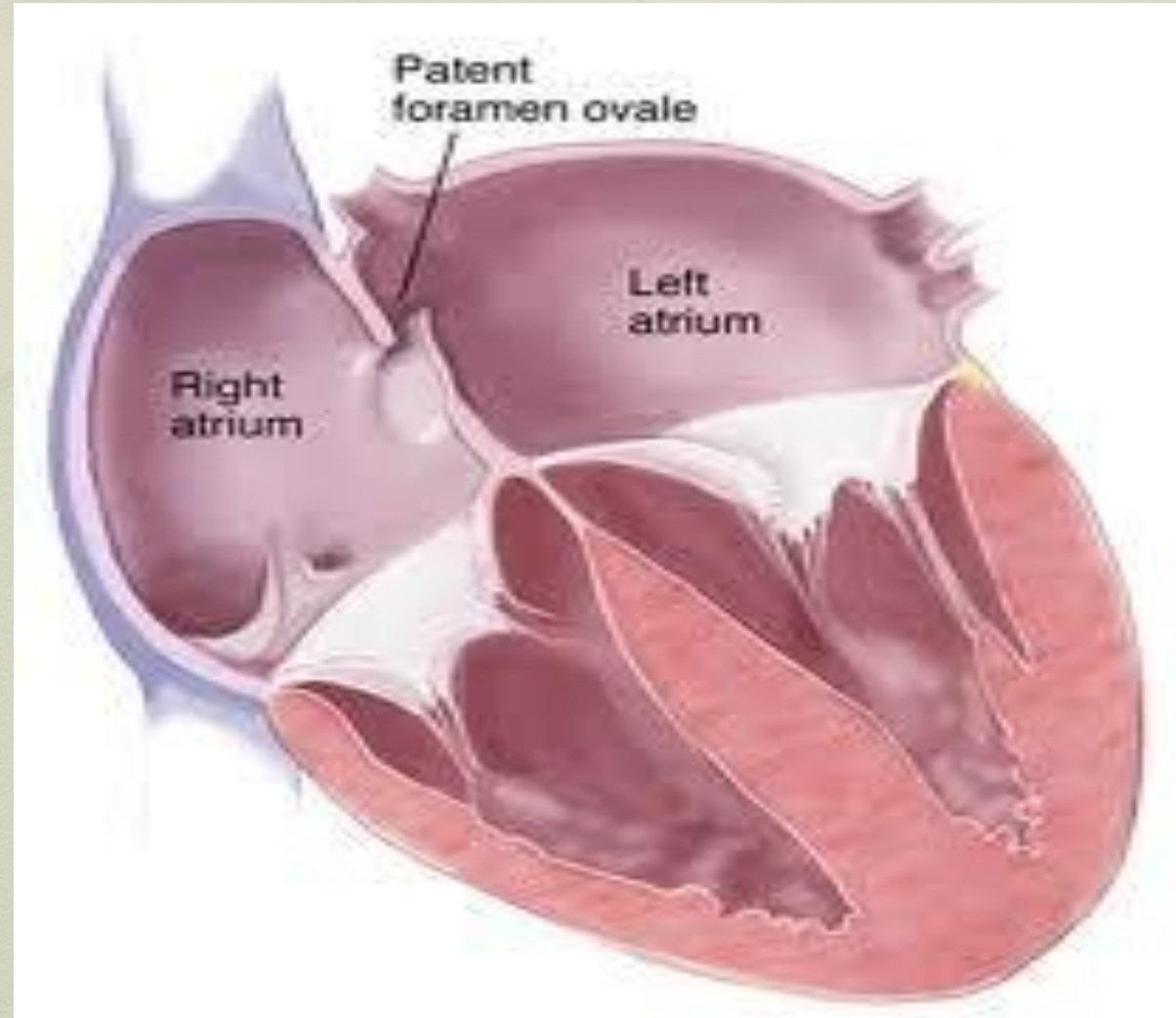
End Stage Renal Disease – Carbon Dioxide

Two Entry Points for Carbon Dioxide into the Neurovasculature

#1 - Reflux into the Arterial Limb of the Shunt



#2 - Patent Foramen Ovale



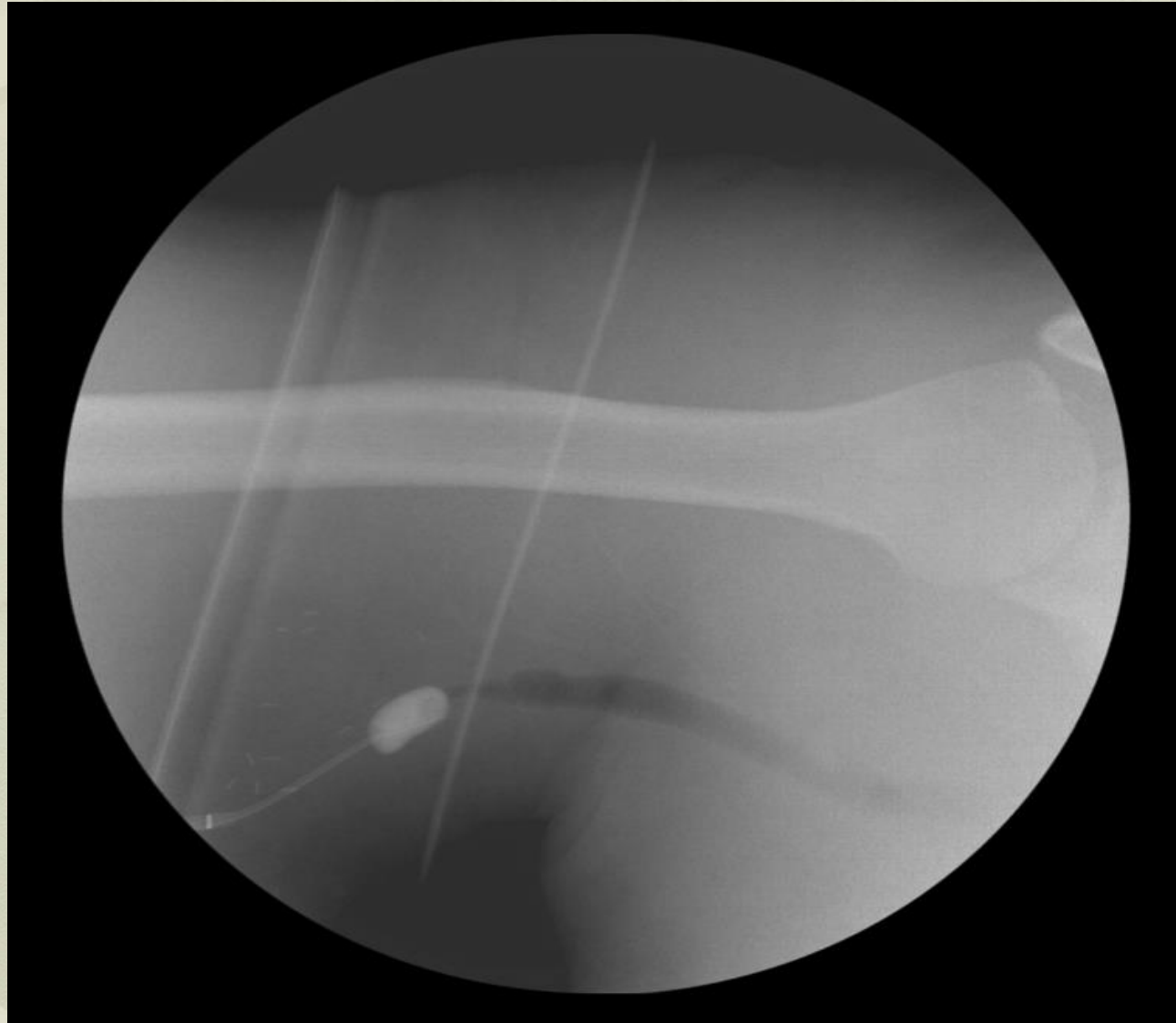
End Stage Renal Disease – Carbon Dioxide and Neurologic Complications

- **What is the dosage at which an effect is produced?**
- **What is the Incidence of Patent Foramen of Ovale?**
 - **6% to 22%**

How to Mitigate Neurologic Complications

- **Judiciously inject carbon dioxide in a peri-anastomotic location**
- **Take advantage of natural buoyancy of carbon dioxide to limit flow into Vertebral Basilar System**
- **Prevent carbon dioxide from refluxing across the anastomosis.**
 - **Compression of inflow**
 - **Balloon occlusion of inflow**
- **Foramen of Ovale**
 - **Avoid valsalva maneuver**

