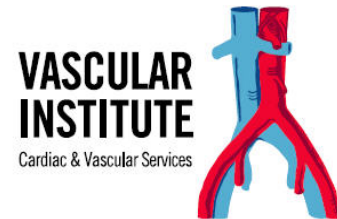


Optimal Imaging During Deep Venous Interventions

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Disclosure

- The opinions and clinical experiences presented herein are for informational purposes only. Individual results may vary depending on a variety of patient-specific attributes and related factors.
- Dr. Razavi has been compensated by Philips Volcano for her services in preparing and presenting this material for Philips Volcano's further use and distribution.

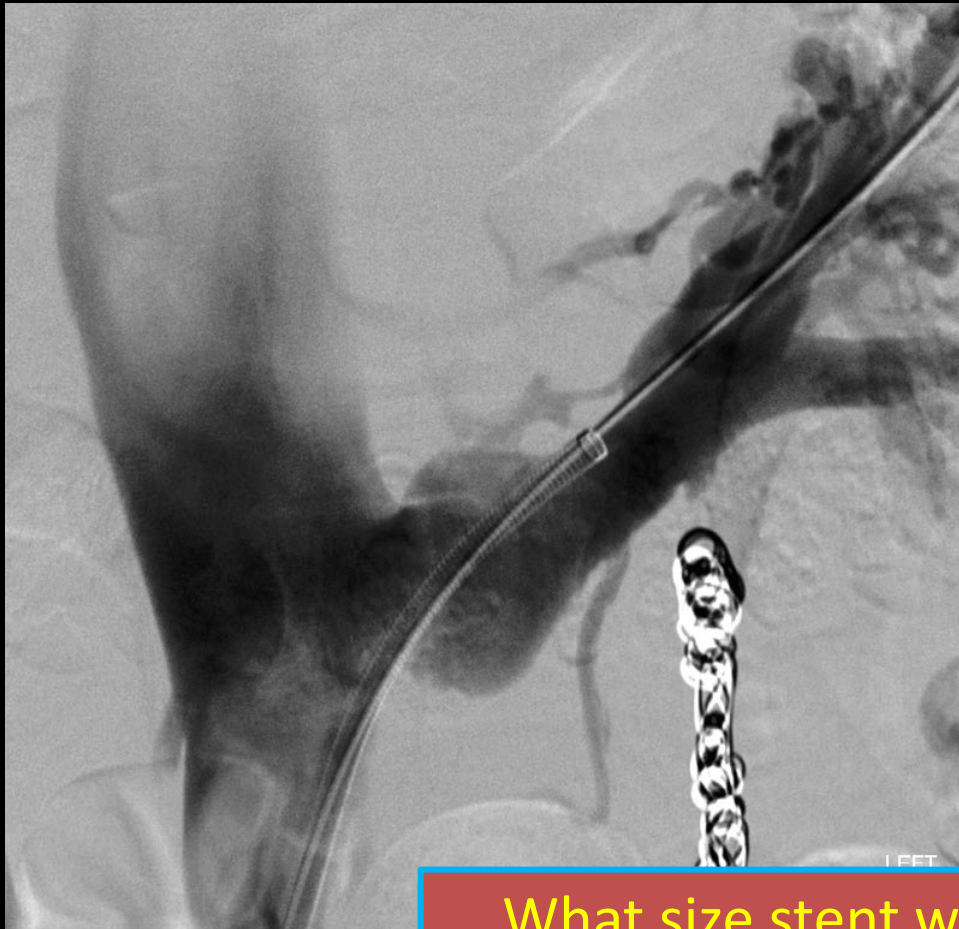
Interventional Imaging Modalities

- Standard contrast venography
- Dyna-CT
- Real-time Duplex imaging
- IVUS

IVUS in Deep Venous Interventions

- How many routinely use IVUS in deep venous interventions?
- Determination or confirmation of disease or stenosis?
- Differentiation of disease (acute v. chronic clot v. compression etc)?
- Diameter measurements?
- Because someone said it is helpful?
- Just to see what you can learn?

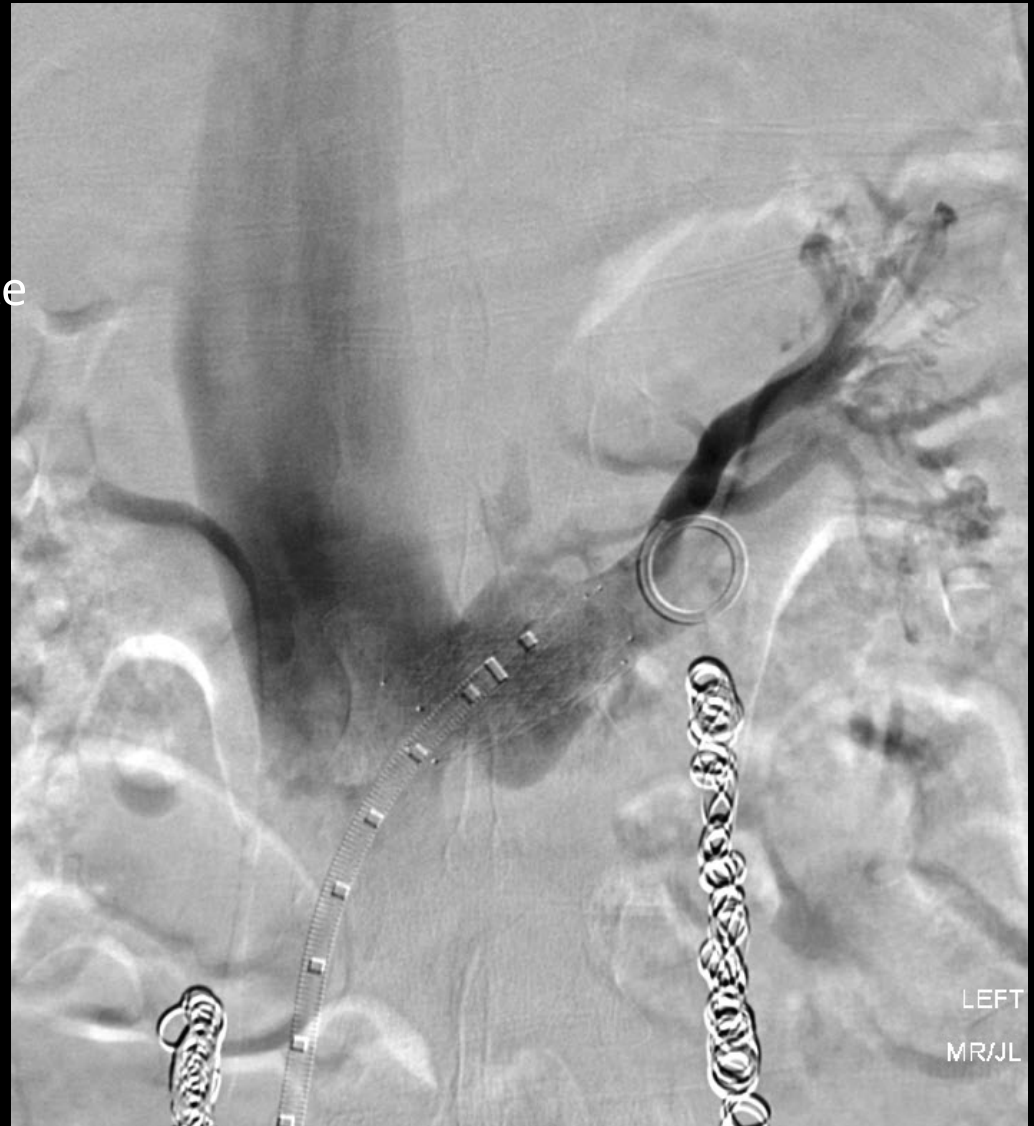
- 38 YO female with painful pelvic variceal syndrome who is s/p embo X 2 with recurrence.
- L renal vein compression (nutcracker syndrome)

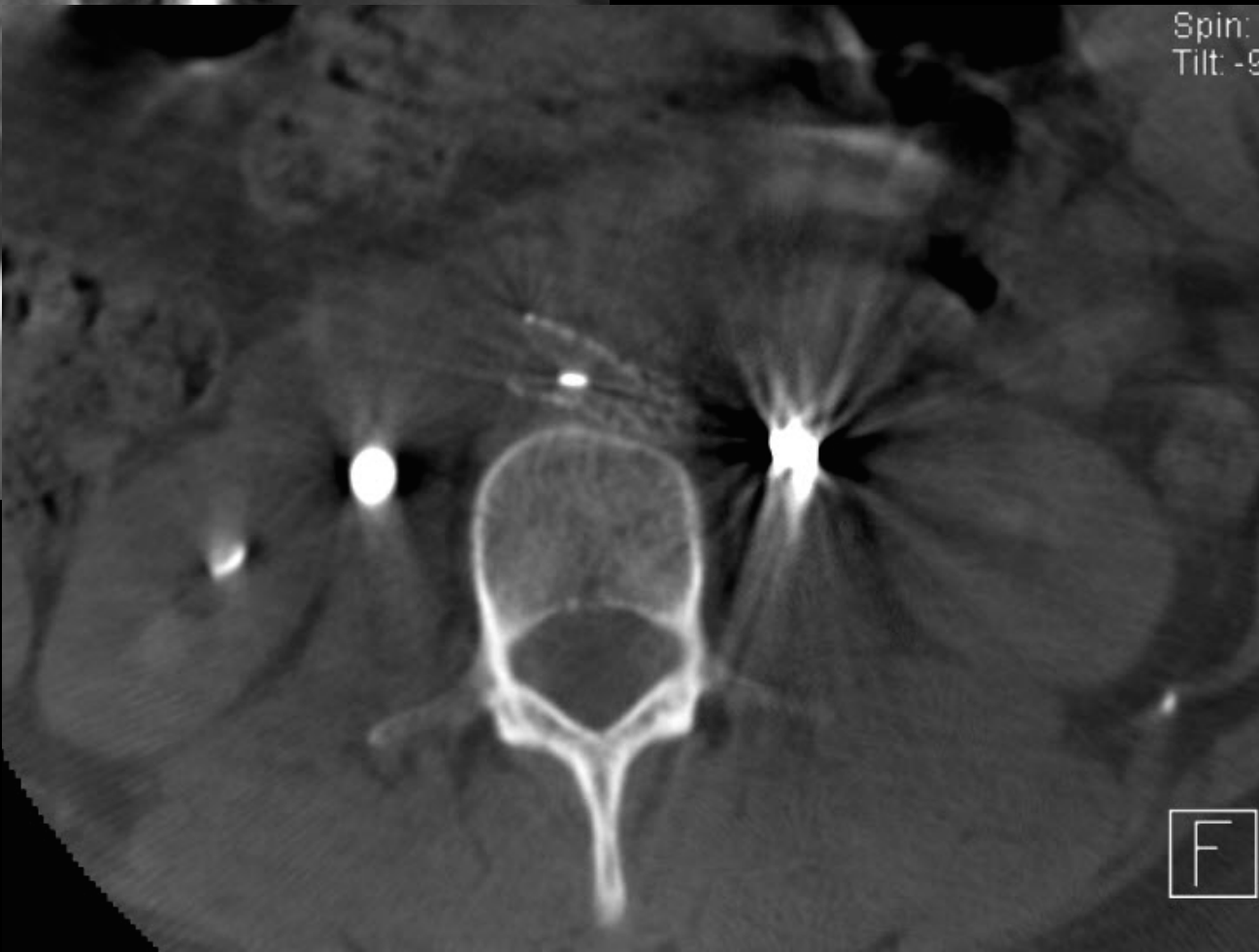
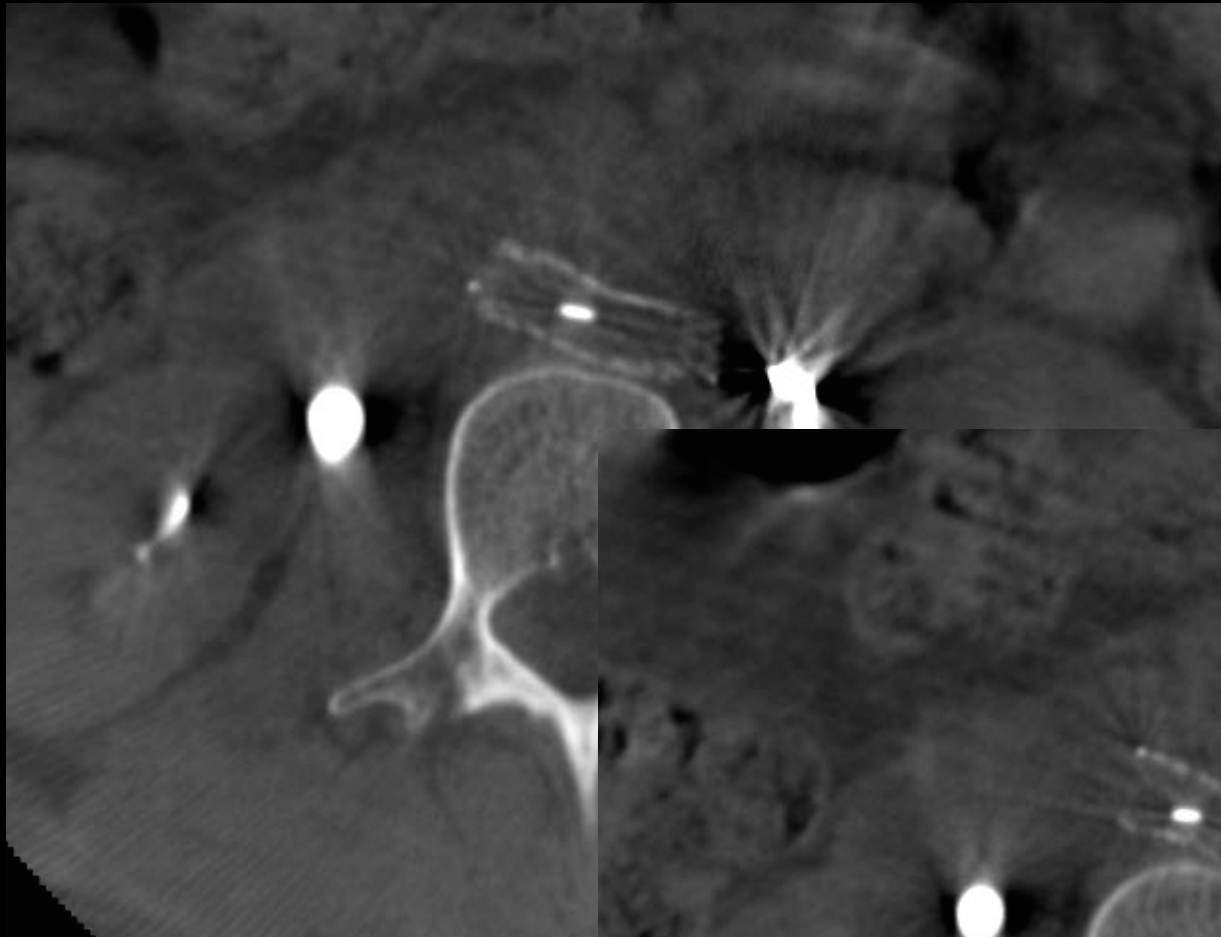


What size stent would you use?
How do you measure the diameter?