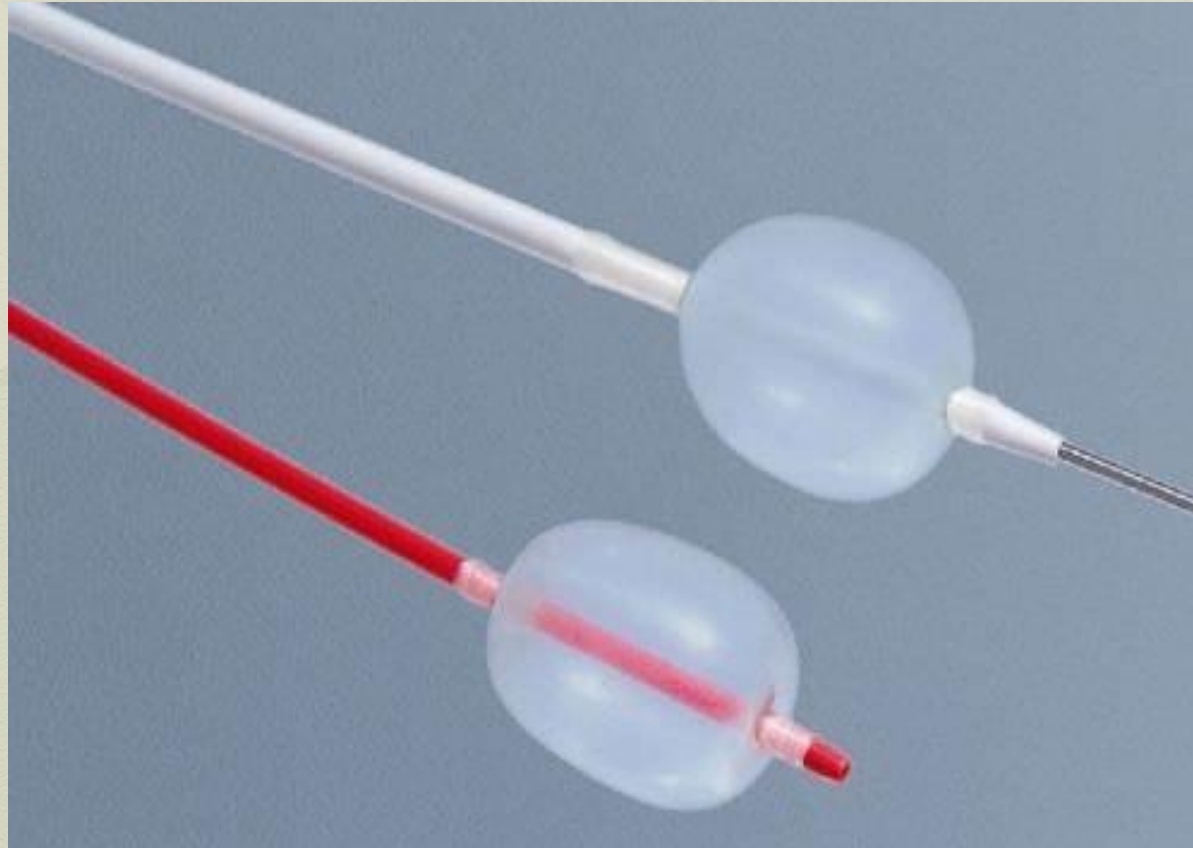
Fogarty Balloon



Fogarty Balloon



Fogarty Balloon

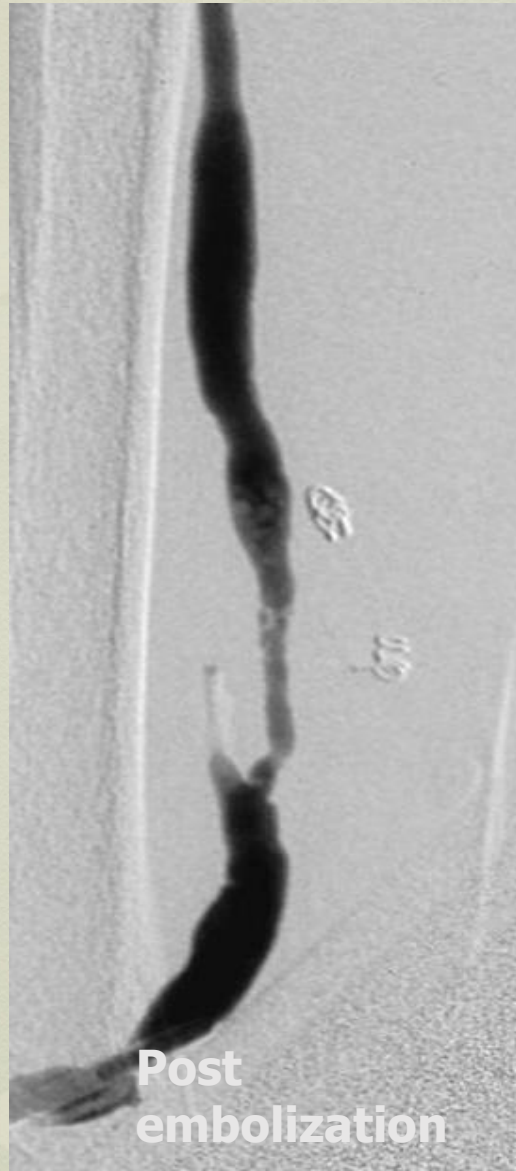


Compression

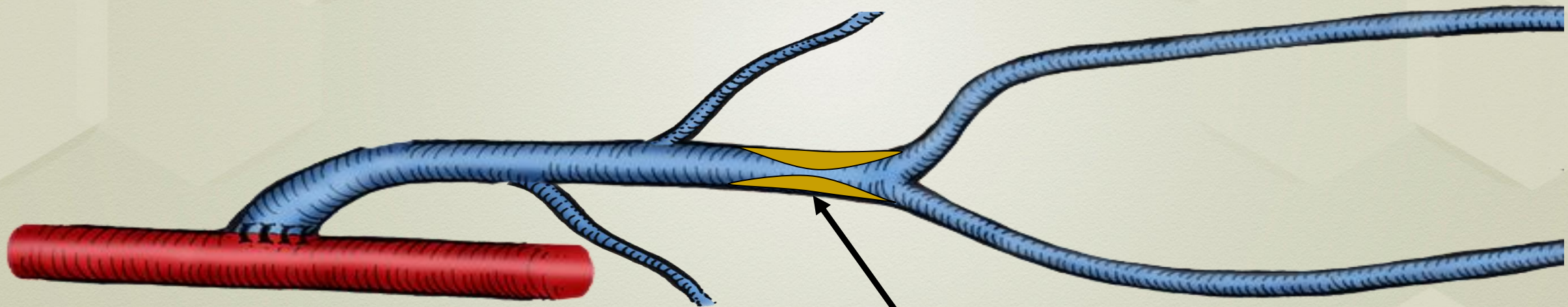


Mitigation of Complications

- **Be mindful of side branches in fistulas**

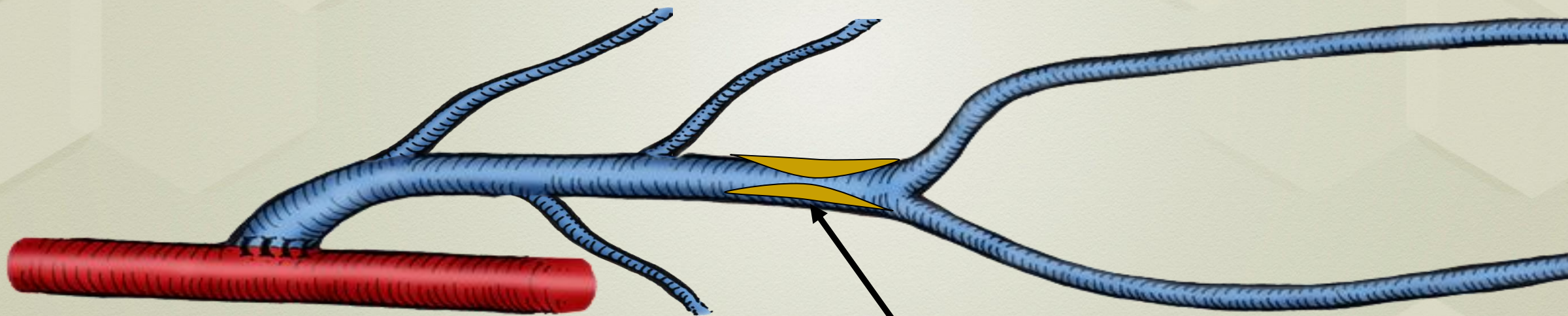


Pay Attention to Side Branches



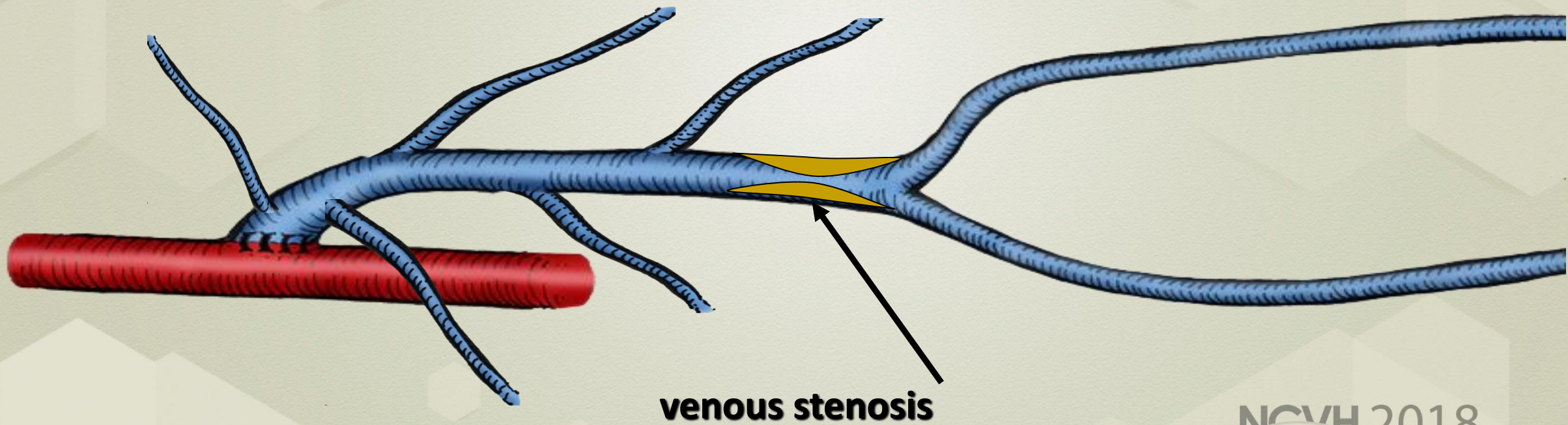
venous stenosis

Pay Attention to Side Branches



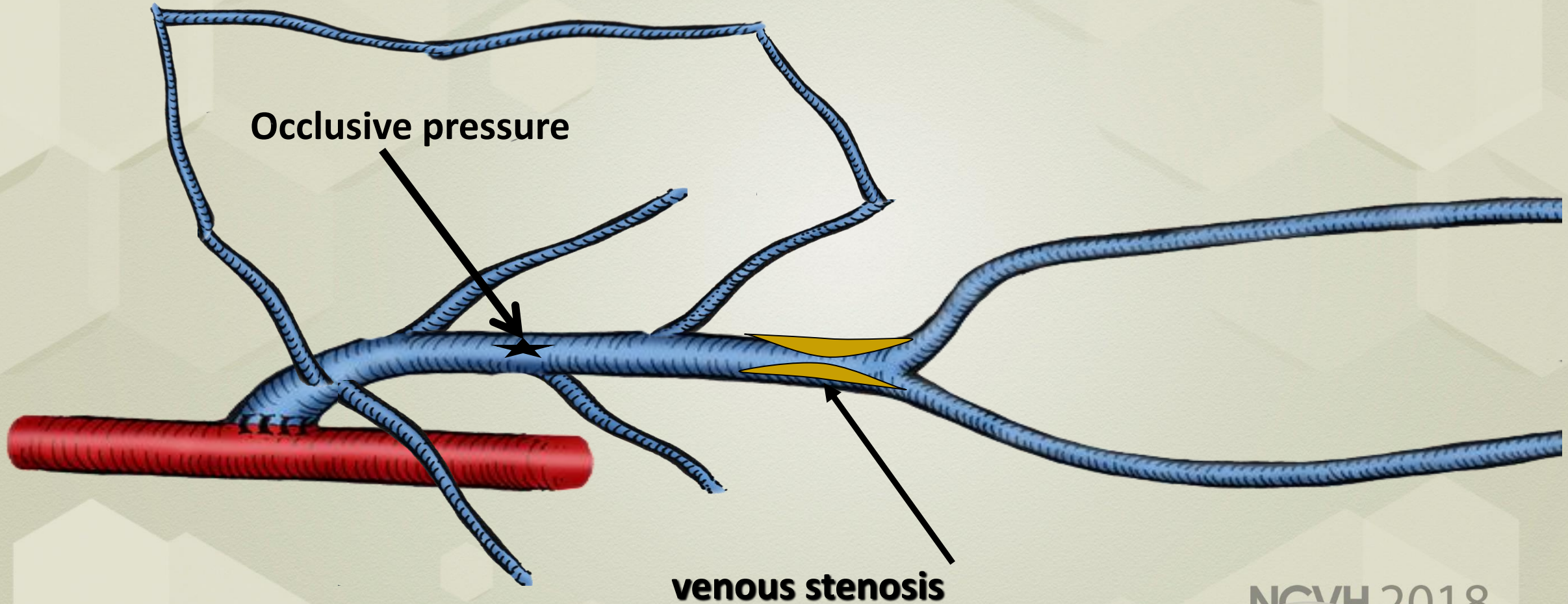
venous stenosis

Prominent Side Branches



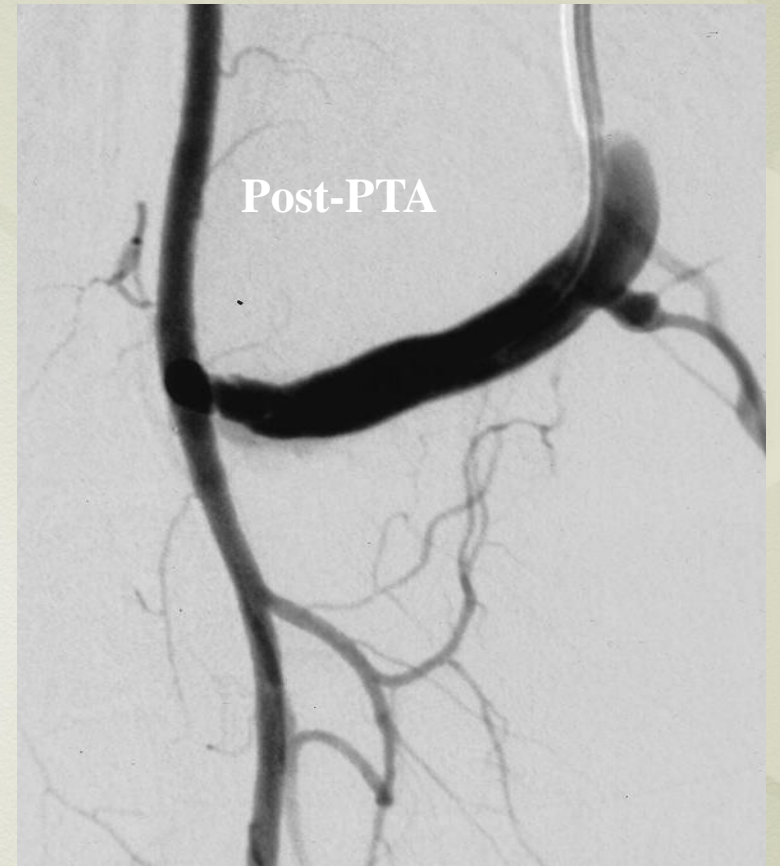
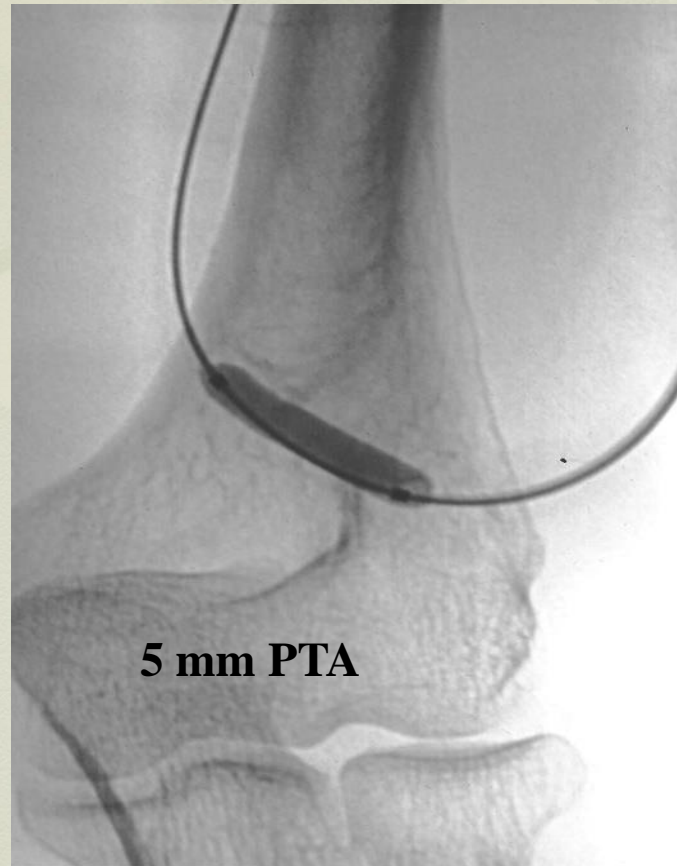
Prominent Side Branches

- Could act as a back channel into the anastomosis



Mitigation of Complications

- Survey fistula with ultrasound
- Use ultrasound liberally
- Low volume low pressure injections at the start until anatomy is understood
- Advent of IVUS will add more options for risk avoidance and anatomic information.



Angioplasty of juxta-anastomotic stenosis

End Stage Renal Disease and Carbon Dioxide

QUESTION – WHY USE CARBON DIOXIDE WHEN NEPHROTOXICITY IS NOT A CONCERN ?

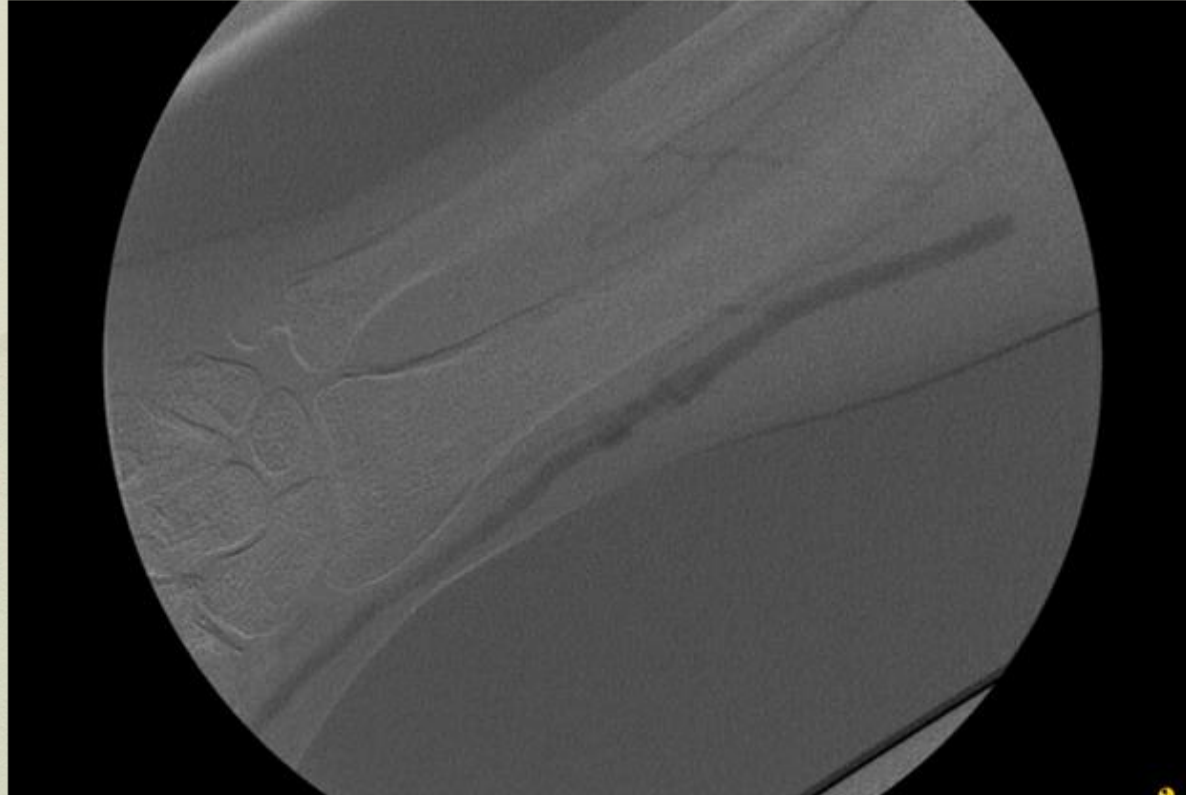
Circumstances

- **Allergy to contrast**
 - Stephens Johnson Reaction
 - History of failure of standard premedication
- **Post Renal Transplant Shunt Preservation**
- **Pre dialysis ESRD Pt. with Shunt dysfunction**
 - Iodine based contrast could end kidney function
- **Catheter Dysfunction**
- **Venography for shunt placement**

Circumstances

In my practice, I do not routinely perform carbon dioxide shunt evaluation unless dictated by circumstances.