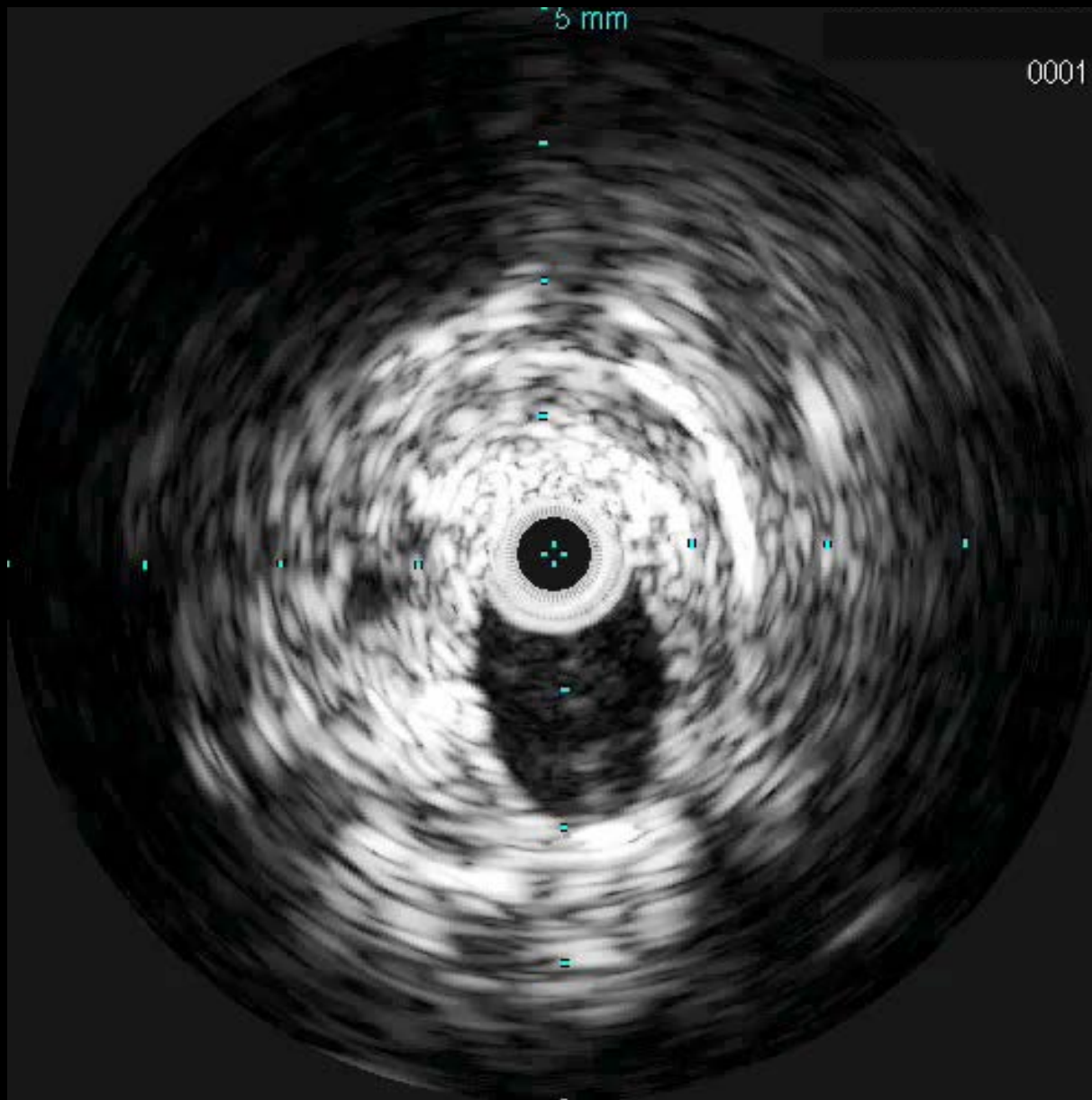
- Limited options for stent type & size
- Is the stent geometry OK
- Does it look like it is not attached to the vessel wall?
- How do we confirm?





Spin:
Tilt: -9

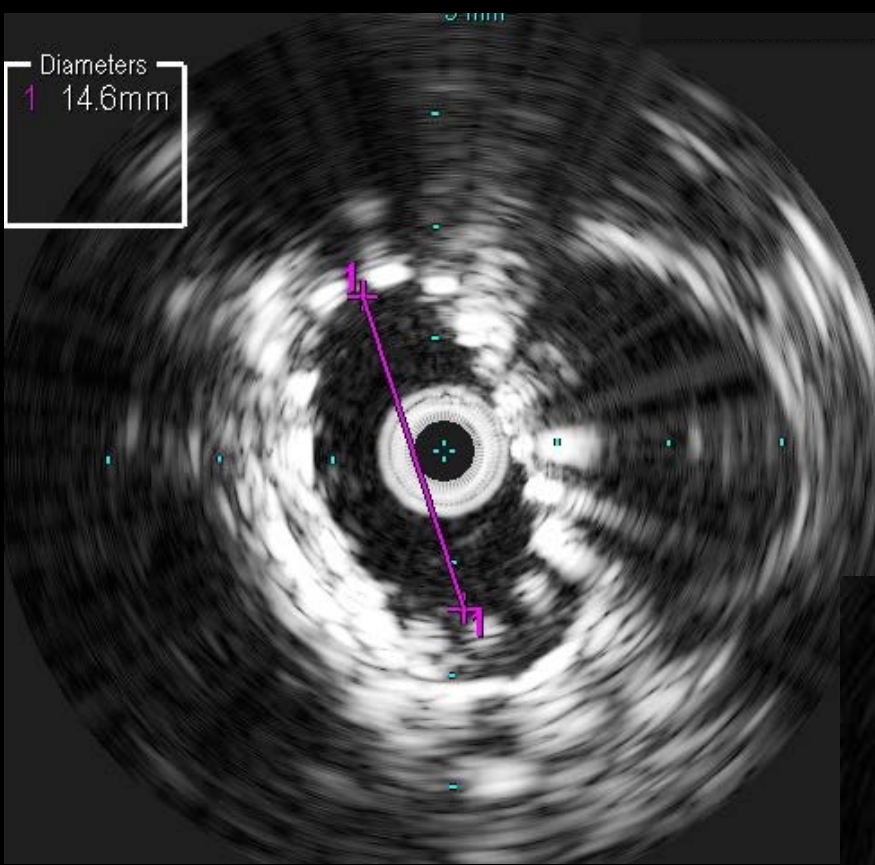
F



5 mm

0001

Diameters
1 14.6mm

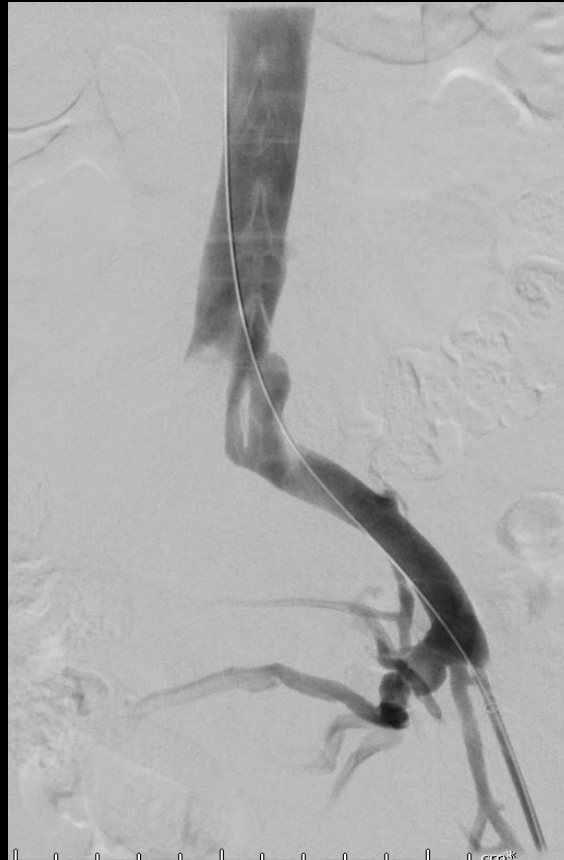


Spin: -90
Tilt: 0

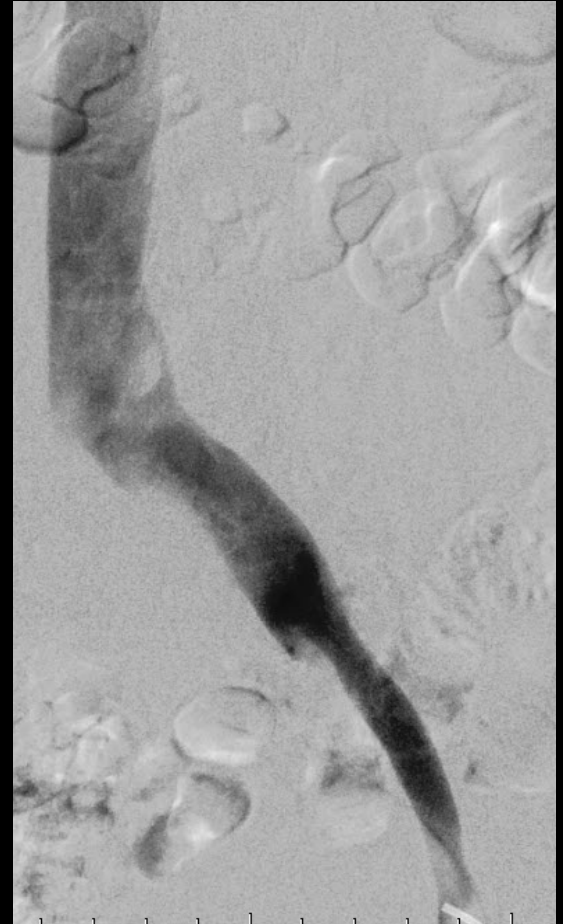
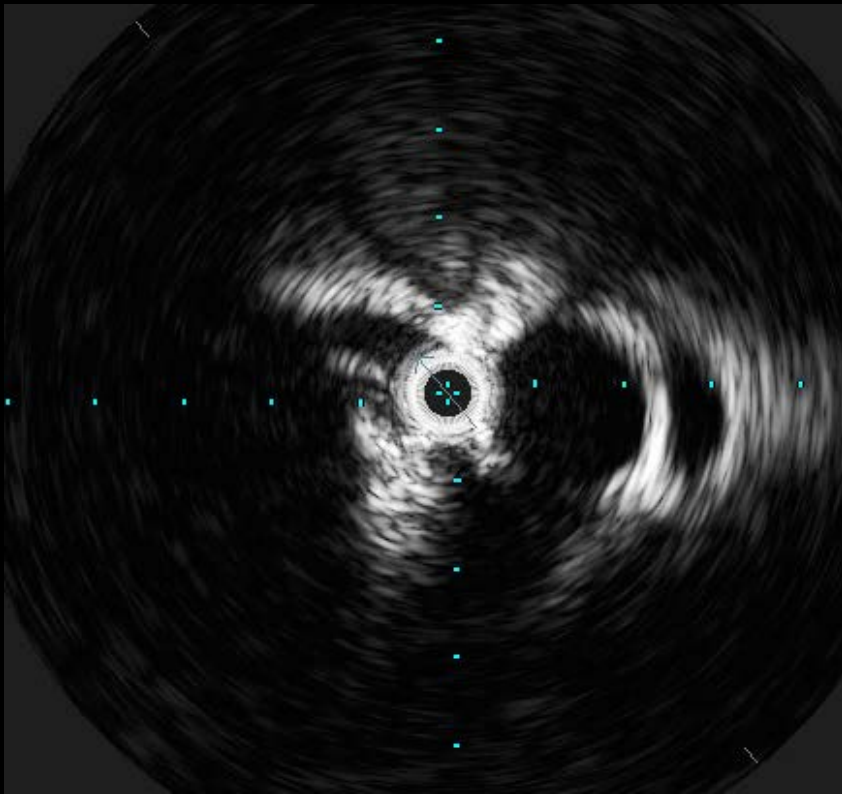


Venography & Venous Obstruction

When do we need more information?