Venography



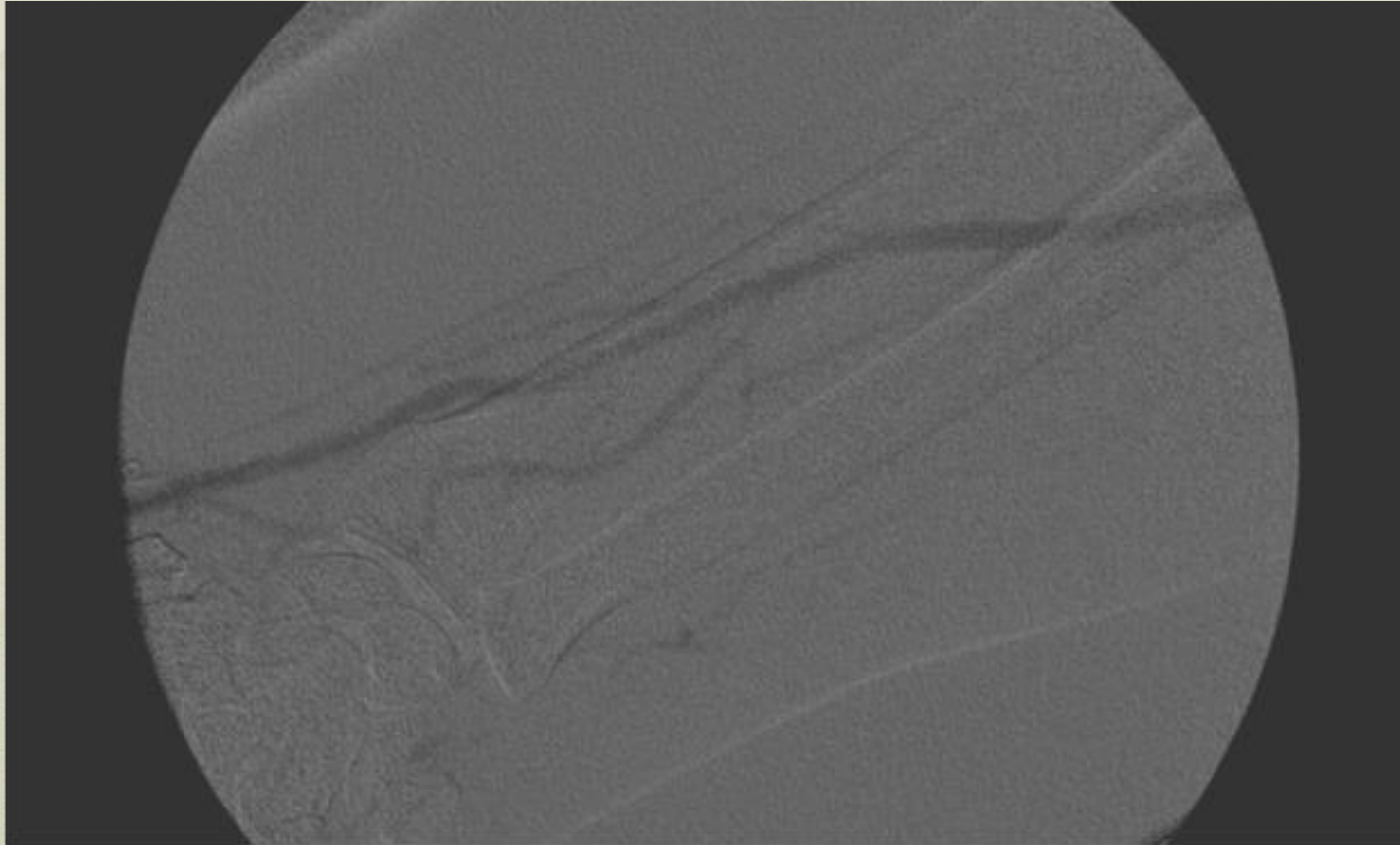
Venography



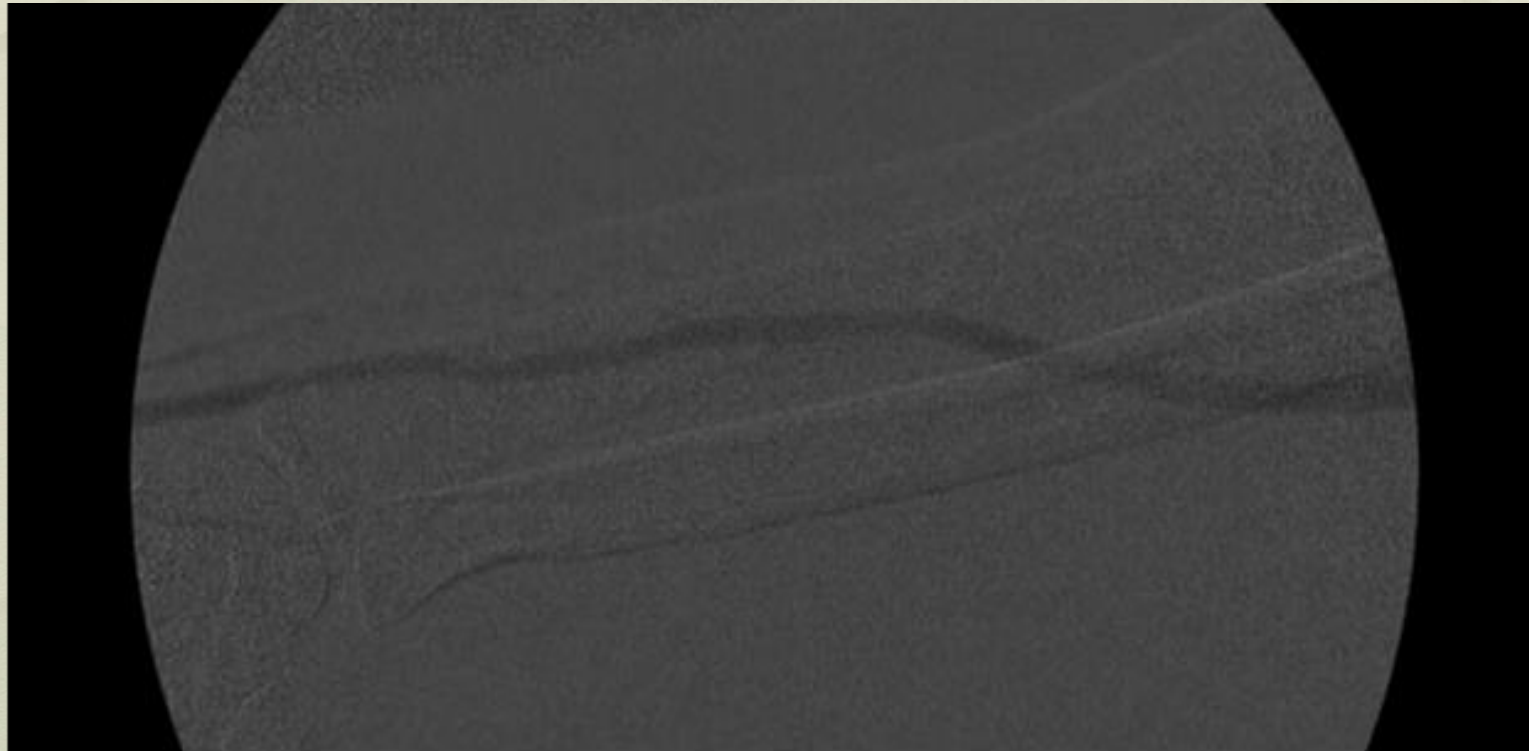
Venography



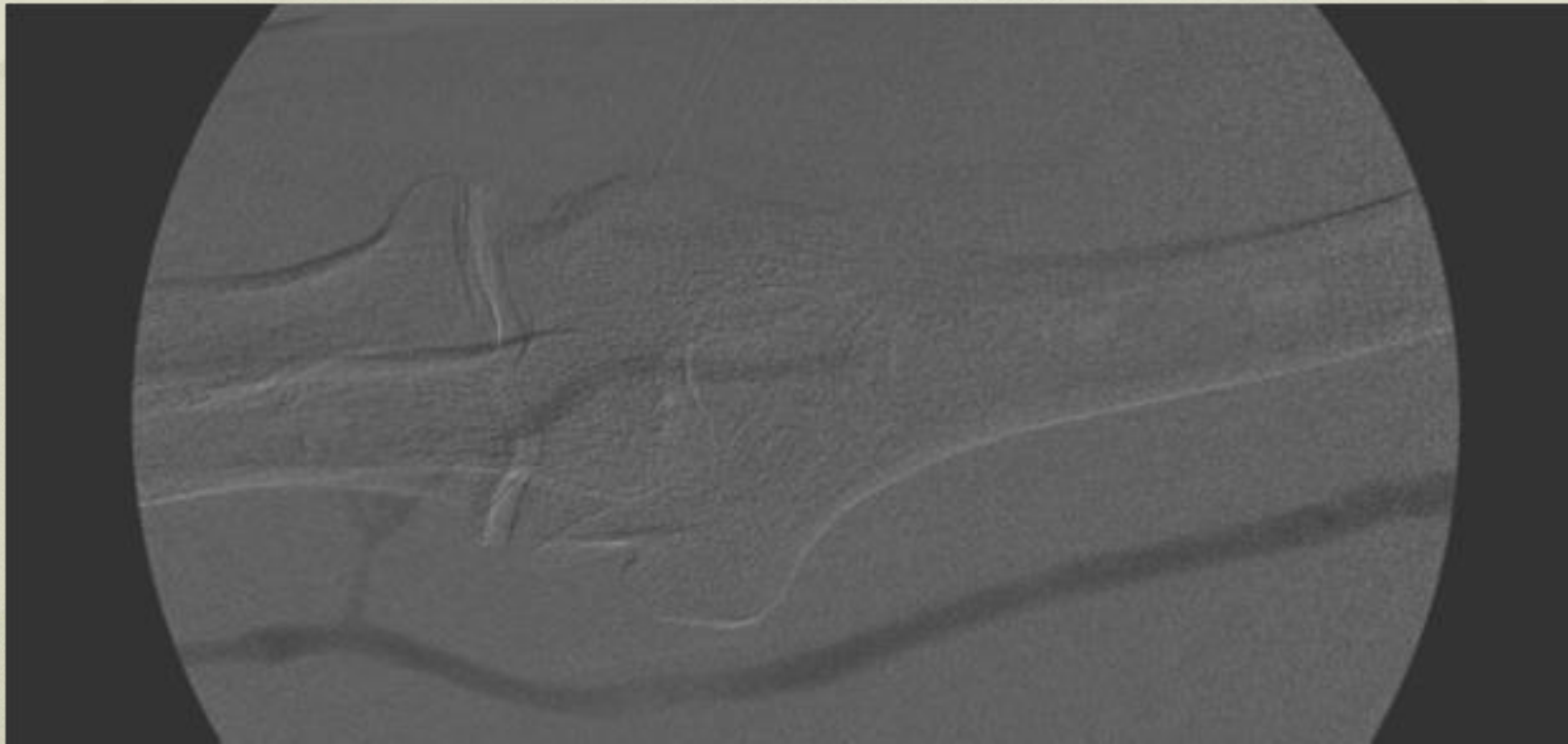
Venography



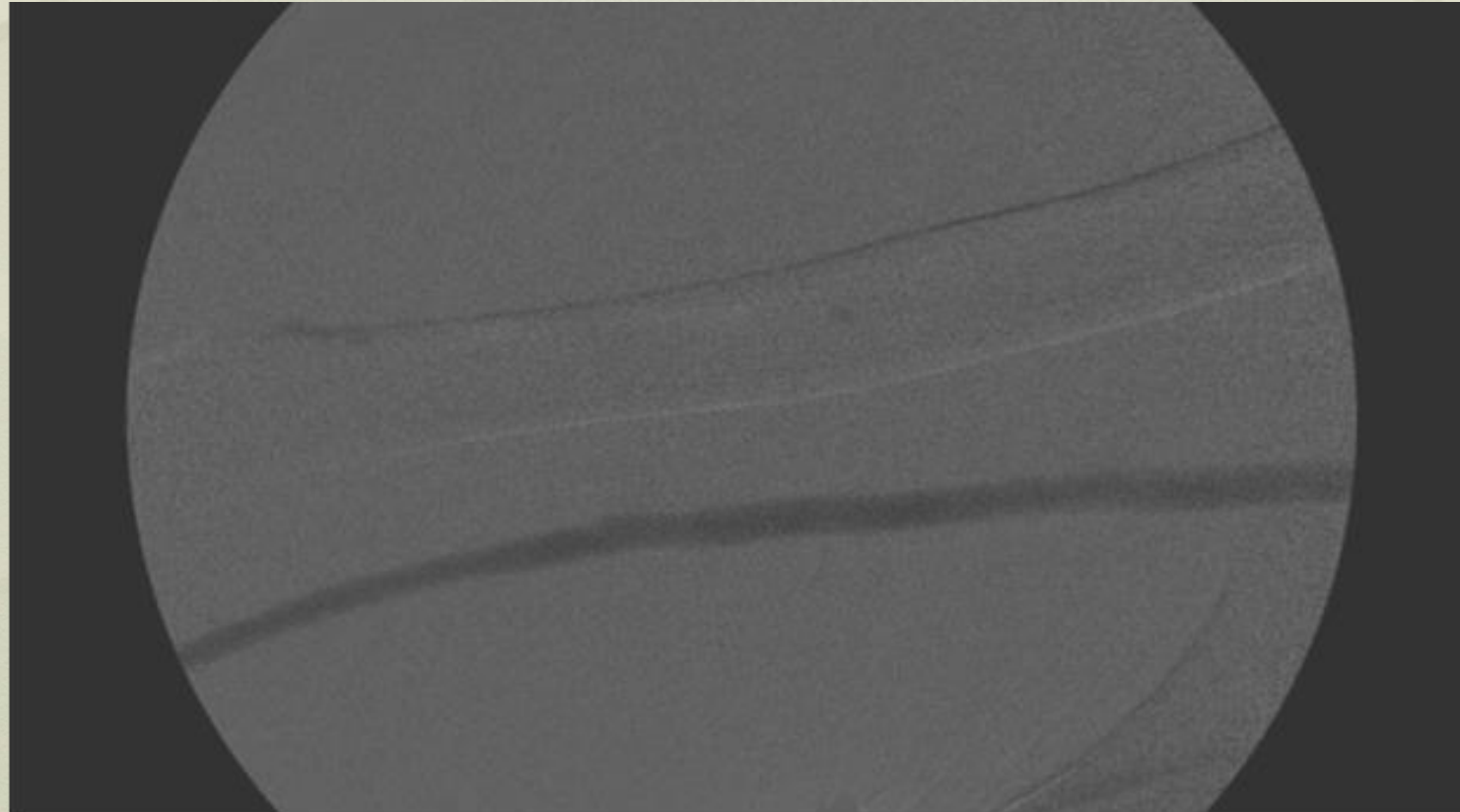
Venography



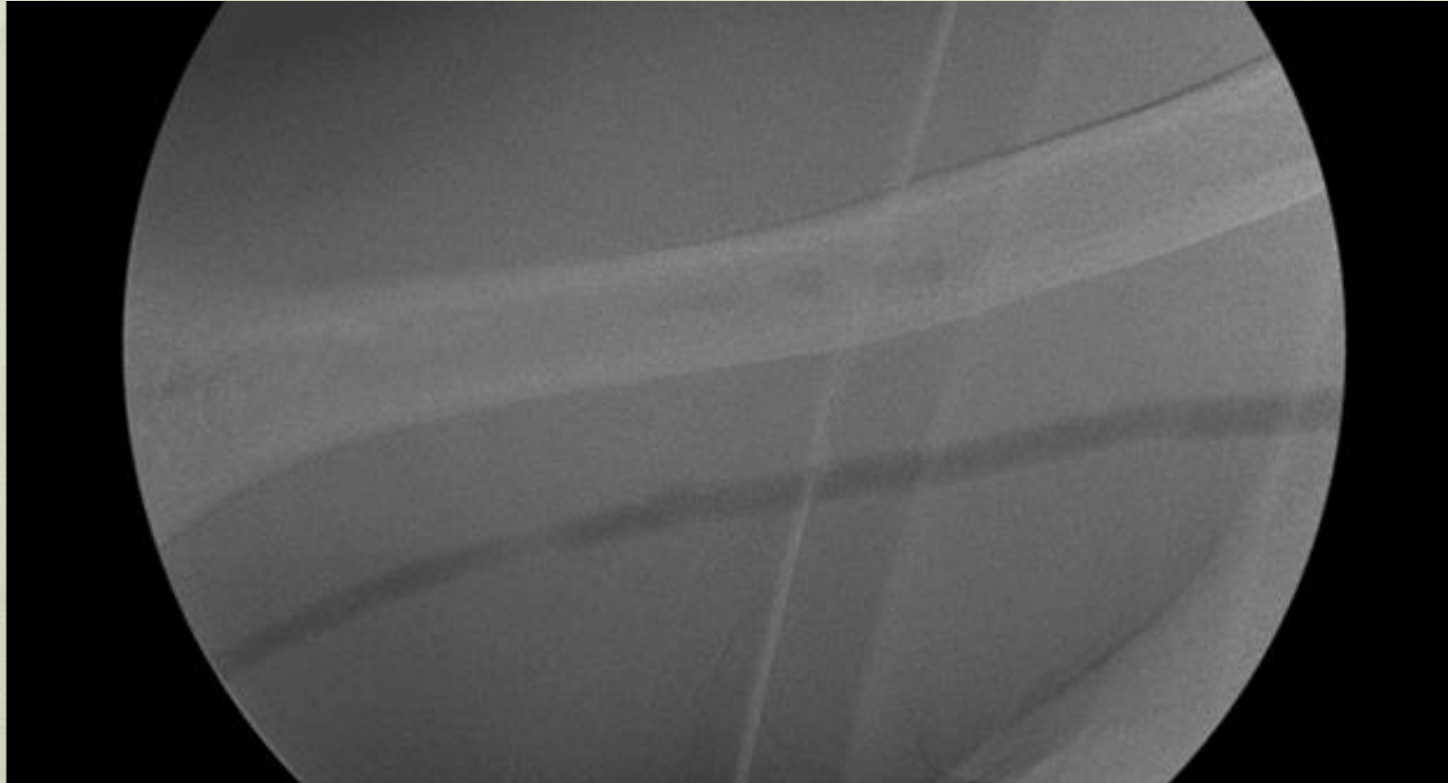
Venography



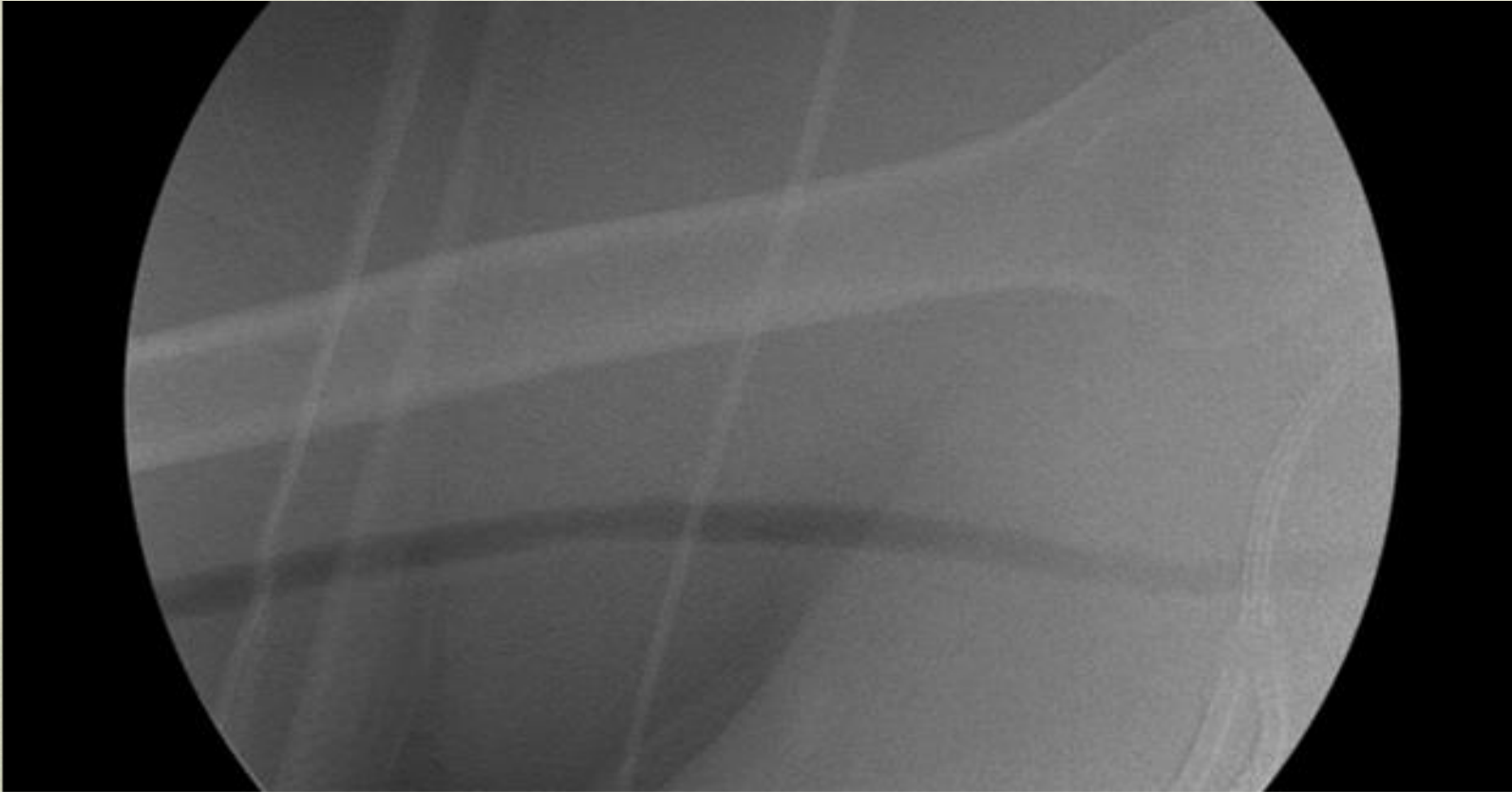
Venography



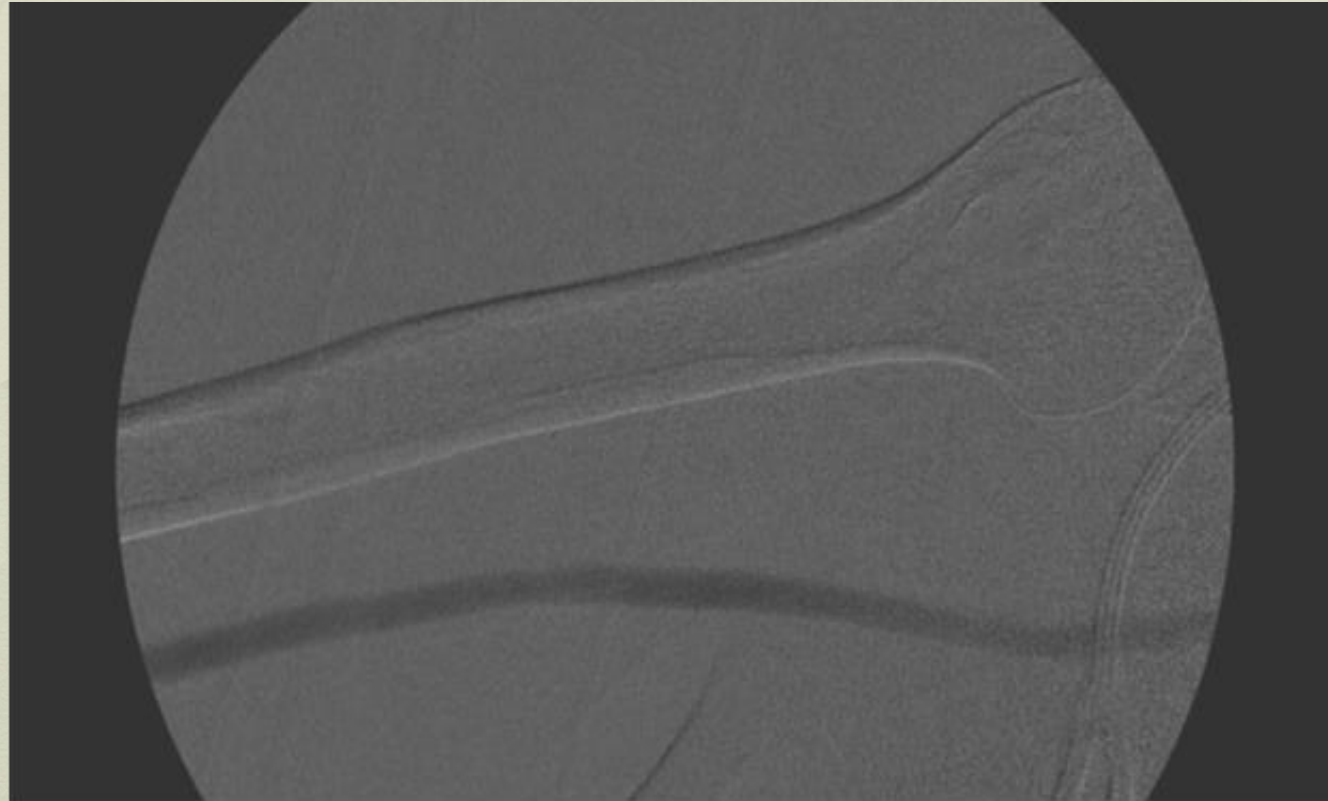
Venography



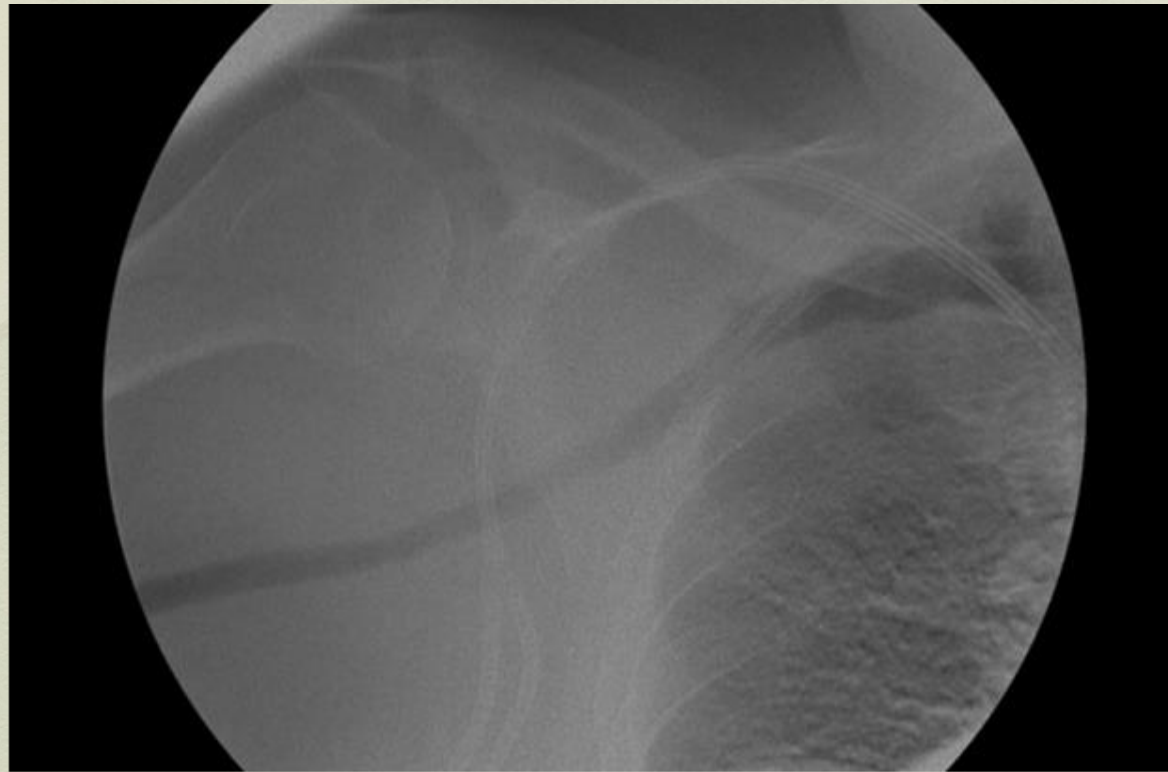
Venography



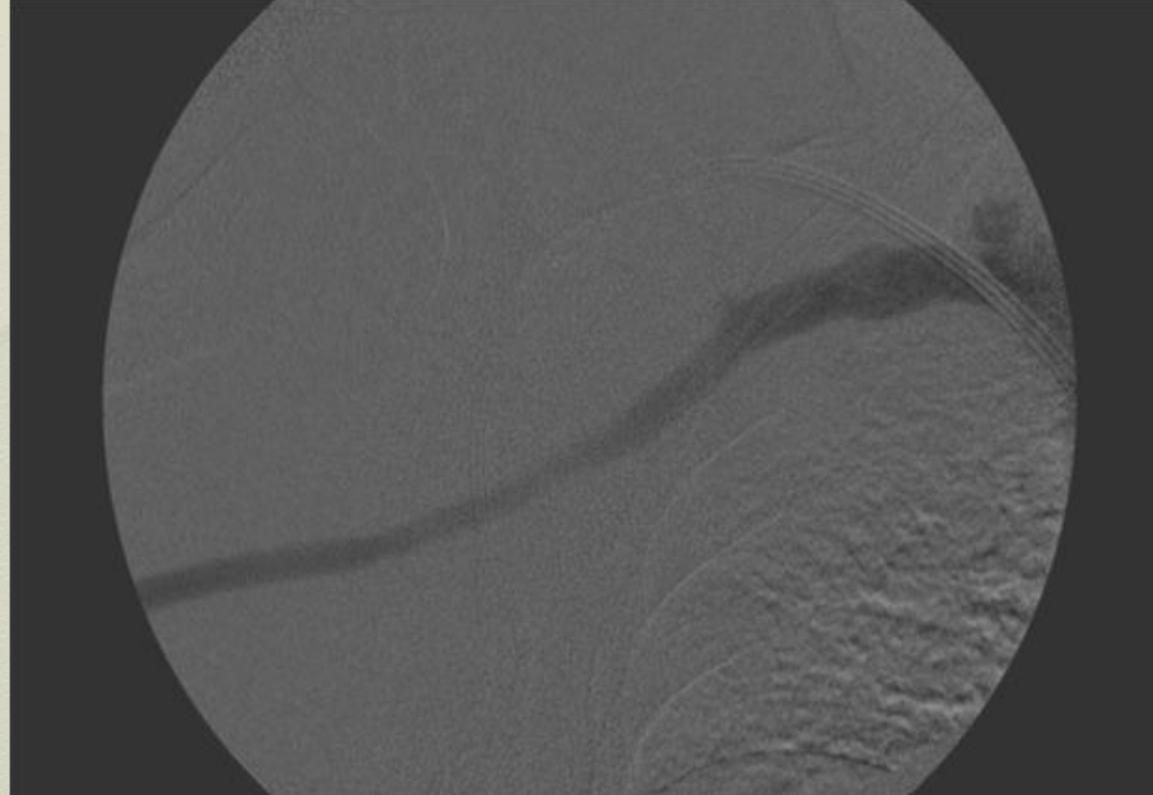
Venography



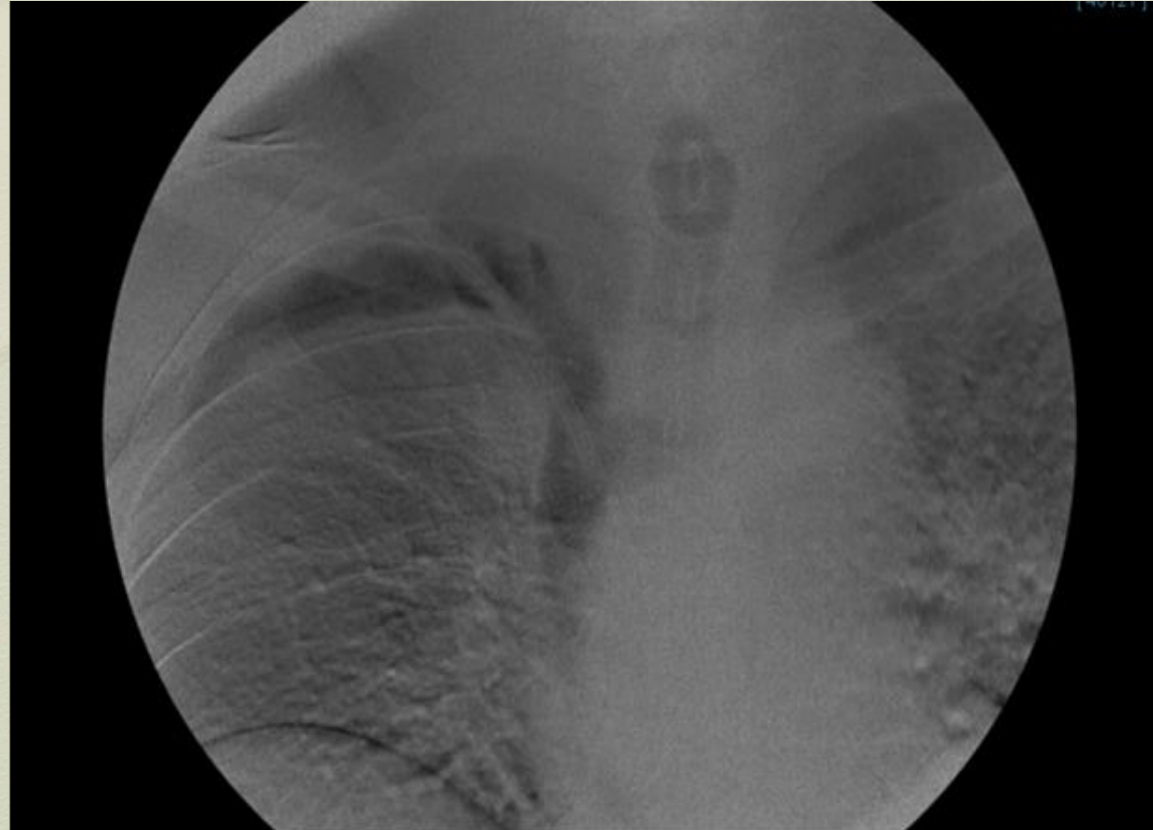
Venography



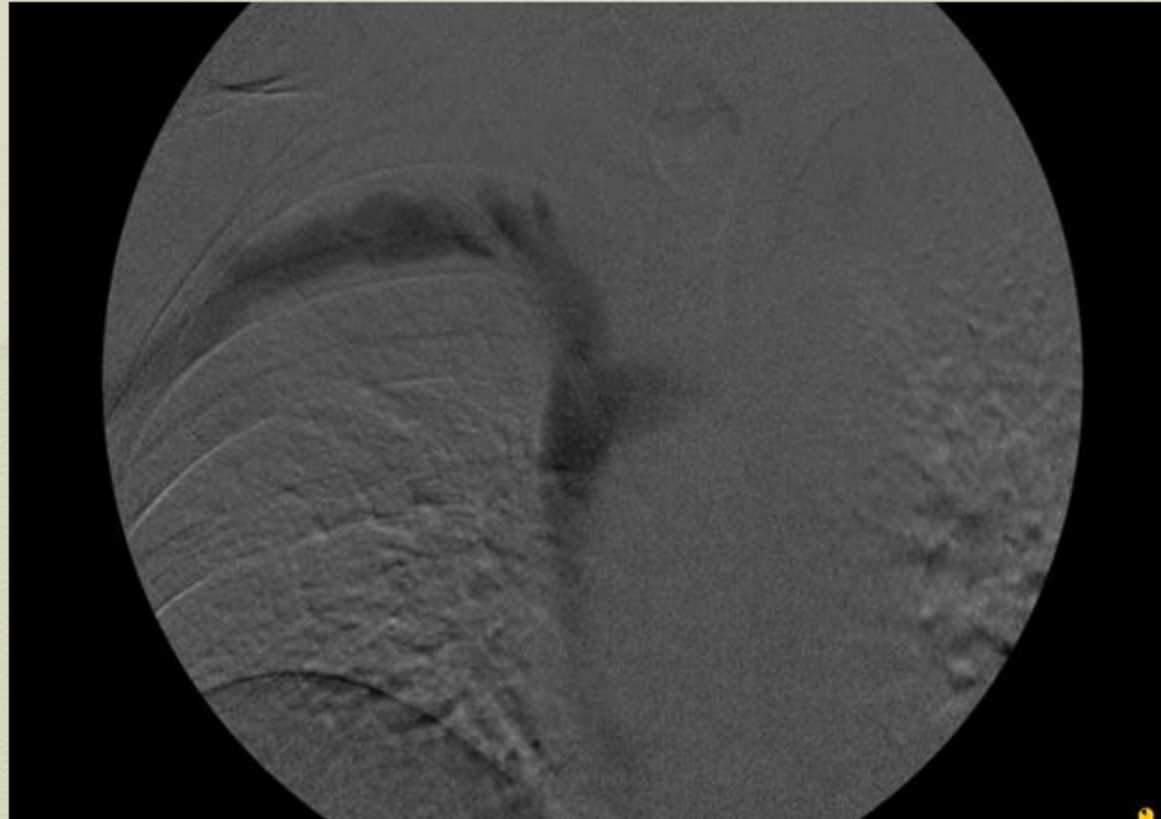
Venography



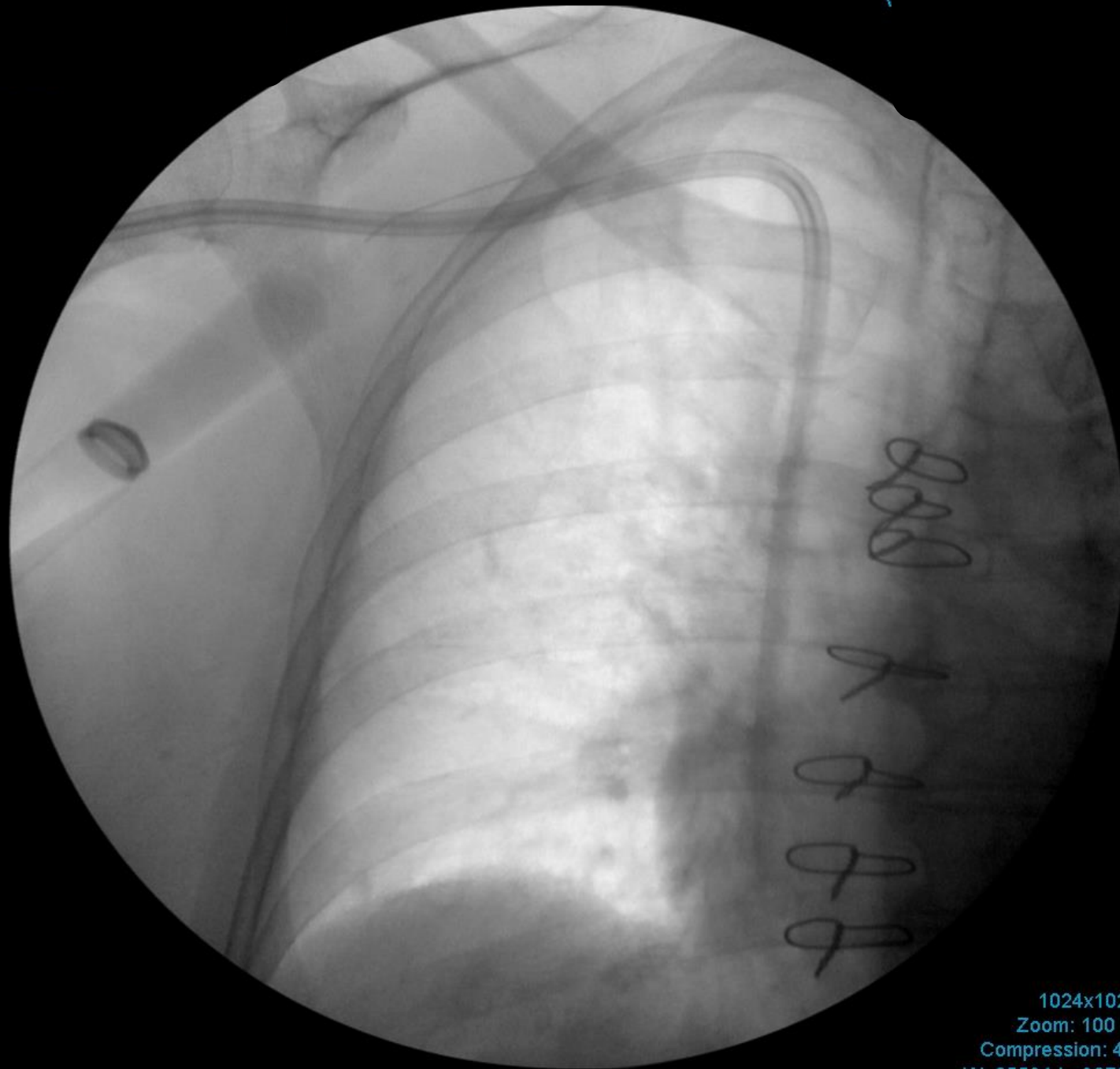
Venography



Venography



Catheter Dysfunction Evaluation



1024x1024
Zoom: 100 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018

IM

00
A]
3]
7]
2]