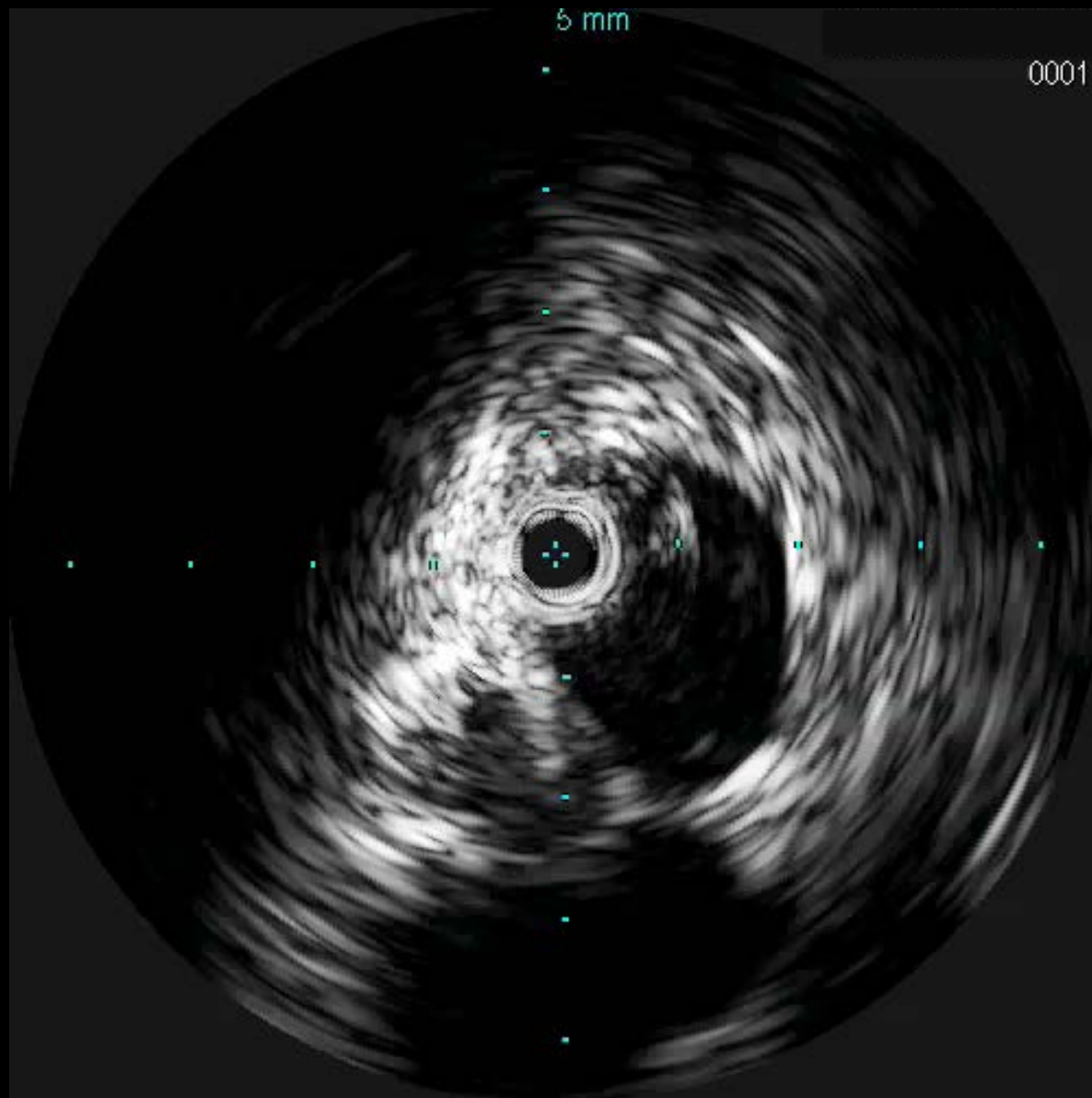
IVUS Image



Venogram in a 71 YO female one day
s/p CDT of LLE for acute iliofem DVT

Is there iliac vein compression??



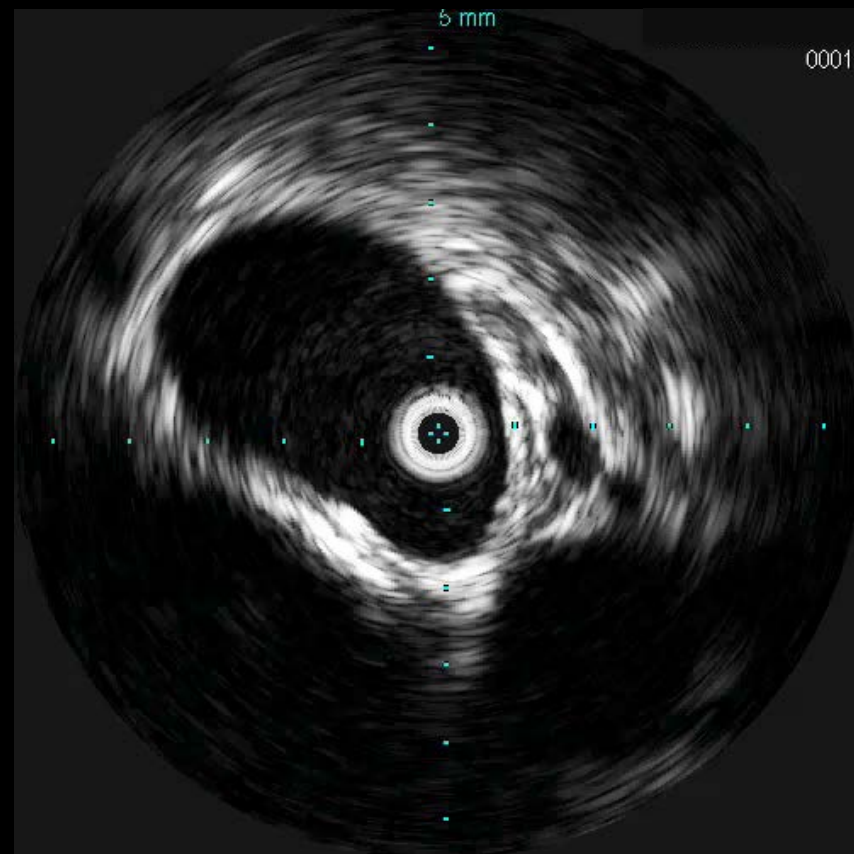


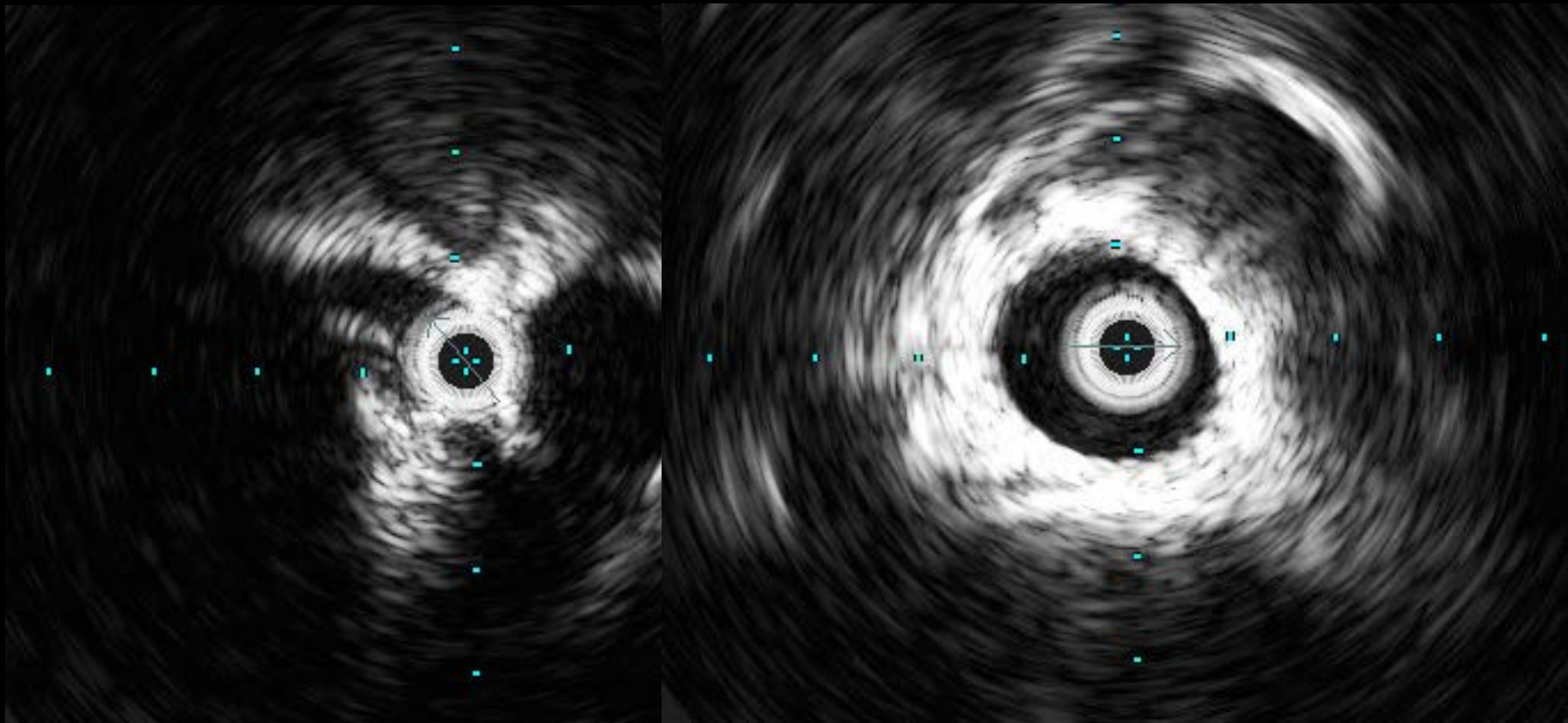
- 33 YO female with LLE edema & pain of 8 months duration
- No sig PMH
- US showed deep reflux in fem & pop veins

Do we need an IVUS for this?









IVUS Literature in Deep Venous Interventions

- Utility of IVUS evaluated in 16 pts with iliofem obstructive lesions
- Diagnostic adjunct to venography & intervention
- IVUS confirmed etiology in all 16 pts
- IVUS influenced intervention in 8/16 pts
 - Dx of acute clot in 2 pts (additional lysis)
 - Additional stents in 2 pts (correcting inflow problems)
 - Incomplete stent expansion & additional PTA in 2 pts
 - Adjustment in size of PTA balloon in 2 pts

Forauer A et al JVIR 2002;13

IVUS Literature in Deep Venous Interventions

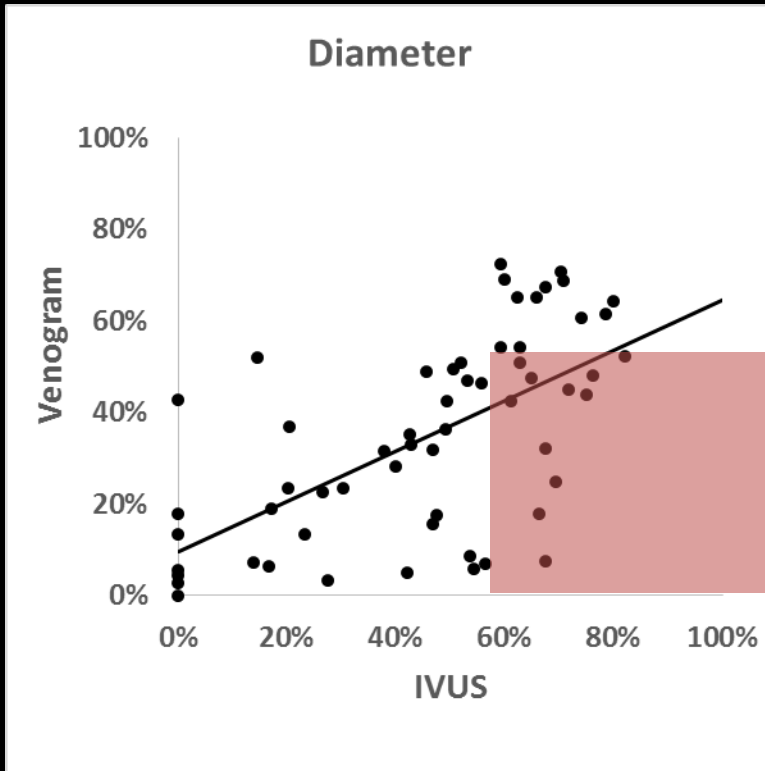
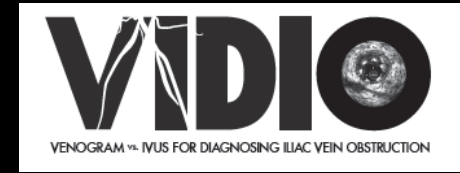
- Compared 2 diff PMT devices in acute DVT using IVUS & venography
- IVUS more accurate than venography in:
 - determining the volume of clot lysis & presence of residual clot
 - Dx of residual dz requiring ancillary interventions
- Conclusion: “IVUS is superior to venography for detection of residual thrombus and underlying venous pathology after PMT”

Murphy EH et al. JEVT 2010;17

IVUS Literature in Deep Venous Interventions

- Literature is scant in deep venous interventions, mostly suggesting improved detection of obstructive lesions as compared to venography
- No rigorous comparative or correlative studies with other imaging, but
- VIRTUS trial will provide the most comprehensive analysis of the role of IVUS & comparison to both venography & Duplex US before & after stenting and at follow up.

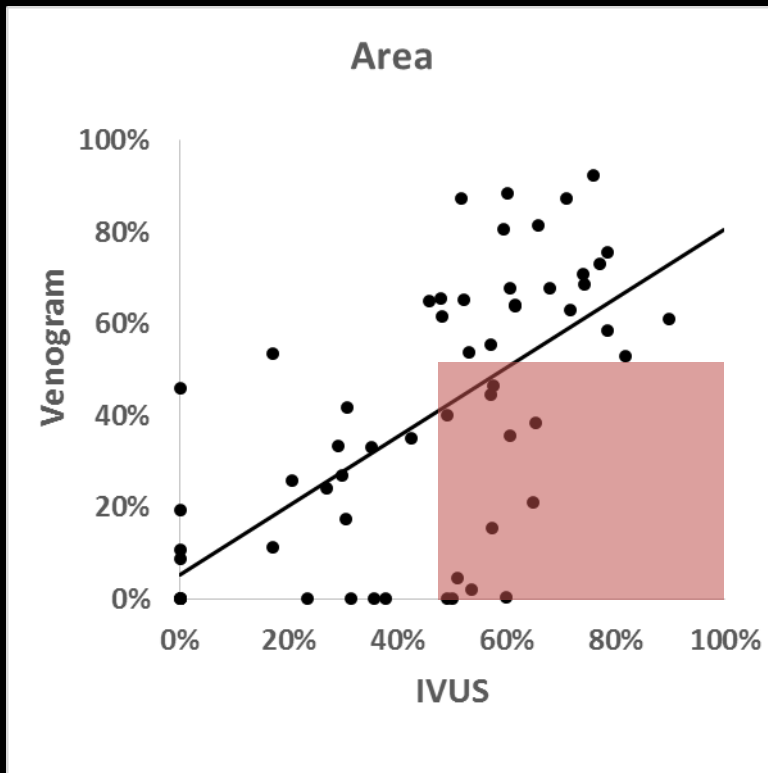
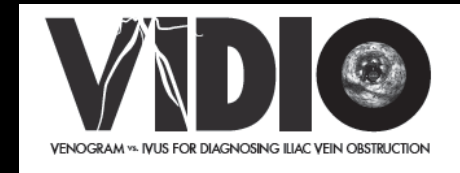
IVUS vs. Venogram: Diameter (Core Laboratory)



- Multiplanar Venography underestimates the degree of diameter stenosis compared to IVUS.
- Venogram missed 26% of >50% diameter-reduction lesions
- IVUS determined stenoses, in general, were 10.9% more severe (mean) than by Venogram (**P < .001**)

<https://clinicaltrials.gov/ct2/show/NCT02142062> Venogram vs. Intravascular Ultrasound (IVUS) for Diagnosing Iliac Vein Obstruction (VIDIO) case details, images, and footage courtesy of Carl Fastabend, MD. Dr. Fastabend is an investigator of VIDIO, a Philips Volcano sponsored study. Results from this case study are not predictive of future results. Data on file at Philips Volcano clinical affairs department. © 2016 Optum, Inc. All rights reserved.