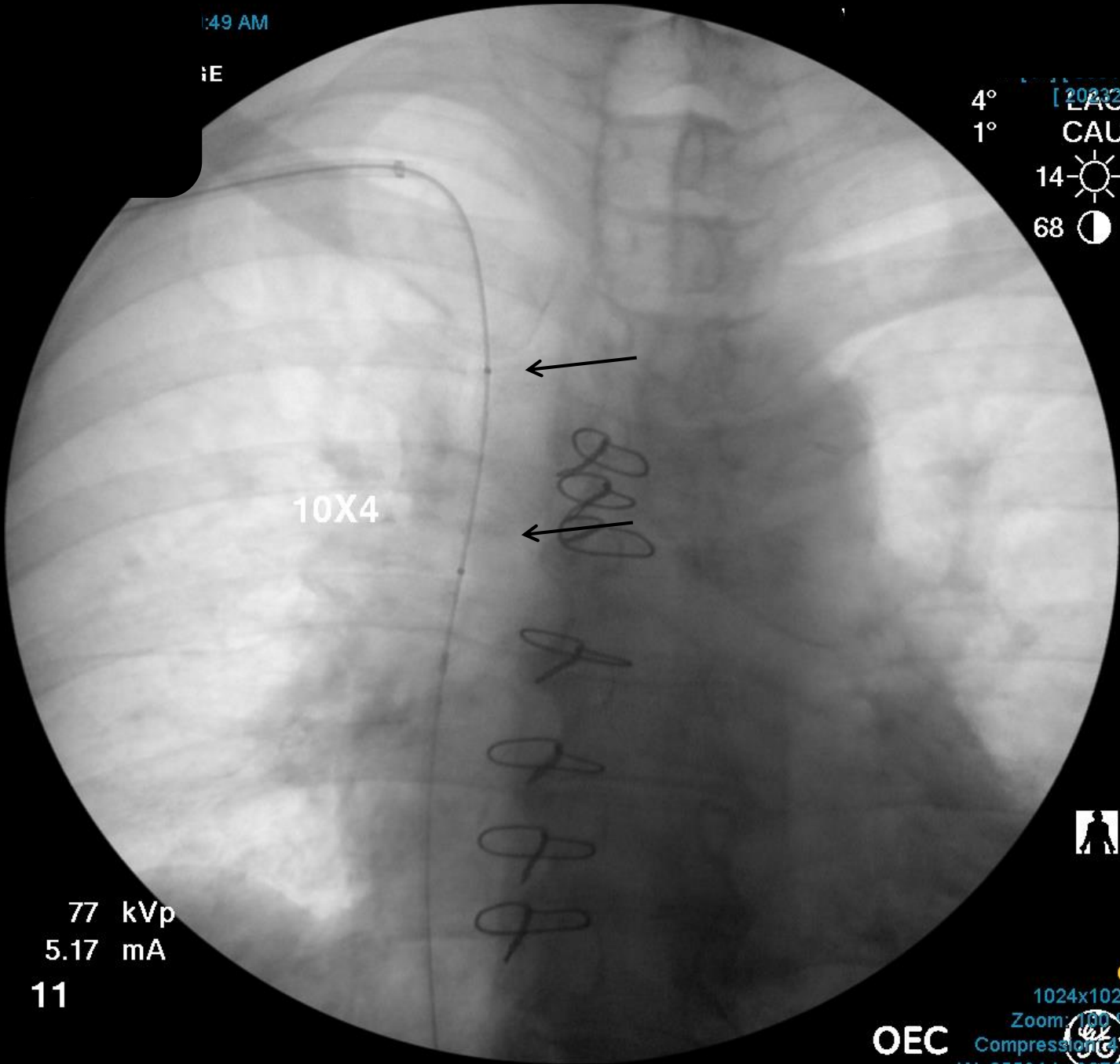
1024x1024
Zoom: 100 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018

10:49 AM

iE

4°
1°
[20232]
LAO
CAU
14
68



10X4

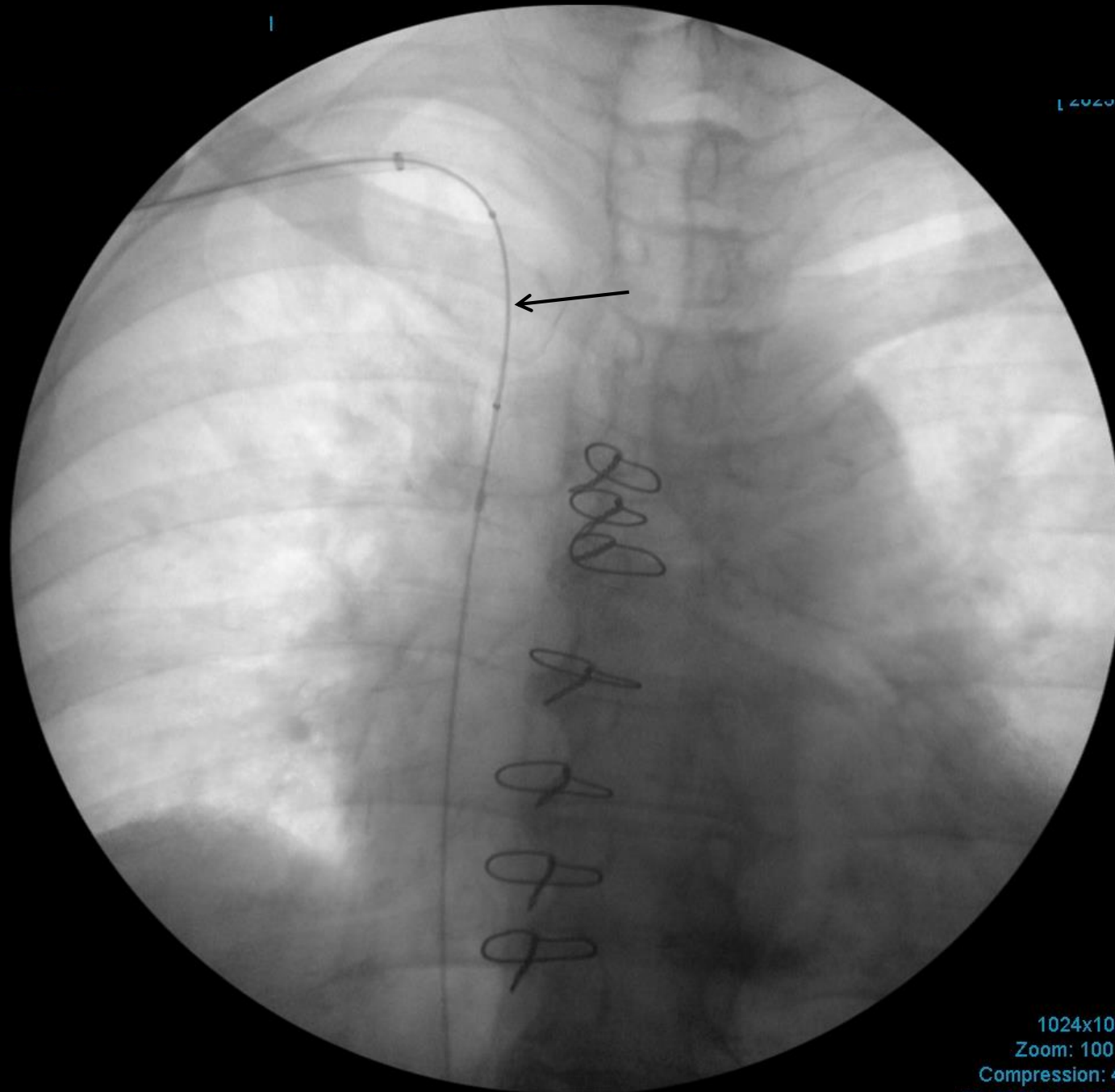
77 kVp
5.17 mA

11

OEC

1024x1024
Zoom: 100%
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



[20202]

1024x1024
Zoom: 100 %
Compression: 4:1
W: 65534 L: 32766

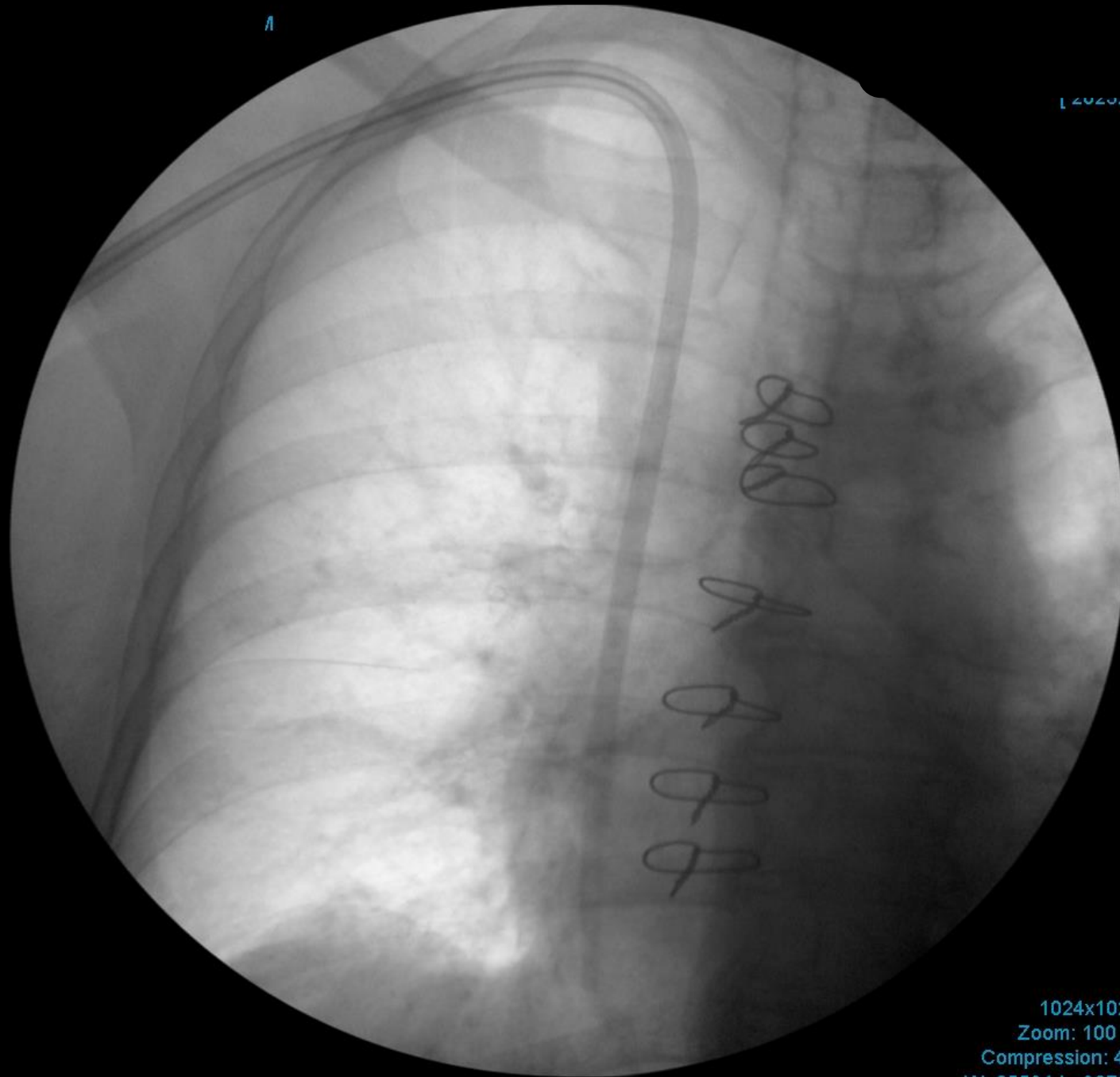
NCVH 2018

Im. 113



1024x1024
Zoom: 100 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018

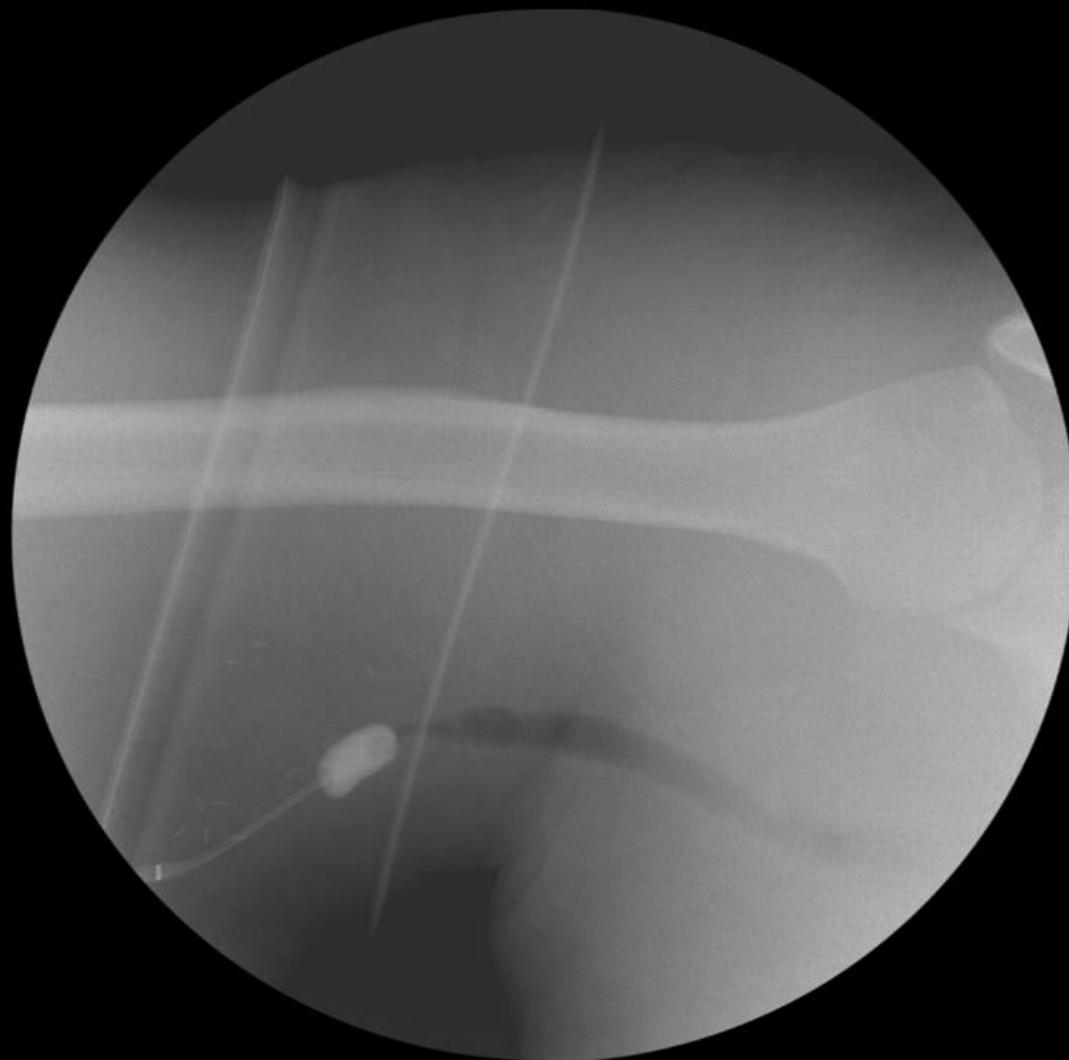


[20202]

1024x1024
Zoom: 100 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018

**68 year old male with severe facial swelling,
and a left arm fistula**



111111

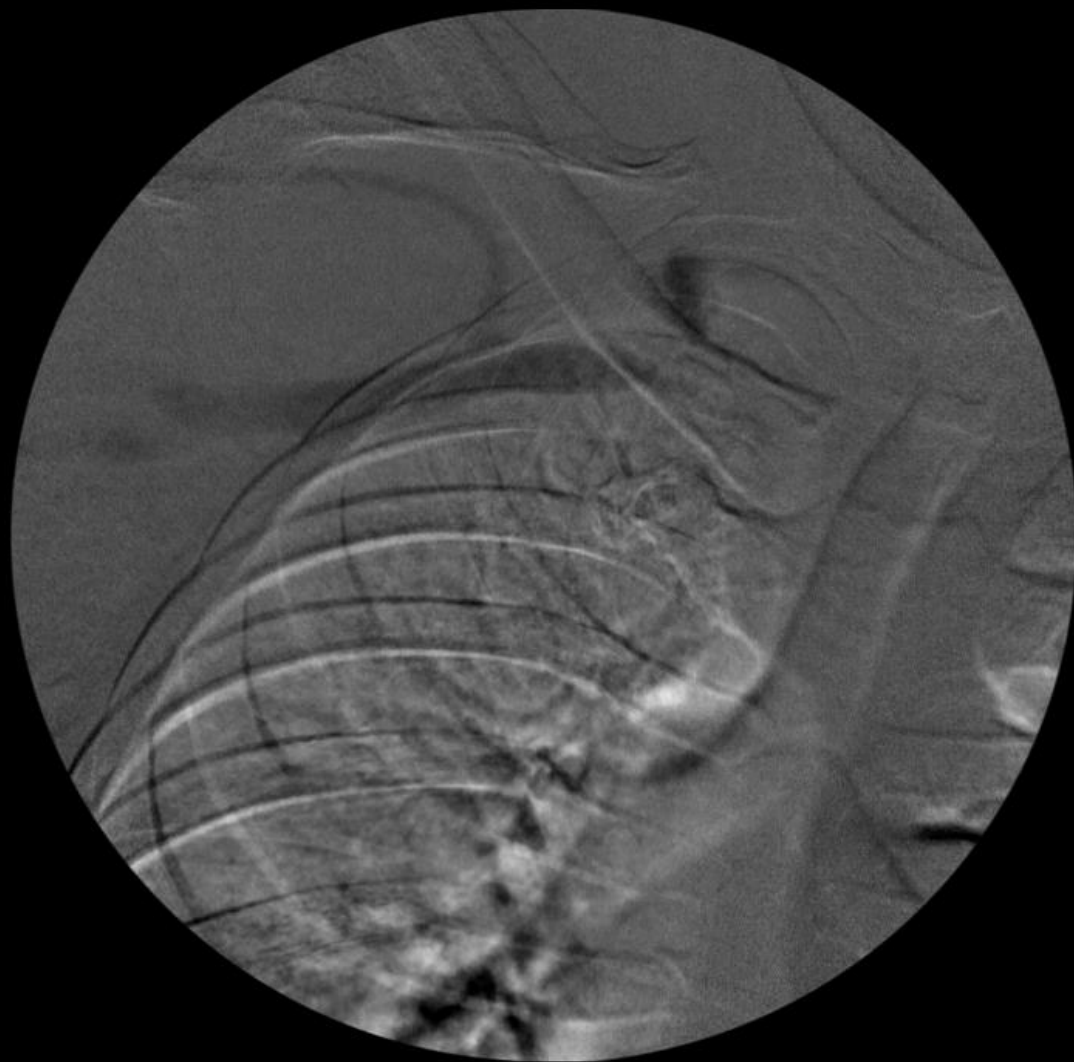
1024x1024
Zoom: 72 %
Compression: 4:1
W: 65534 L: 32766



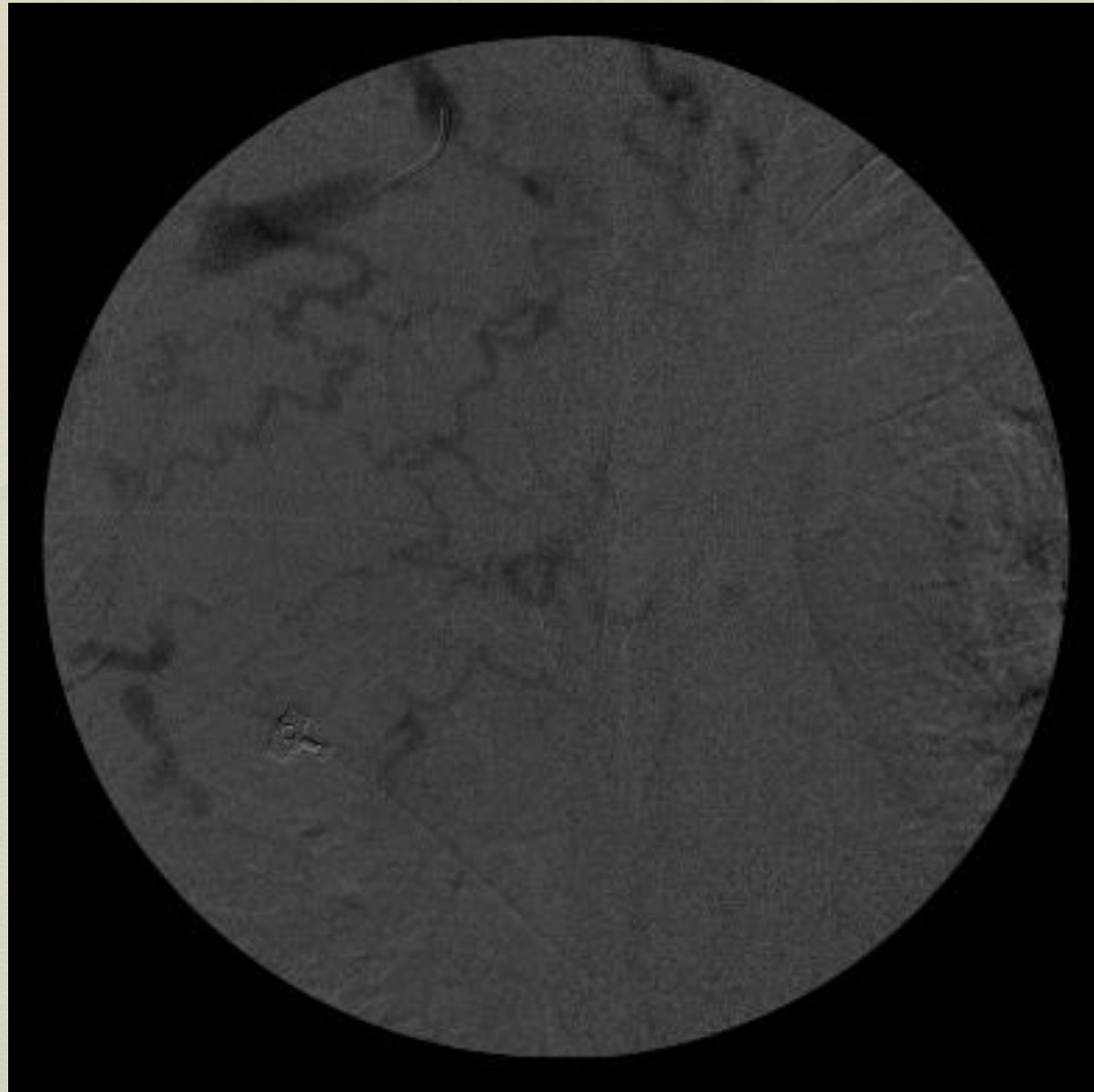
1024x1024
Zoom: 72 %
Compression: 4:1
W: 65534 L: 32766



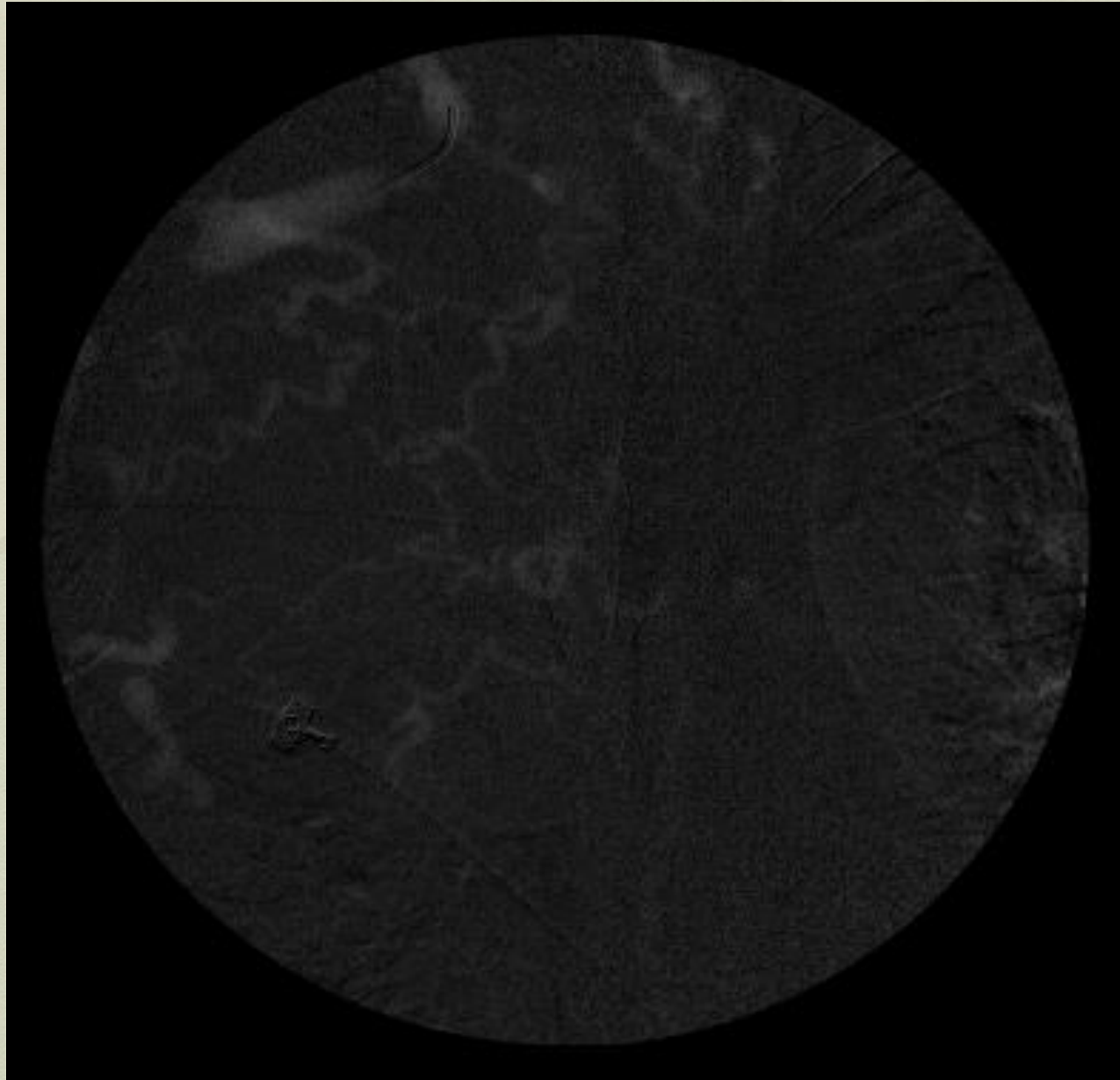
1024x1024
Zoom: 72 %
Compression: 4:1
W: 65534 L: 32766