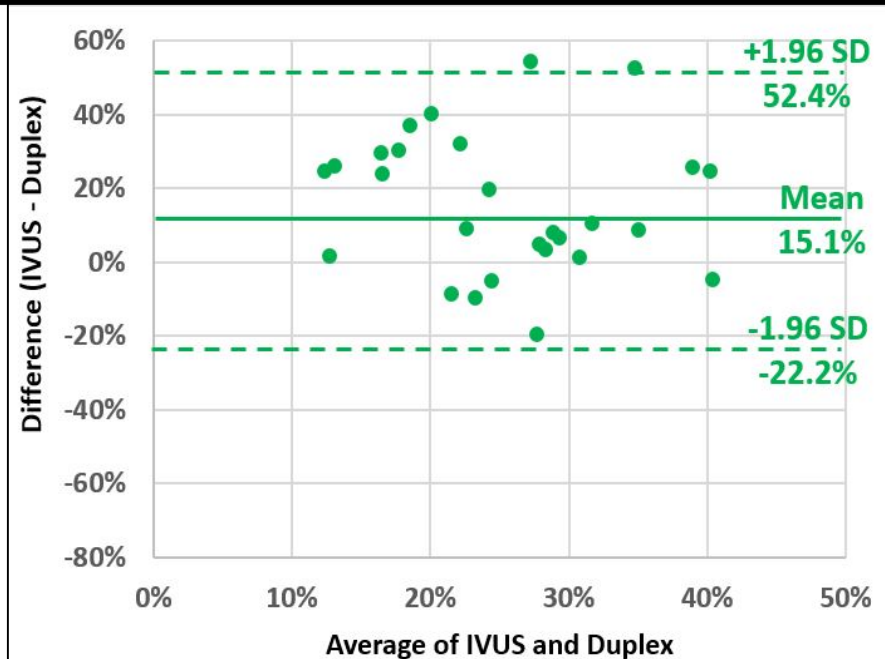
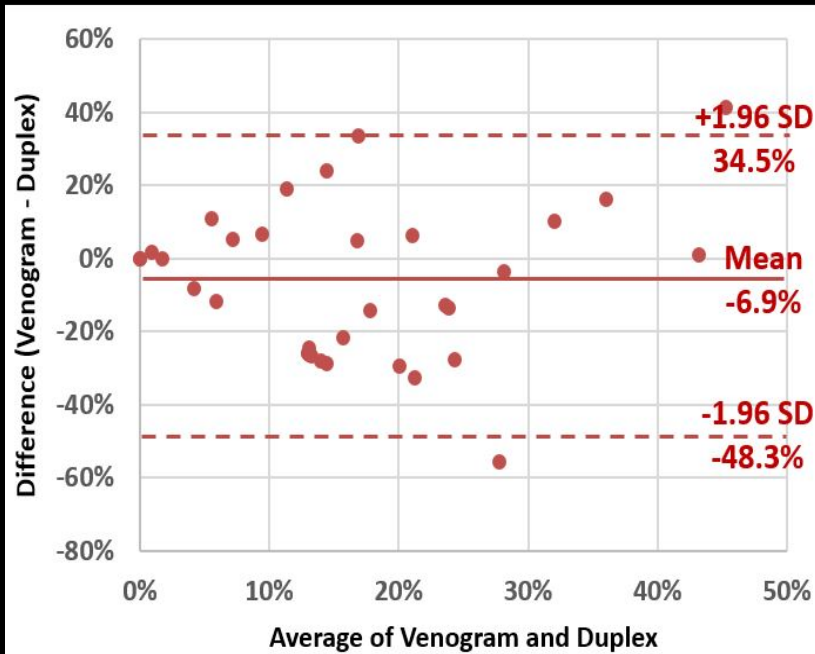
IVUS vs. Venogram: Area (Core Laboratory)



- Multiplanar venography allows a relatively accurate assessment of area reduction / stenosis when compared to IVUS.
- However, 3 view venograms missed 17.7% of significant CSA lesions (defined by >50% area reduction).

Feasibility Arm of the VIRTUS Trial:

First of its kind analysis

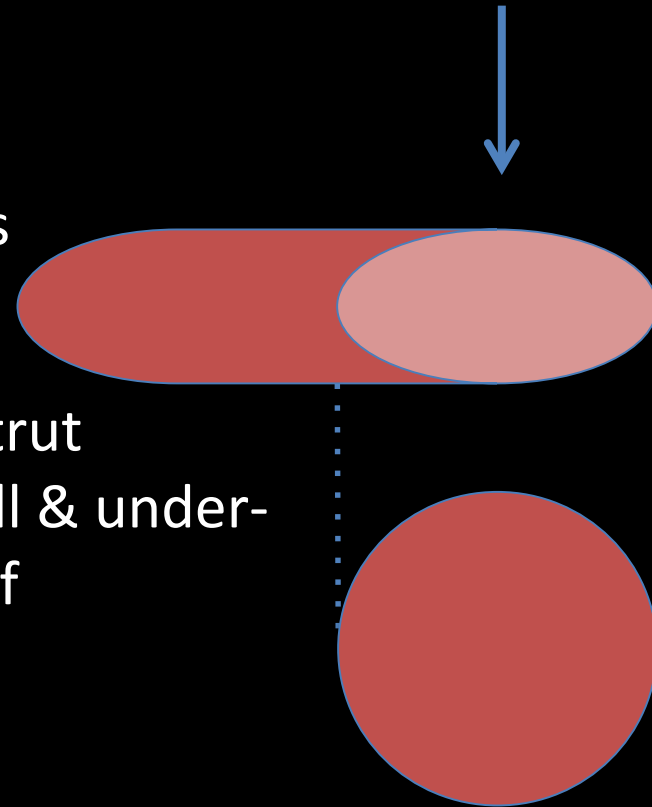


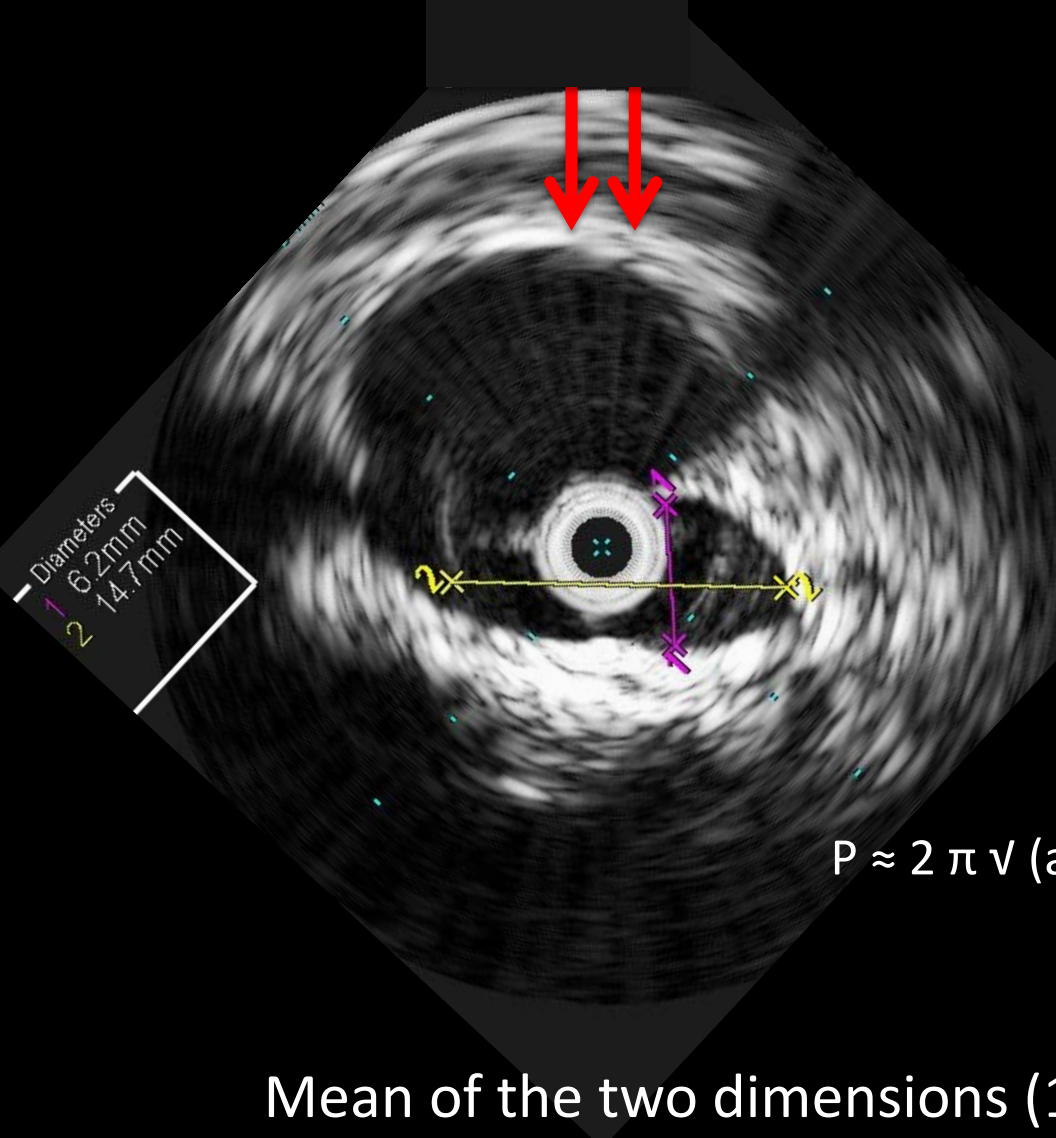
- Venography under-estimated degree of stenosis by $\pm 12.8\%$
- Duplex tended to overestimate the degree of stenosis:
 - $-6.9\% \pm 21.1\%$ compared to venography
 - $+15.1\% \pm 19.0\%$ compared to IVUS

Degree of stent over-sizing greater with venography as compared to IVUS

IVUS Advantage: Sizing of the Vessel

- Difficult to do by venography
- Has lead to mis-sizing of stents & balloons
- Oversizing may lead to stent strut erosion through the vessel wall & under-sizing could increase the risk of thrombosis





Based on circumference of an eclipse:

$$p = \pi(a + b) \sum_{n=0}^{\infty} \binom{0.5}{n}^2 h^n$$

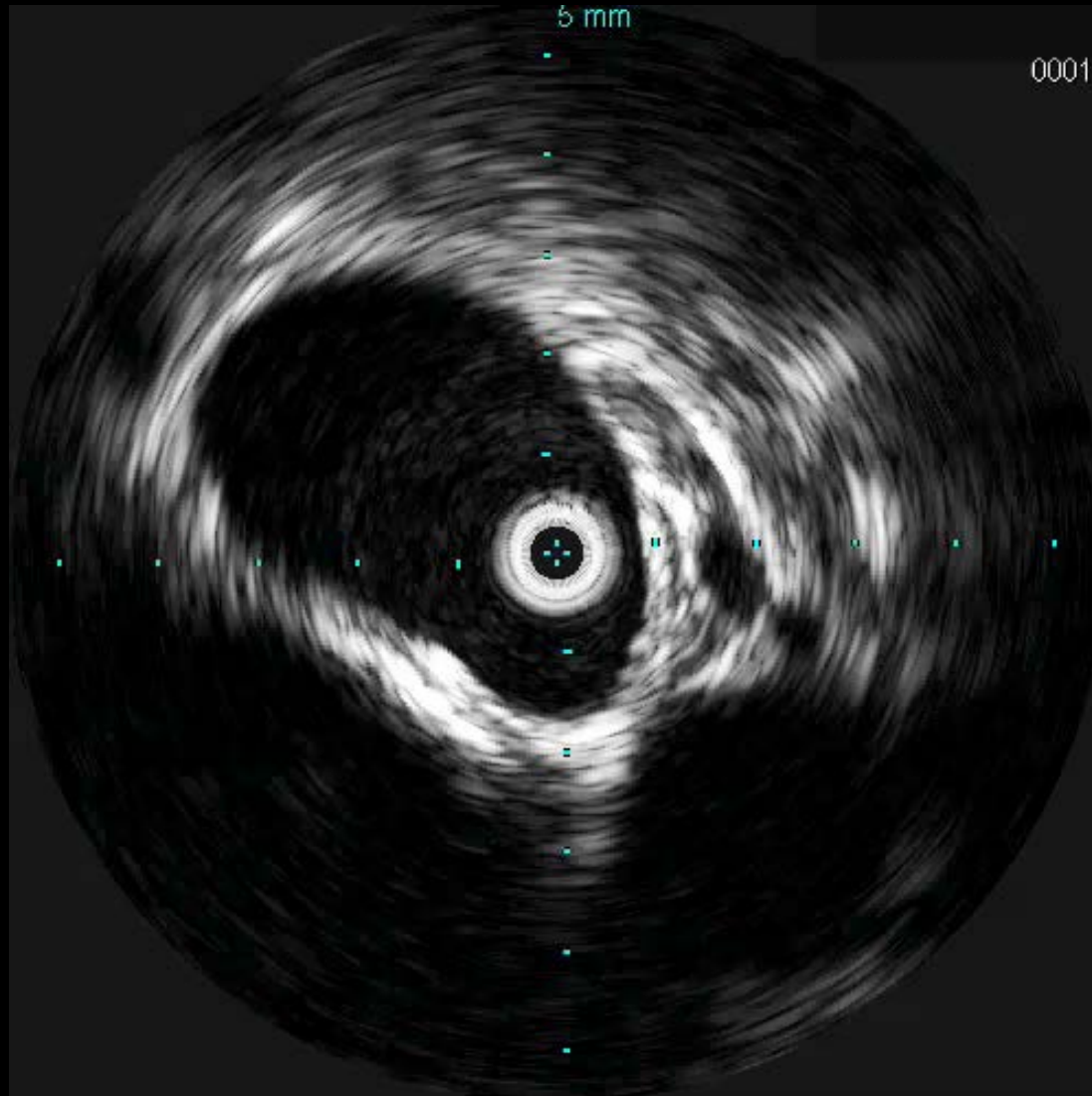
$$P \approx 2 \pi \sqrt{(a^2 + b^2)/2} \rightarrow \text{diameter} = \underline{11.2 \text{ mm}}$$

Mean of the two dimensions $(15+6.2)/2 = 10.6 \text{ mm}$

IVUS Advantage: Presence of Acute Clot

- Residual clot after DVT lysis associated with increased risk of recurrence
 - Enden et al Lancet 2011
- Acute clot has therapeutic solutions
- Chronic clot above the SFJ can be stented

IVUS Advantage: Determination of Extent of Disease & Precision of Stent Placement



Conclusion

- Optimal imaging depends on what information is needed
 - Distinguish acute v. chronic clot
 - Determine the accurate size of the vessel
 - Depict the length of the diseased segment
 - Pinpoint extent of pathology requiring stent placement
- Use of IVUS may change the therapeutic plan during deep venous interventions
- Does that change the patient outcome??