1024x1024
Zoom: 72 %
Compression: 4:1
W: 65534 L: 32766

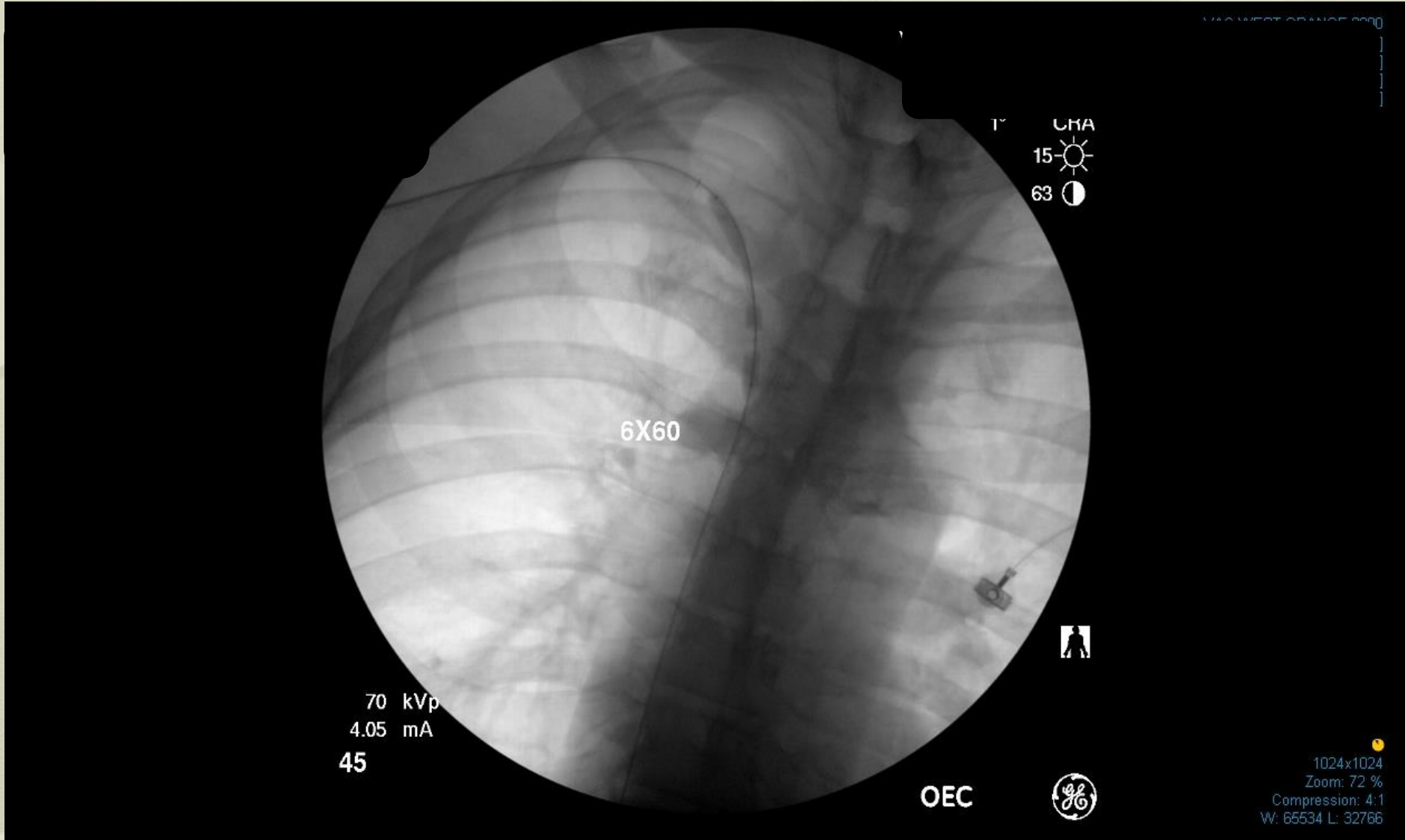


NCVH 2018

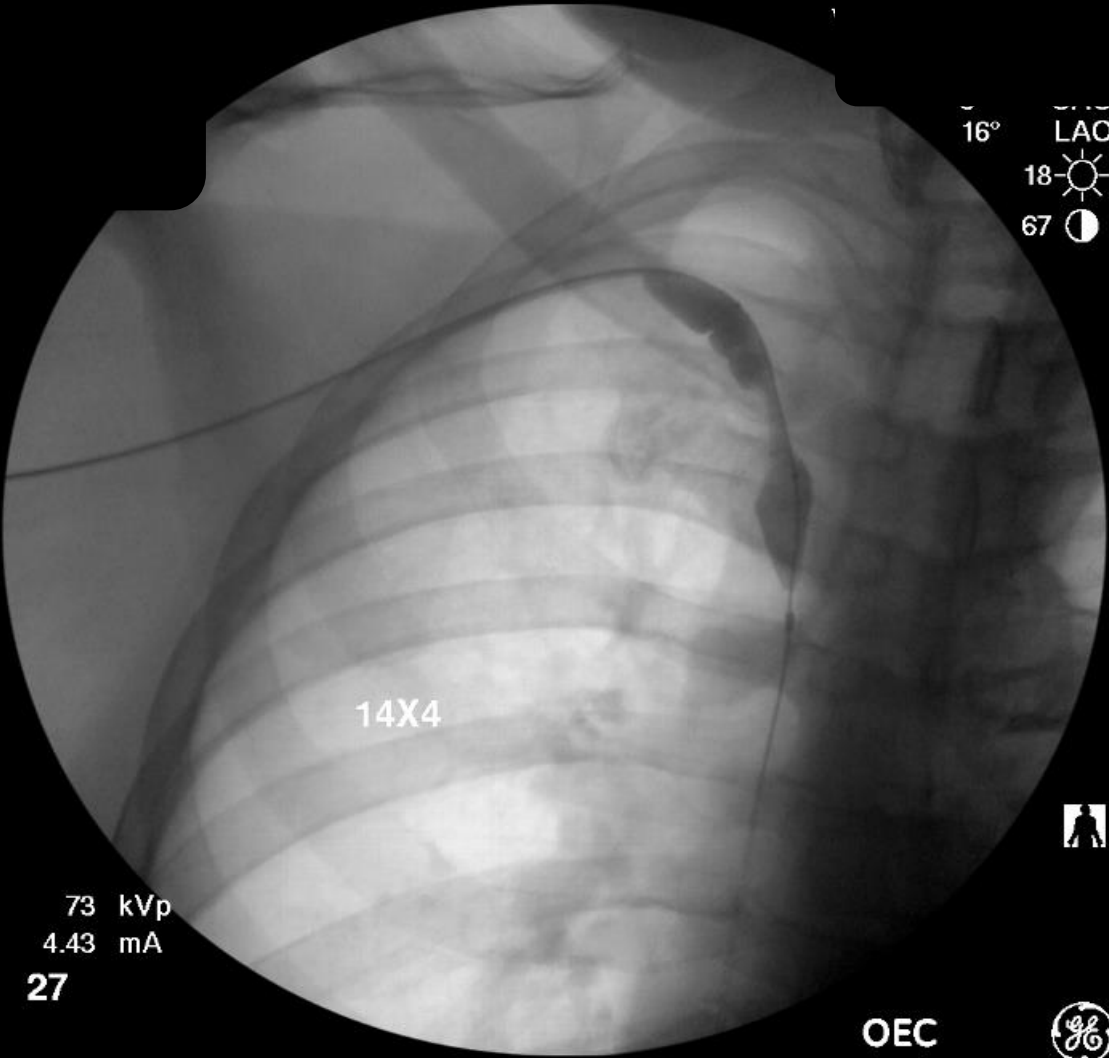


NCVH 2018





DI IAF



16° LAO
18
67

73 kVp
4.43 mA
27

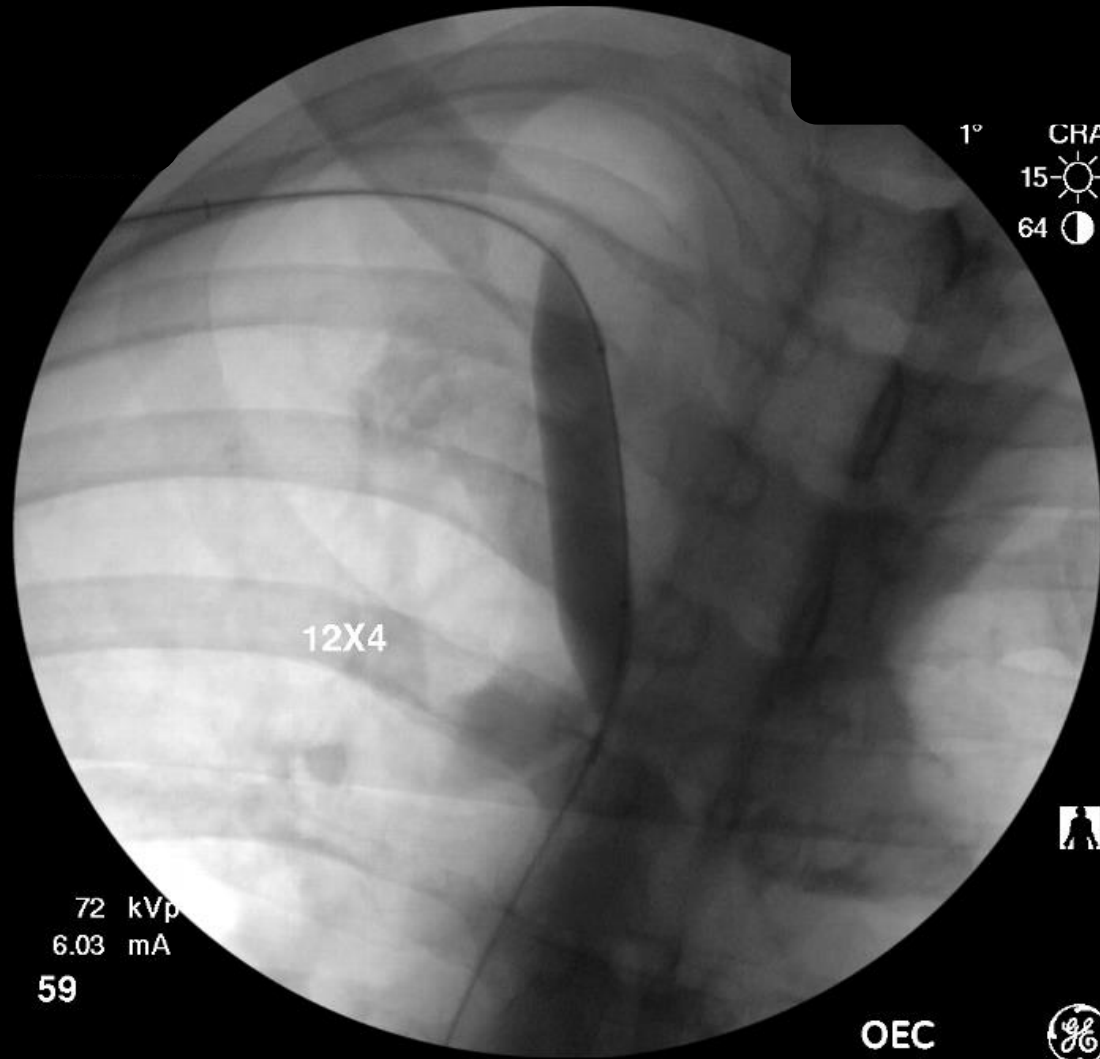
14X4



OEC



1024x1024
Zoom: 72 %
Compression: 4:1
W: 65534 L: 32766



1°
CHA
15
64

72 kVp
6.03 mA
59



OEC



1024x1024
Zoom: 72 %
Compression: 4:1
W: 65534 L: 32766

DIAC



1024x1024
Zoom: 72 %
Compression: 4:1
W: 65534 L: 32766

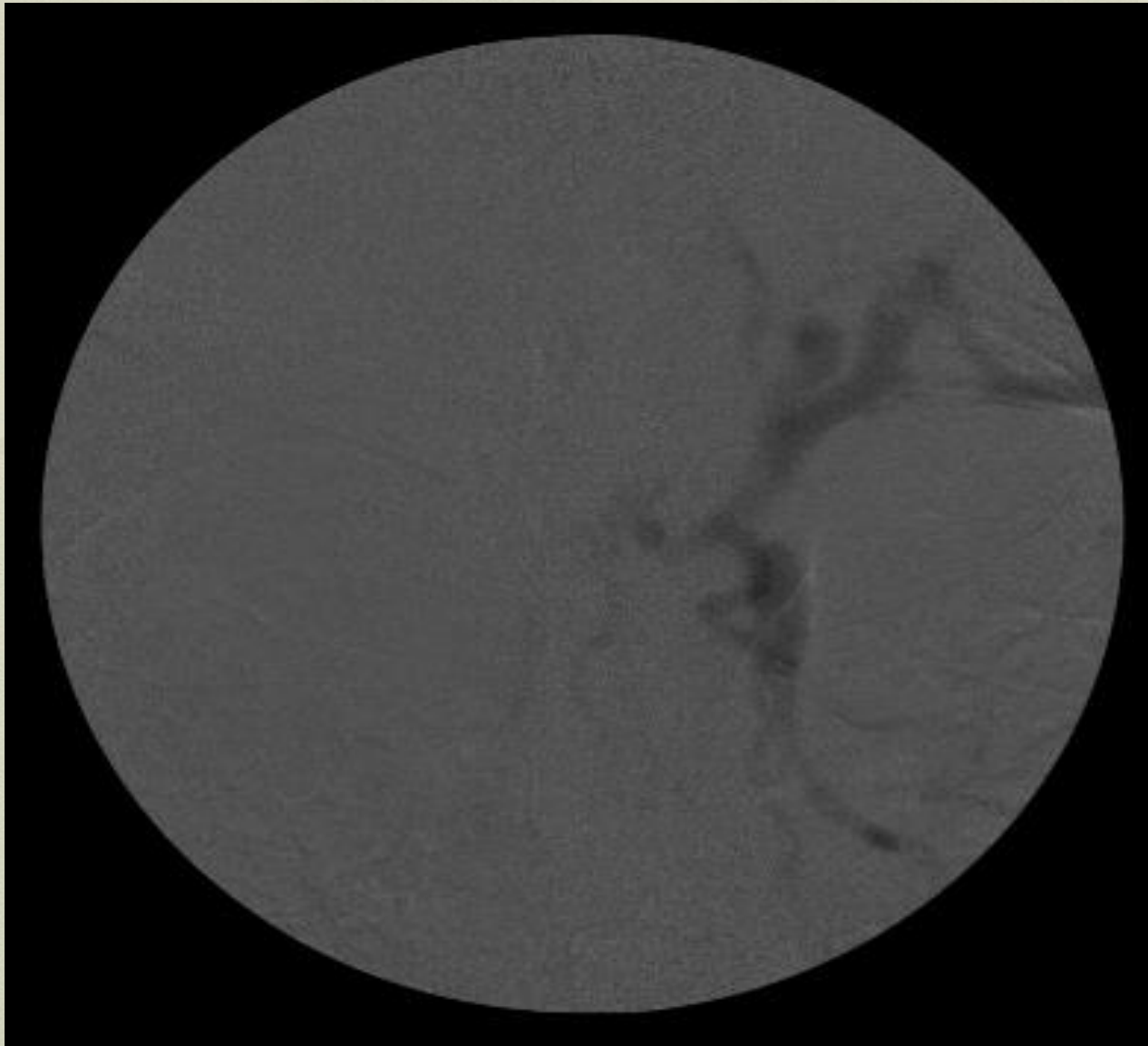


NCVH 2018

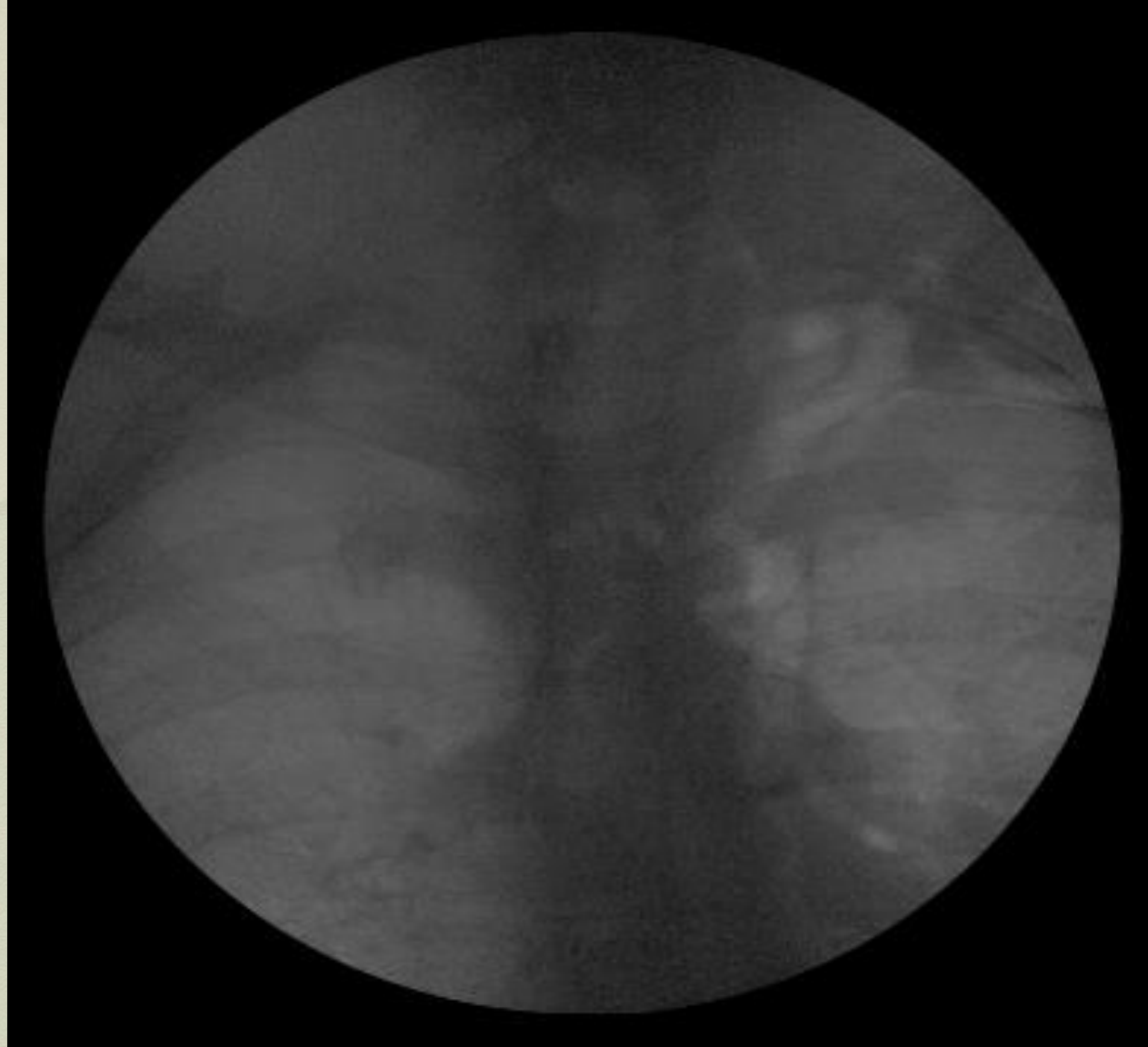
Adult male with left arm swelling and a left arm fistula



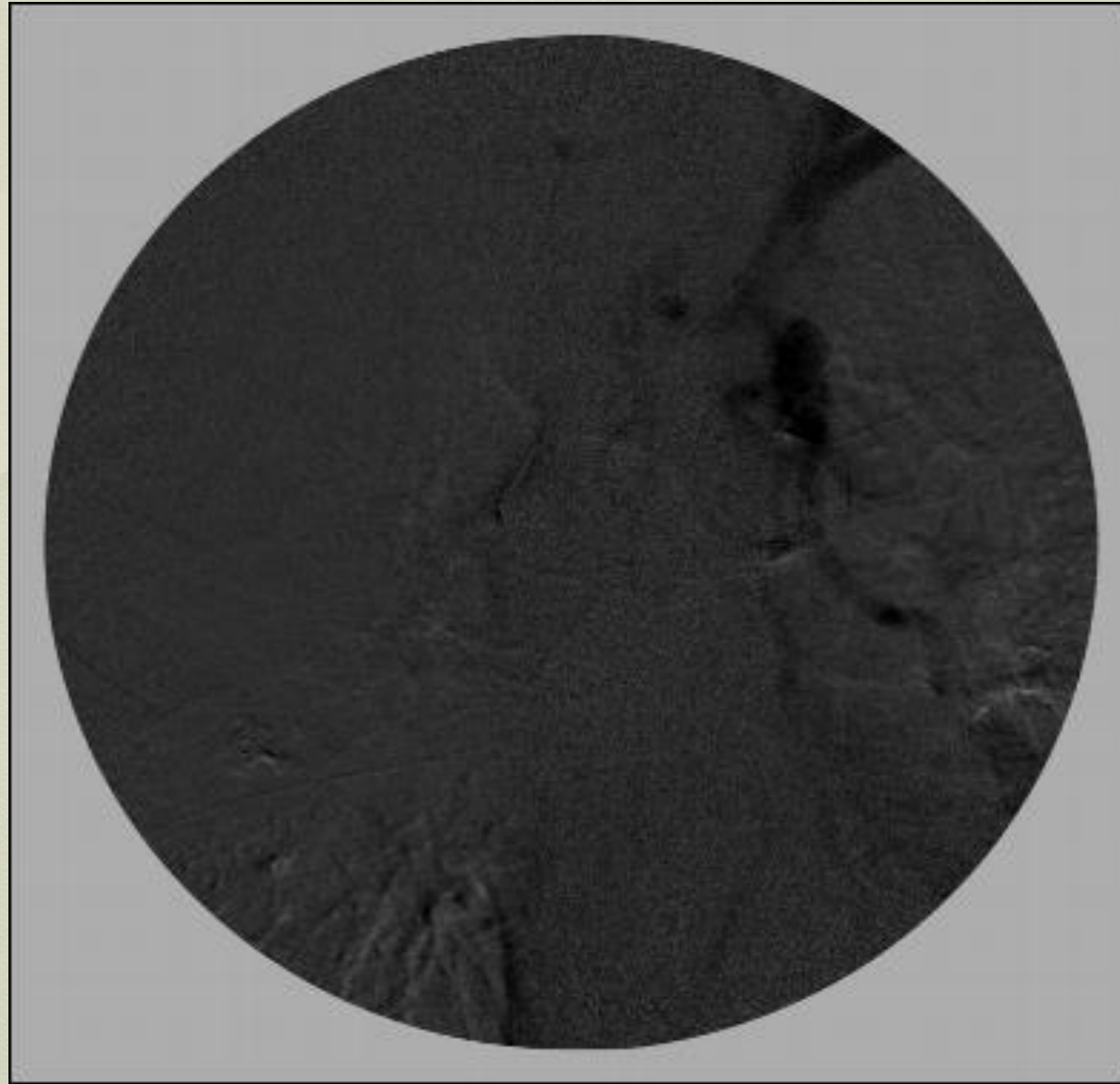
1024x1024
Zoom: 100 %
Compression: 4:1
W: 26163 L: 19543



NCVH 2018



NCVH 2018





NCVH 2018



1024x1024
Zoom: 100 %
Compression: 4:1
W: 26213 L: 39779

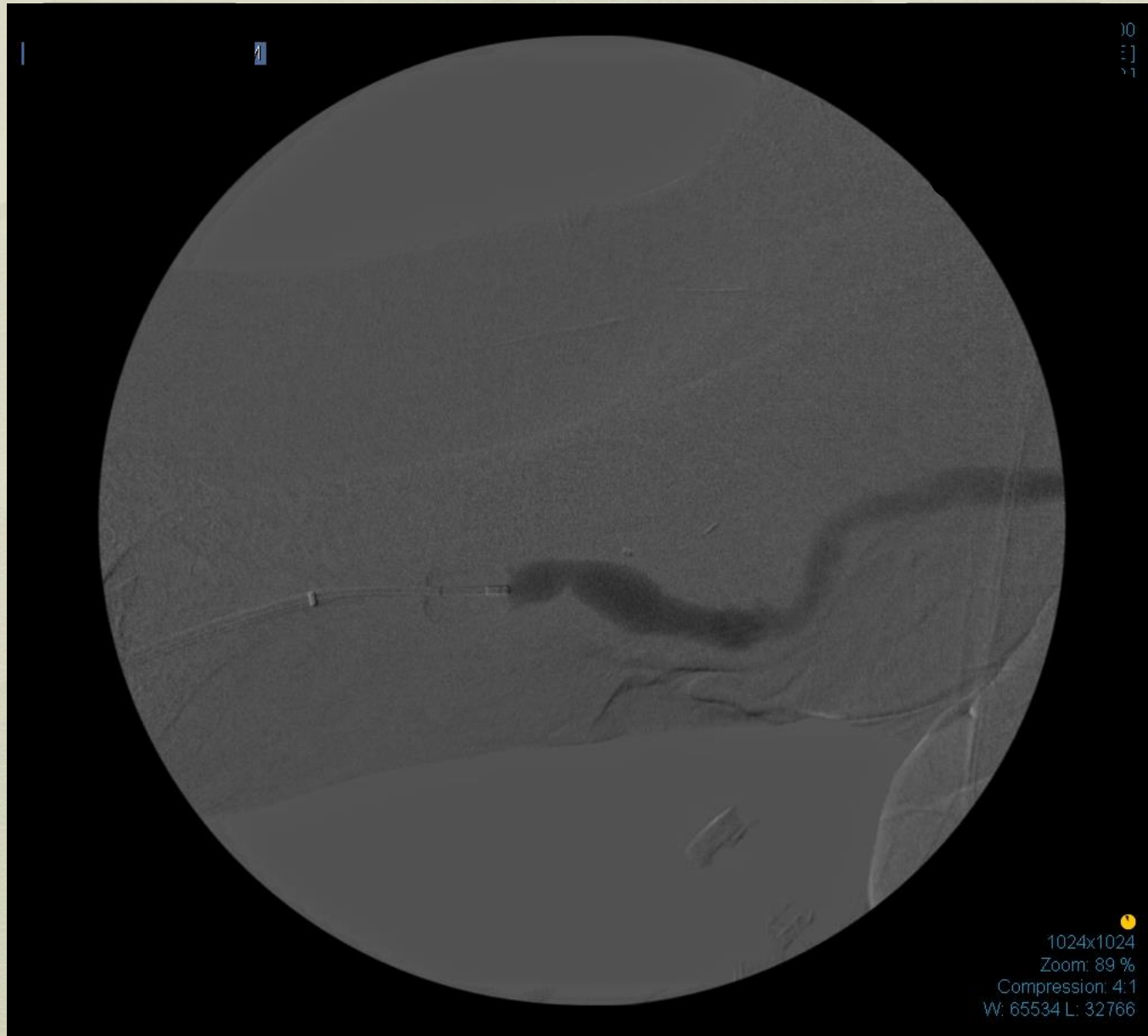
NCVH 2018

41 year old female with fistula and a history of Stevens Johnson Syndrome



1024x1024
Zoom: 89 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



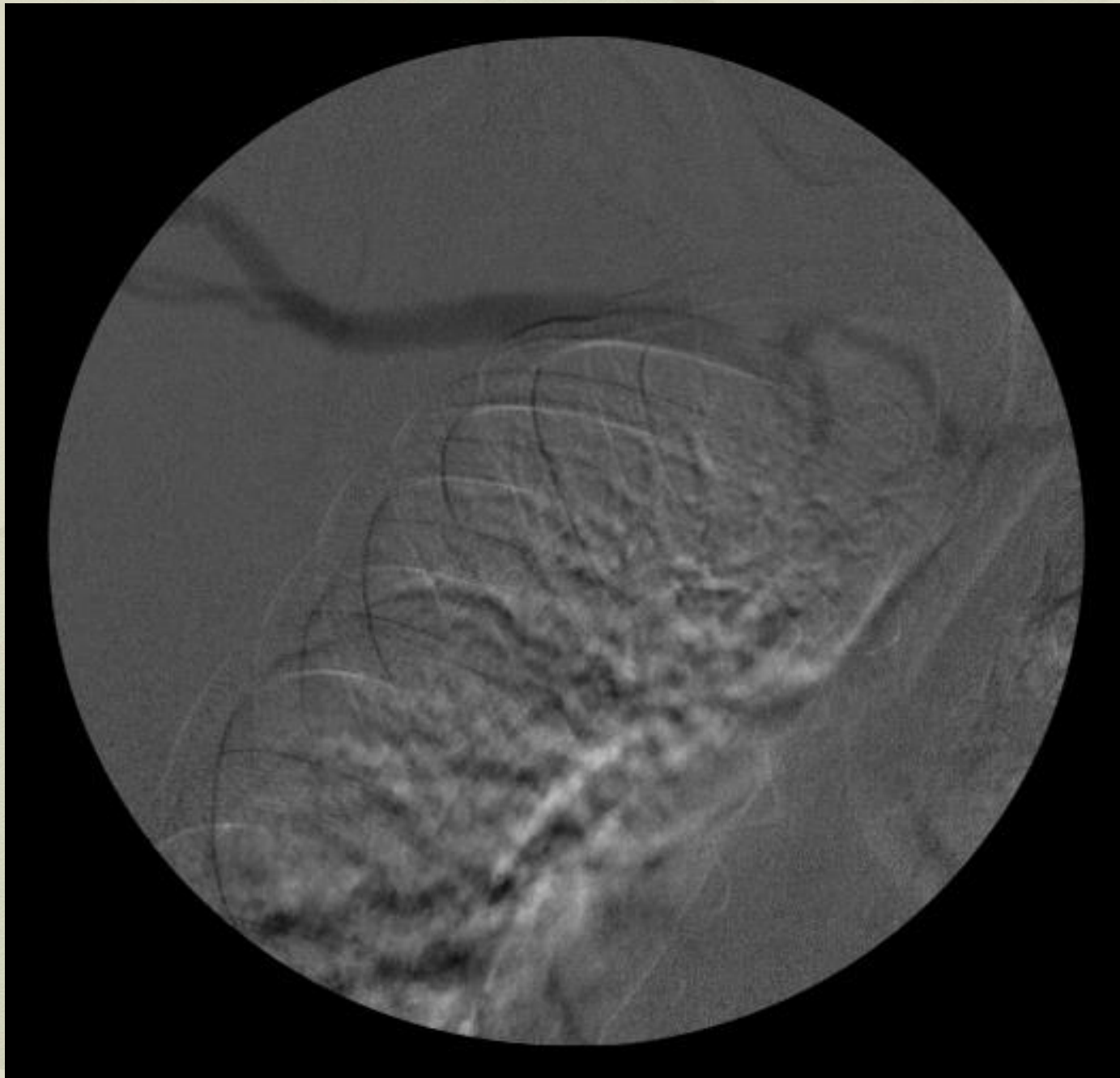


1024x1024
Zoom: 89 %
Compression: 4:1
W: 65534 L: 32766

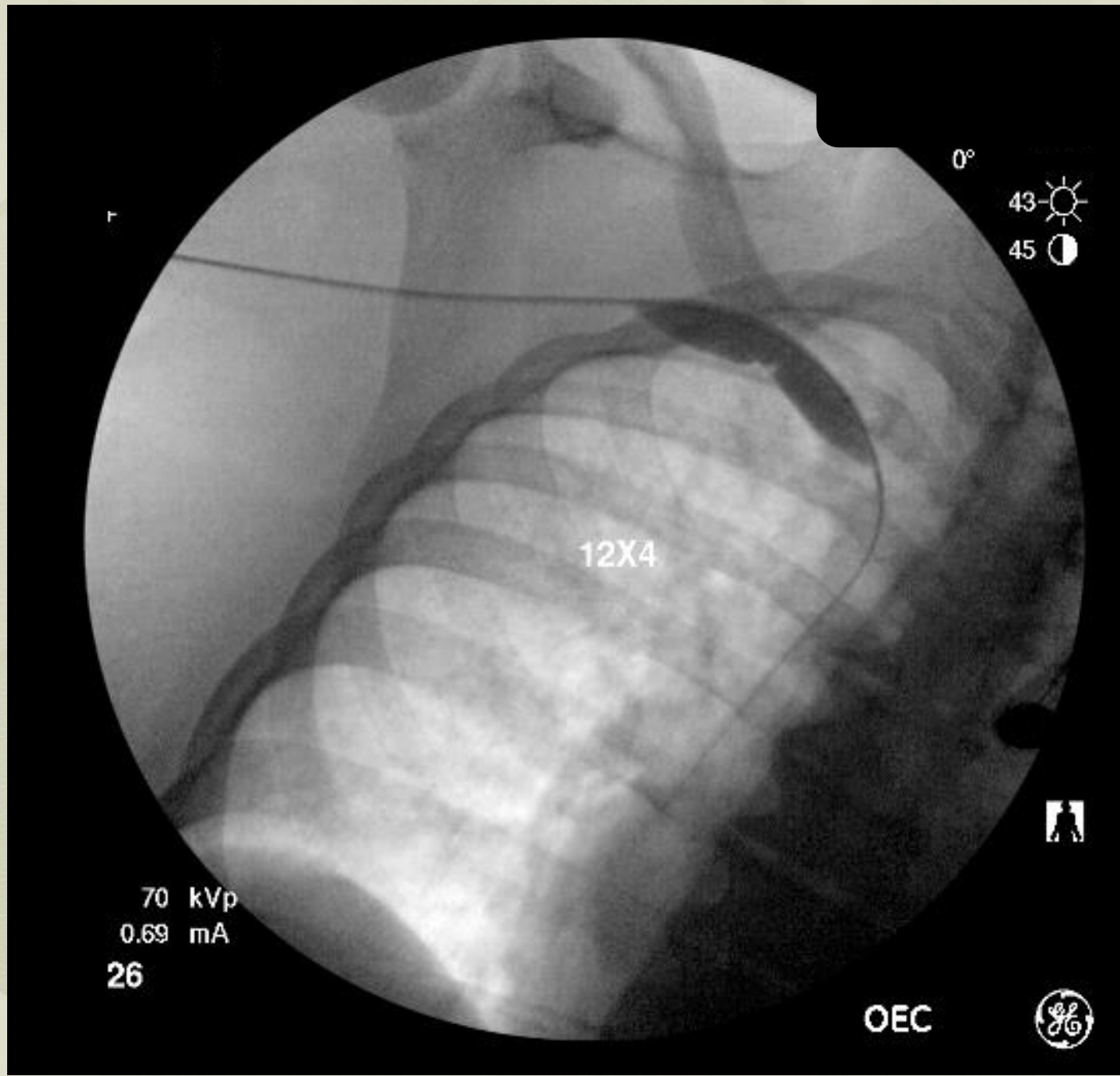








NCVH 2018



r

0°

43 ☀

45 🌙

12X4

70 kVp

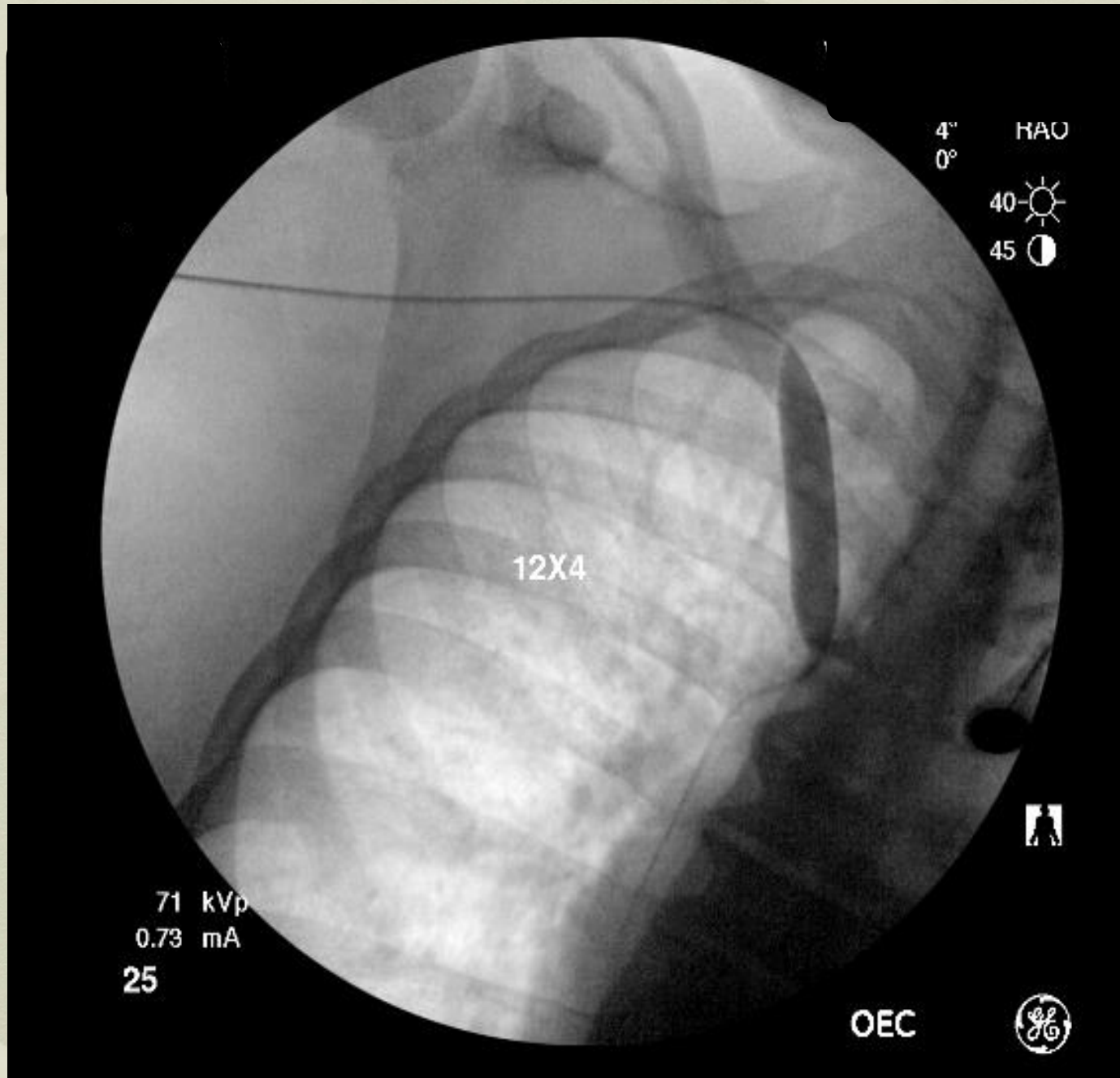
0.69 mA

26

OEC



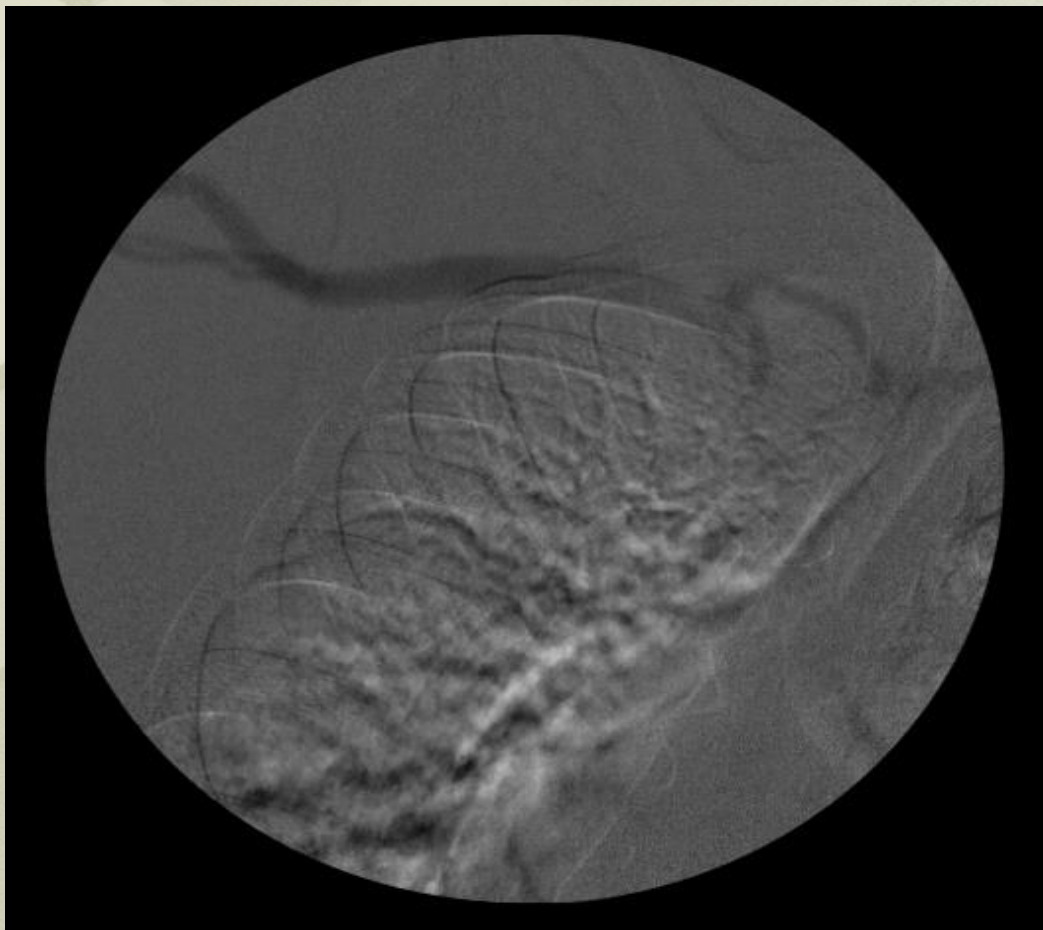
NCVH 2018





NCVH 2018

Pre



Post



66 year old female s/p transplant with painful ringing
in left ear and a left arm fistula



1024x1024
Zoom: 89 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



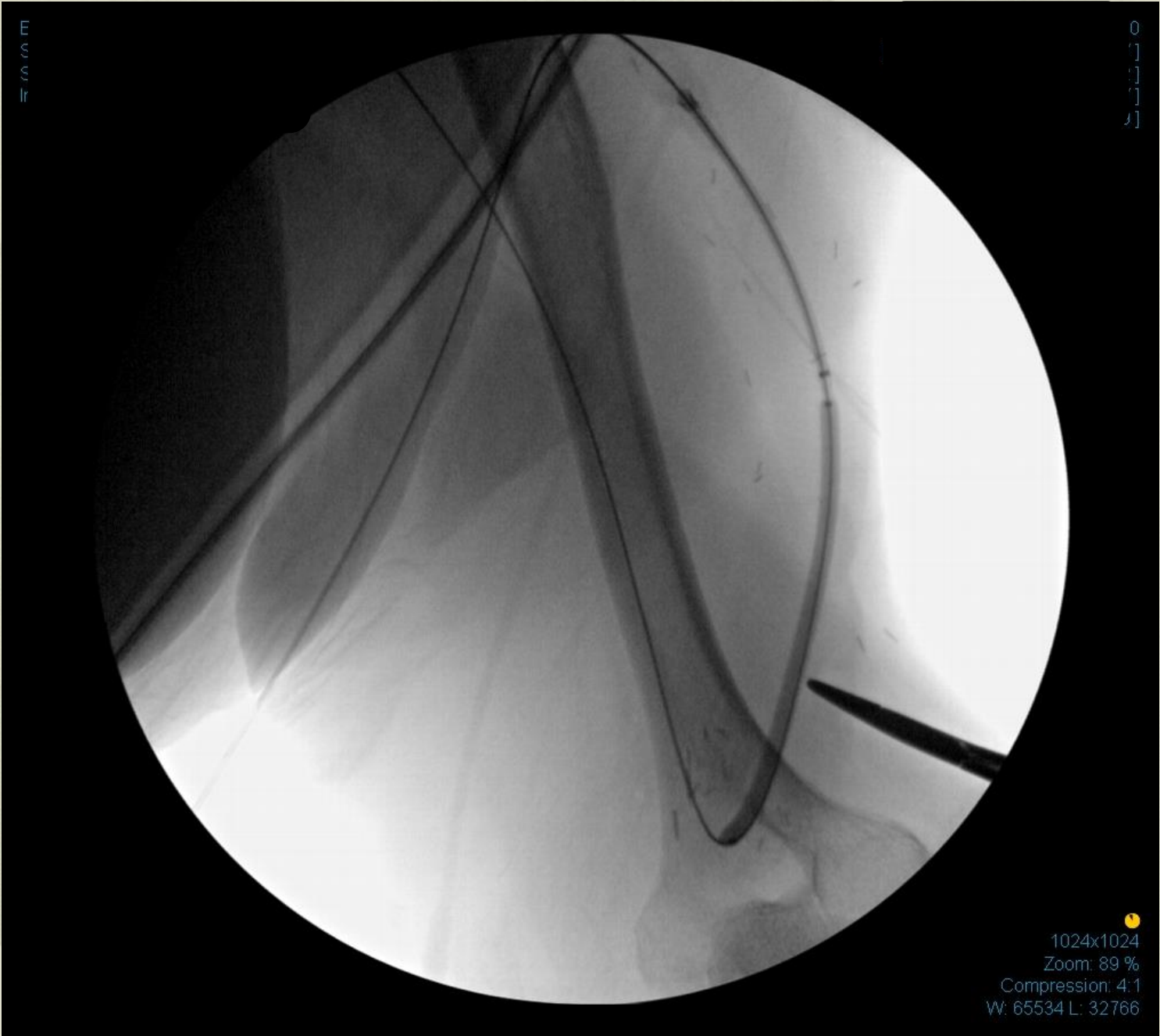
1024x1024
Zoom: 89 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



00
Y]
2]
Y]
[26 / 49]

1024x1024
Zoom: 89 %
Compression: 4:1
W: 65534 L: 32766



11 3 3 3 3 3

0 0 0 0 0 0

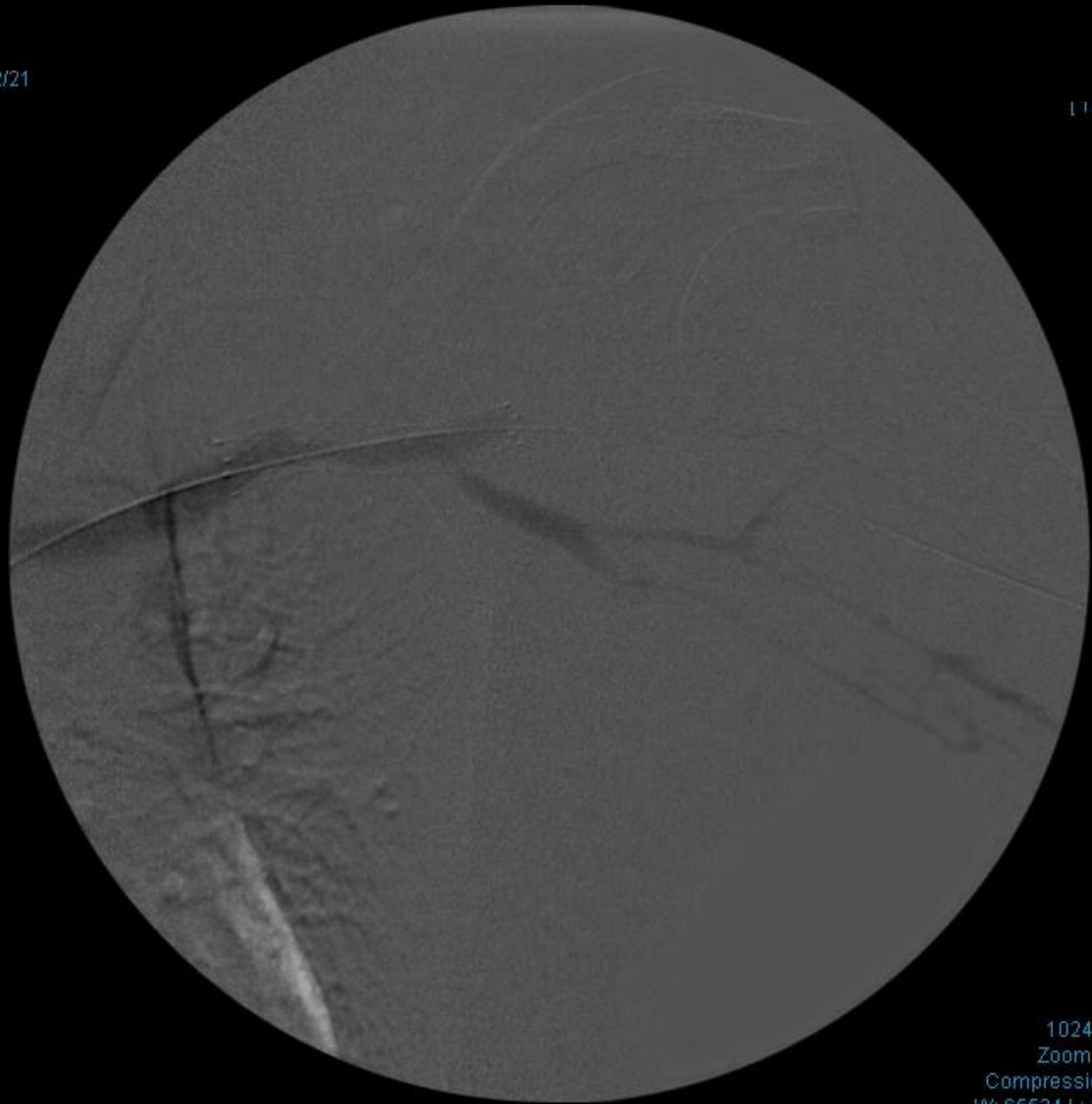
NCVH 2018

42 year old male s/p Renal Transplant with left
arm swelling



Im: 12/21

[1228]



1024x1024
Zoom: 86 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



00
L]
8]
Y]
1.0008]

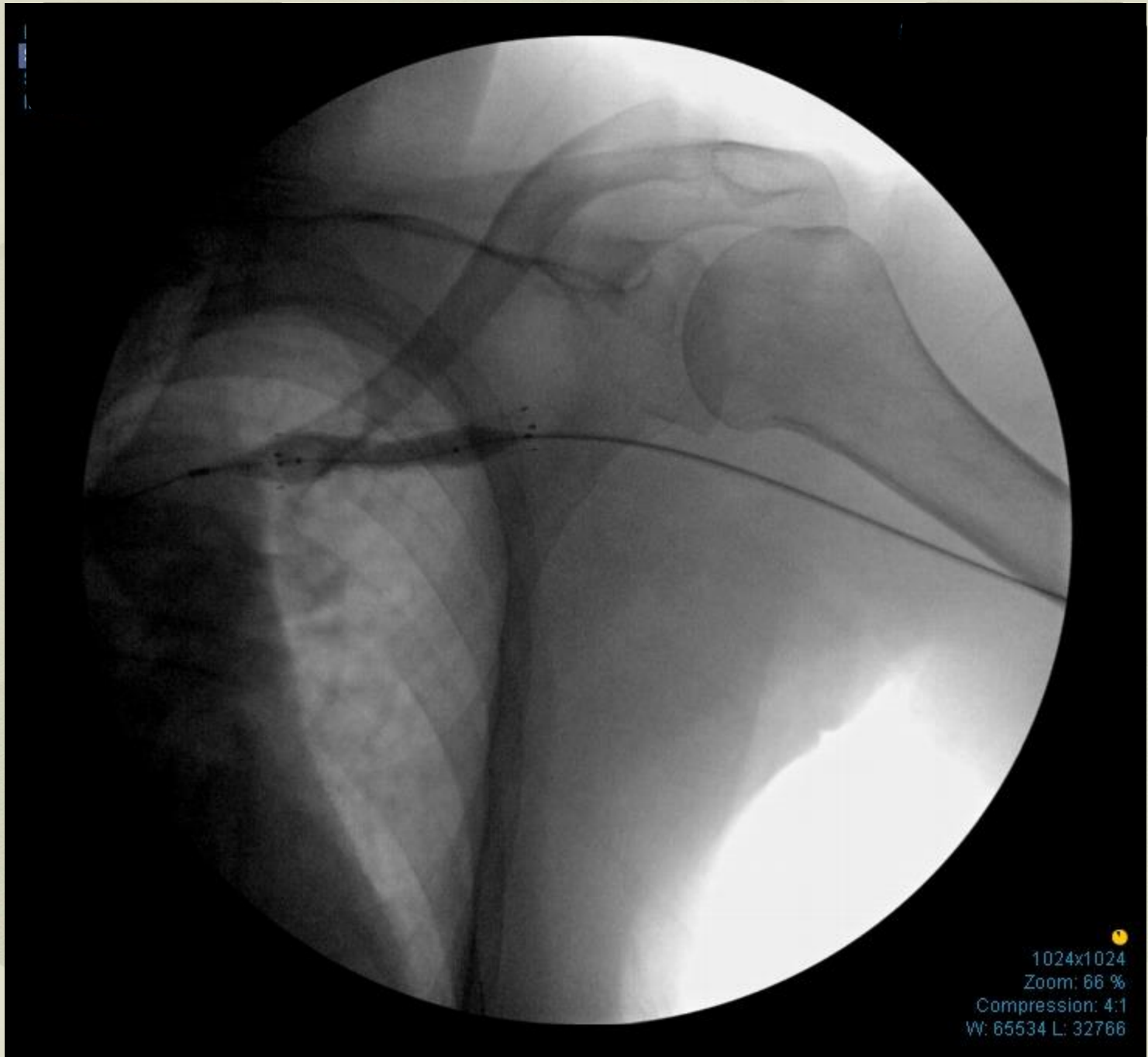
1024x1024
Zoom: 66 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



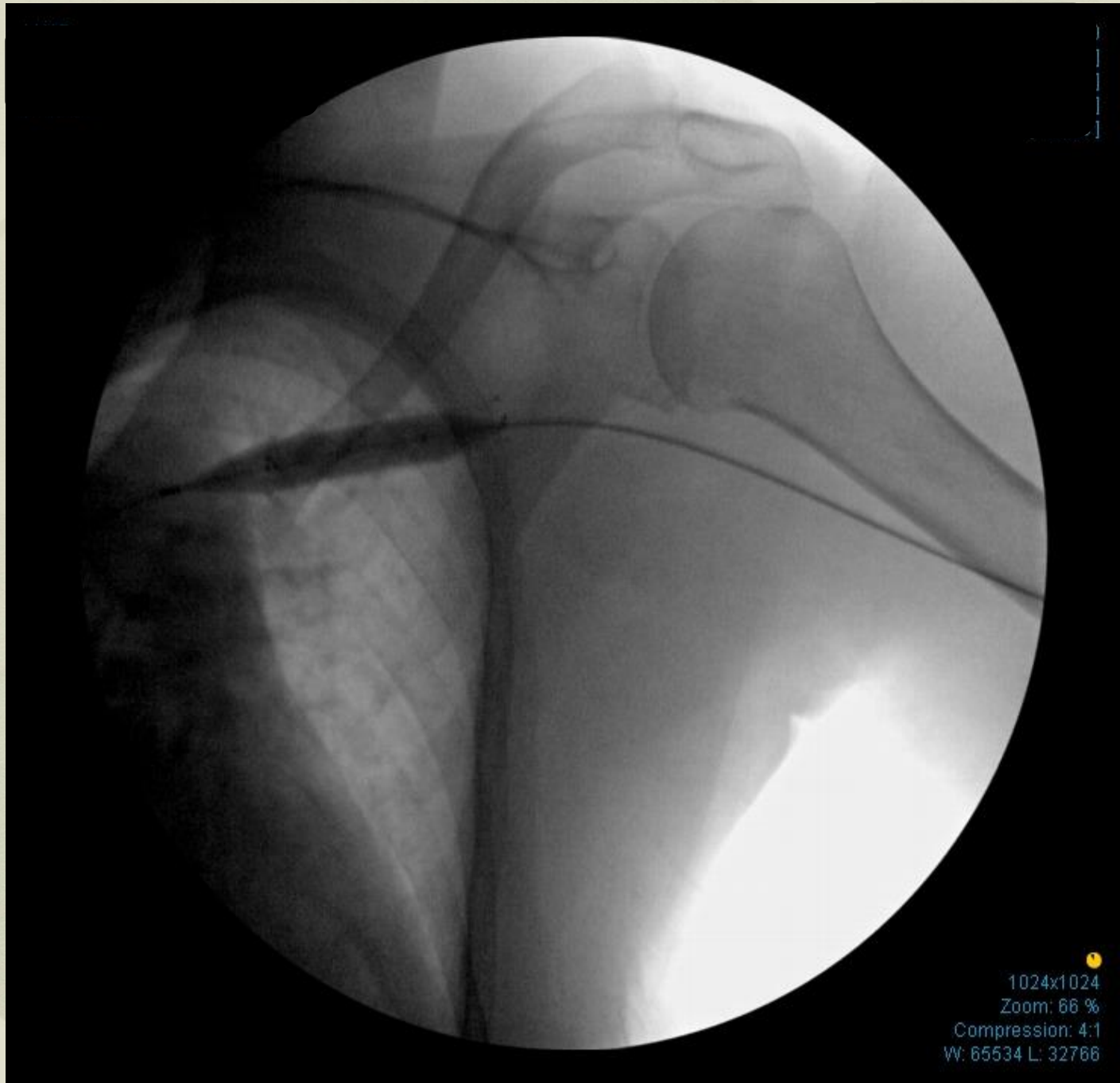
1024x1024
Zoom: 66 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



1024x1024
Zoom: 66 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



1024x1024
Zoom: 66 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



1024x1024
Zoom: 66 %
Compression: 4:1
W: 65534 L: 32766

NCVH 2018



NCVH 2018



1024x1024
Zoom: 66 %
Compression: 4:1
W: 65534 L: 32766





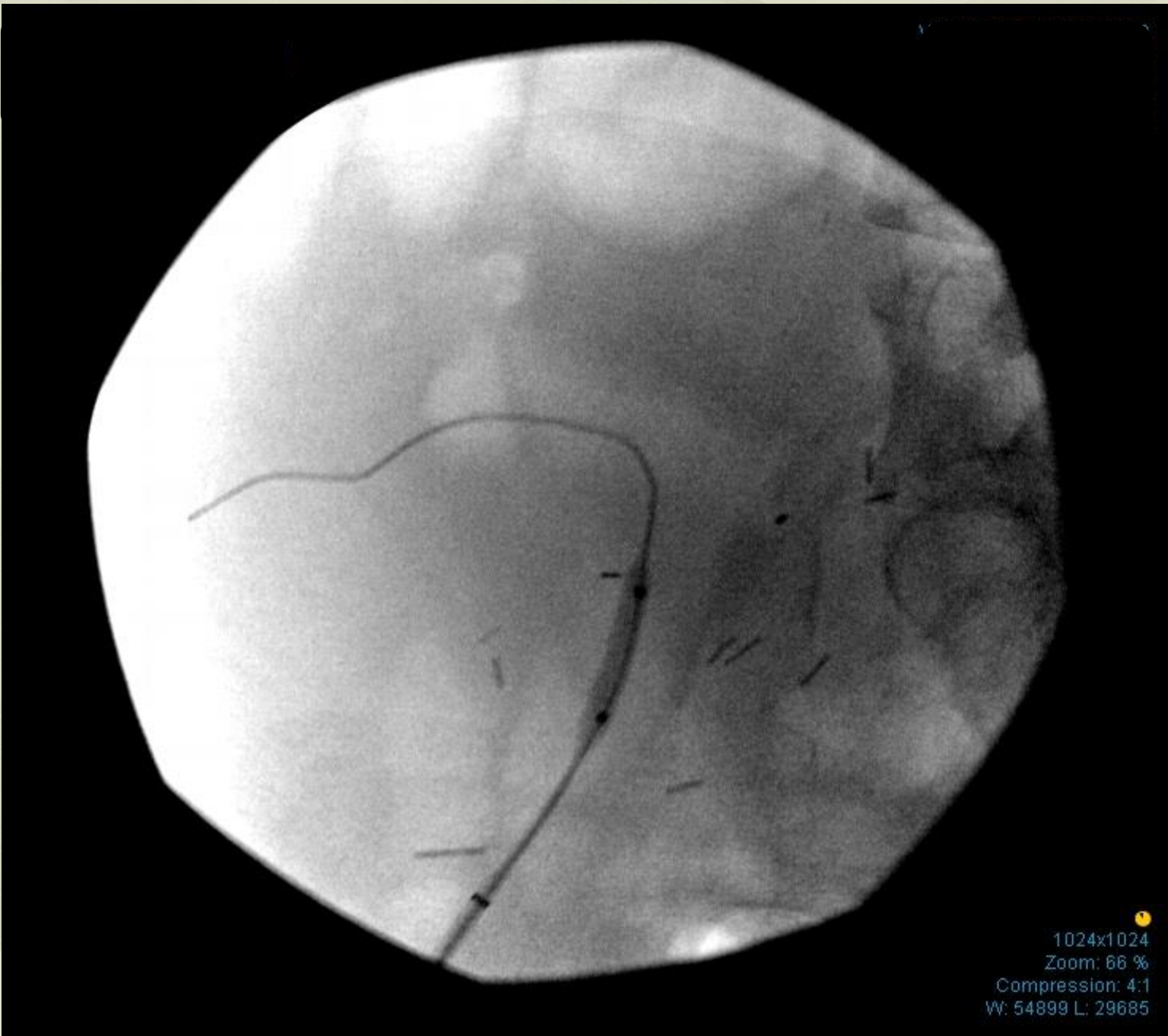


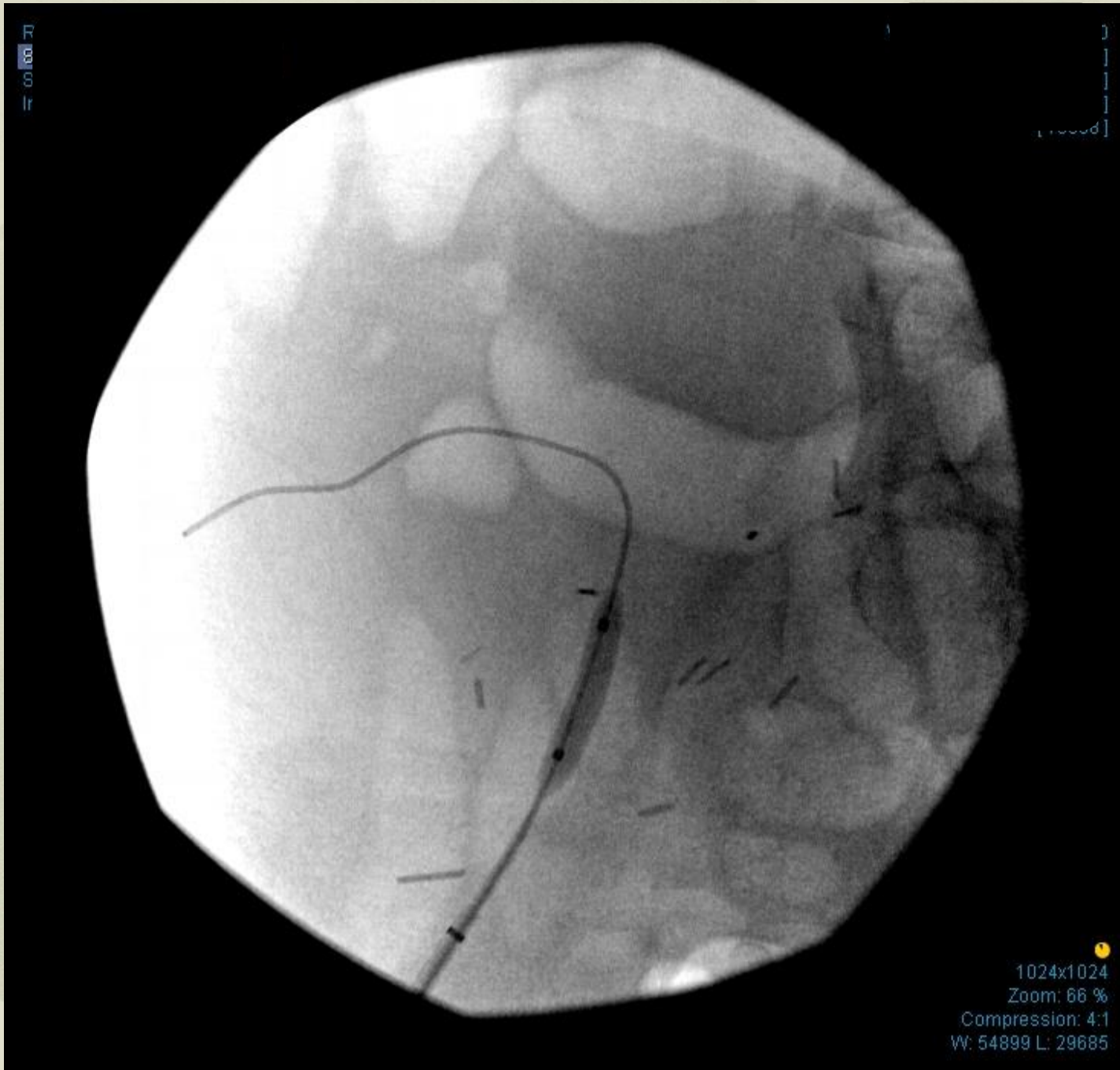
NCVH 2018



1024x1024
Zoom: 66 %
Compression: 4:1
W: 54899 L: 29685

NCVH 2018





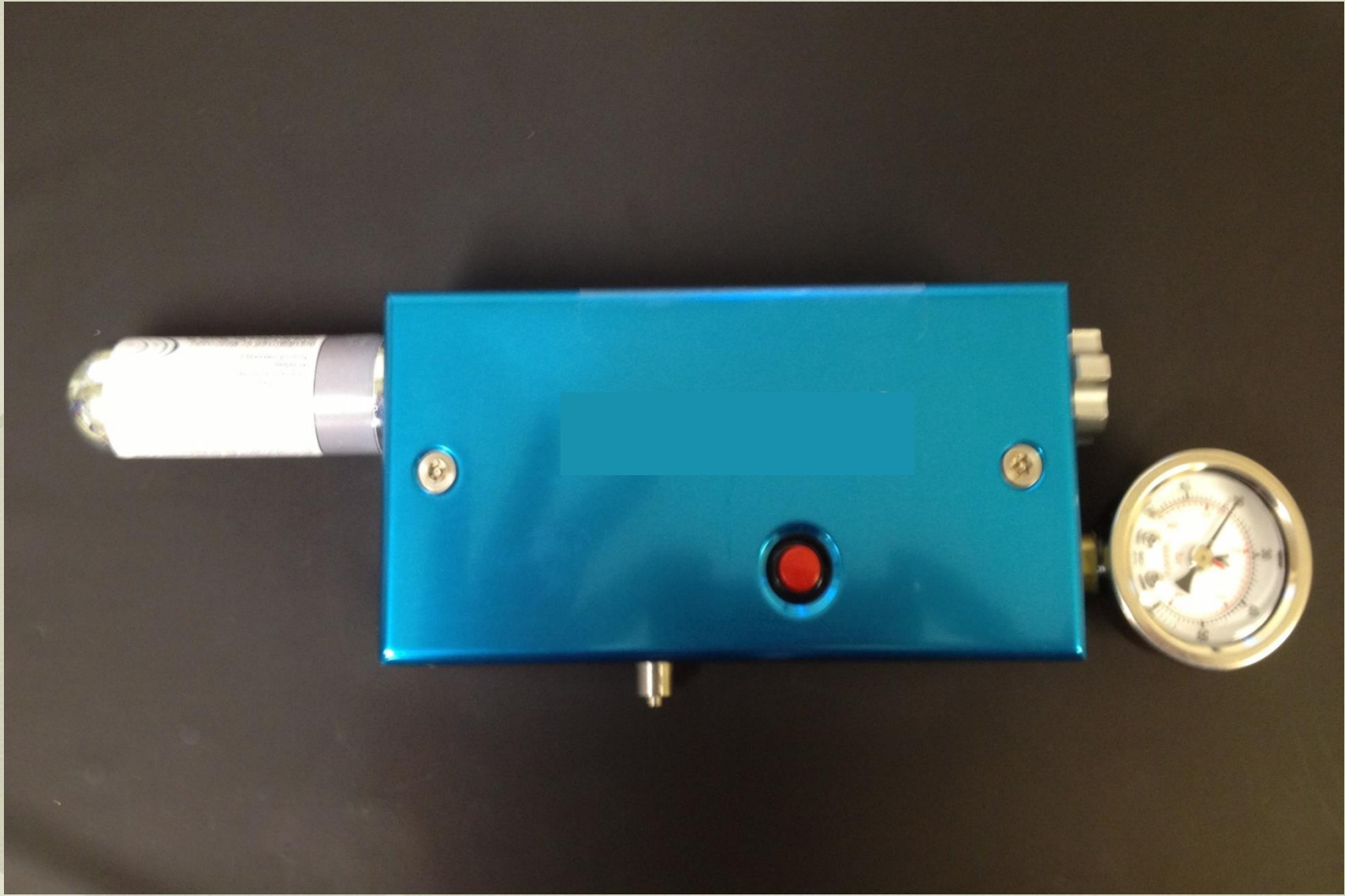
Im: 11/33

0
1
1
1
1



1024x1024
Zoom: 66 %
Compression: 4:1
W: 54899 L: 29685

NCVH 2018





Technique Matters

- Patient positioning
- Breath holding
- Motion
- Bowel gas
- Injection rate





NCVH 2018



Comprehensive Strategy

Combine Carbon Dioxide with IVUS

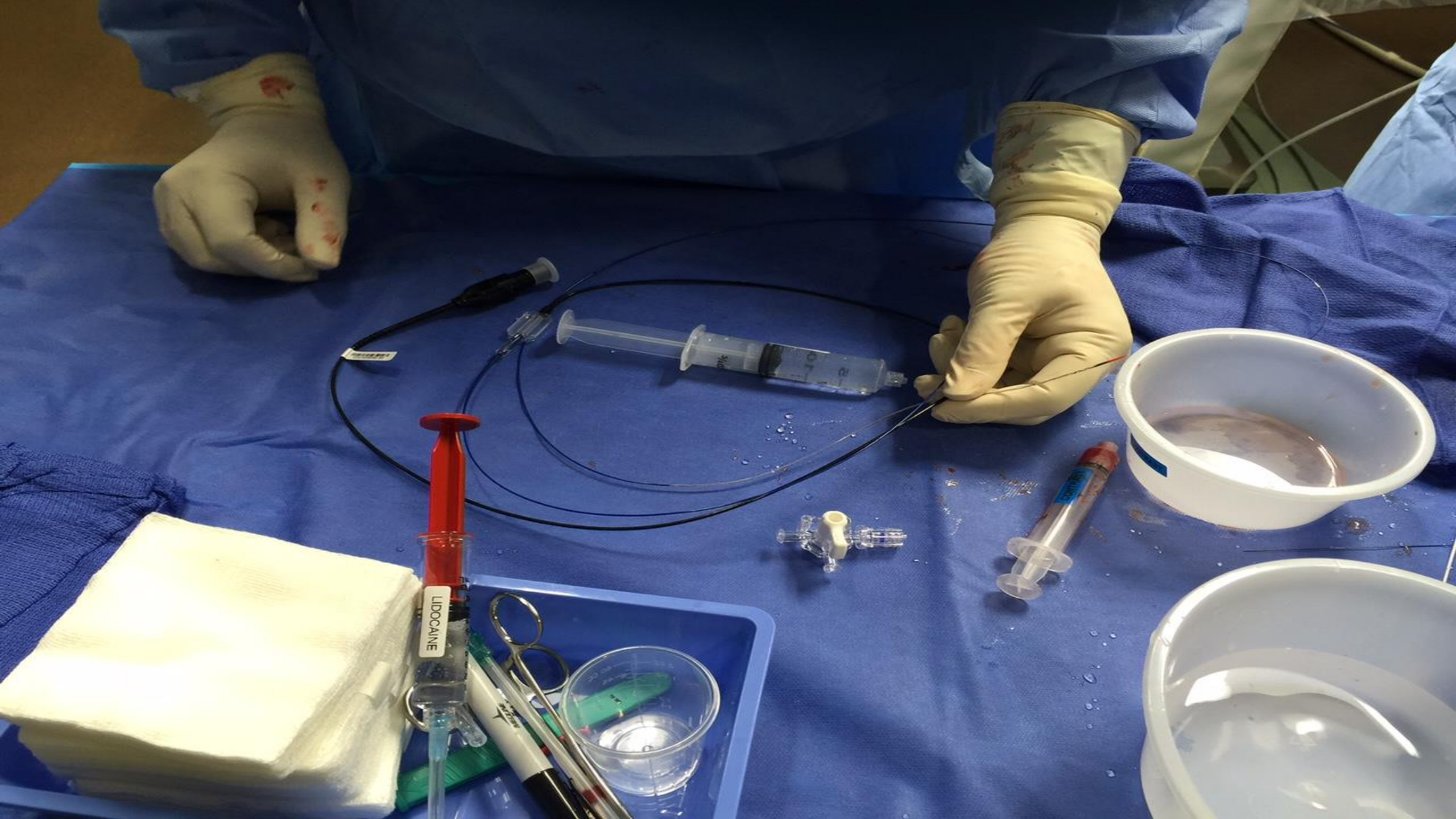
Intra Vascular Ultra Sound IVUS



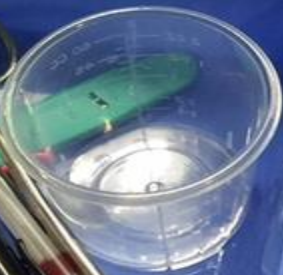


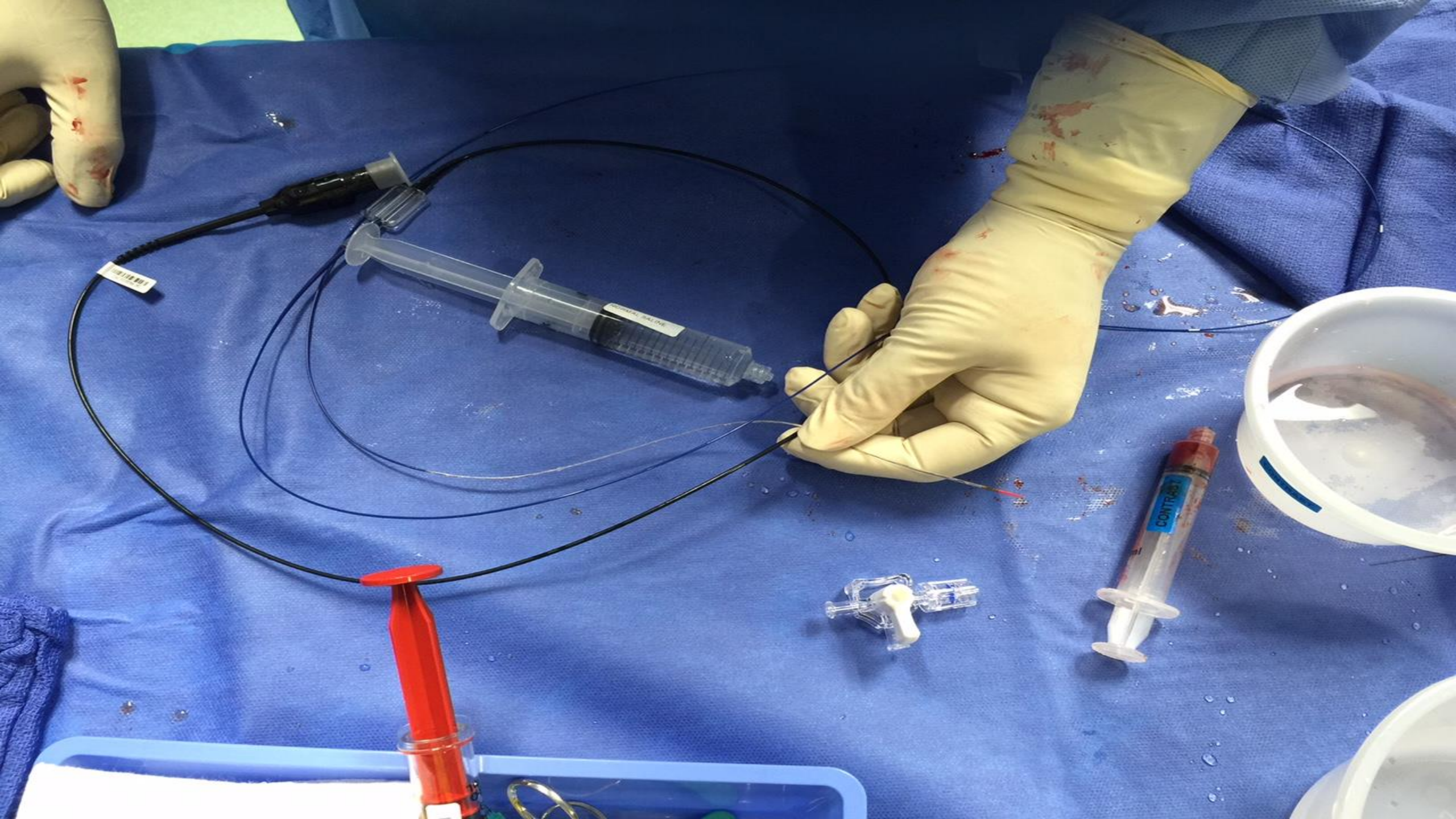


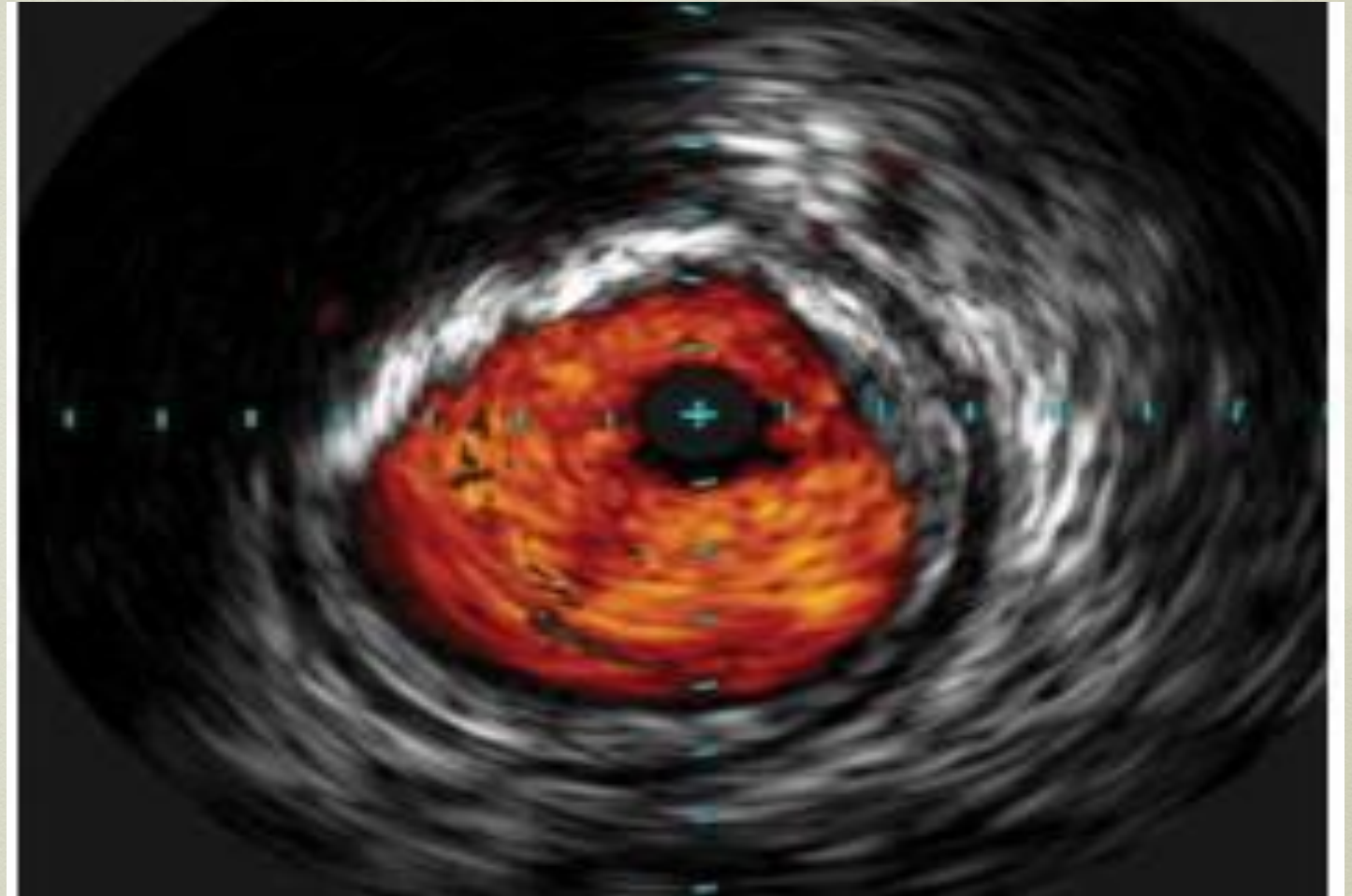




LIDOCAINE







Manage Expectations

- Approach as a LOW contrast study rather than a NO contrast study
- Pain resolves.
- Final Rule
 - When you see nothing, its usually because there is nothing there.

Helpful Technical Tips – Making a Road Map (GE OEC Imaging Platform)

Step 1: Perform standard subtracted run.

Step 2: Select Un-subtracted mode on the user interface

Step 3: Select best single image in un-subtracted mode

Step 4: Select on interface “Save Mask”

Step 5: Select on interface “Use Mask”

Step 6: step on pedal

Questions on CO2

Cell Phone: 917-716-1567

Thank you

CO₂ Digital Subtraction Angiography in Dialysis: Do's and Don'ts

Daniel Simon, MD

Chief Medical Officer
Vascular Management Associates
New Brunswick NJ

Director Peripheral Interventions
Maryland Cardiology Associates
Greenbelt Maryland



19th Annual Conference

2018

May 30 - June 01

THE PERIPHERAL EVENT OF THE YEAR

