

# Carbon Dioxide Angiography in Lower Extremity Interventions

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19th Annual Conference

**2018**  
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# Disclosures

## **Speaker's Bureau:**

- Philips/Volcano

## **Consultant/CTO Proctor:**

- Boston Scientific

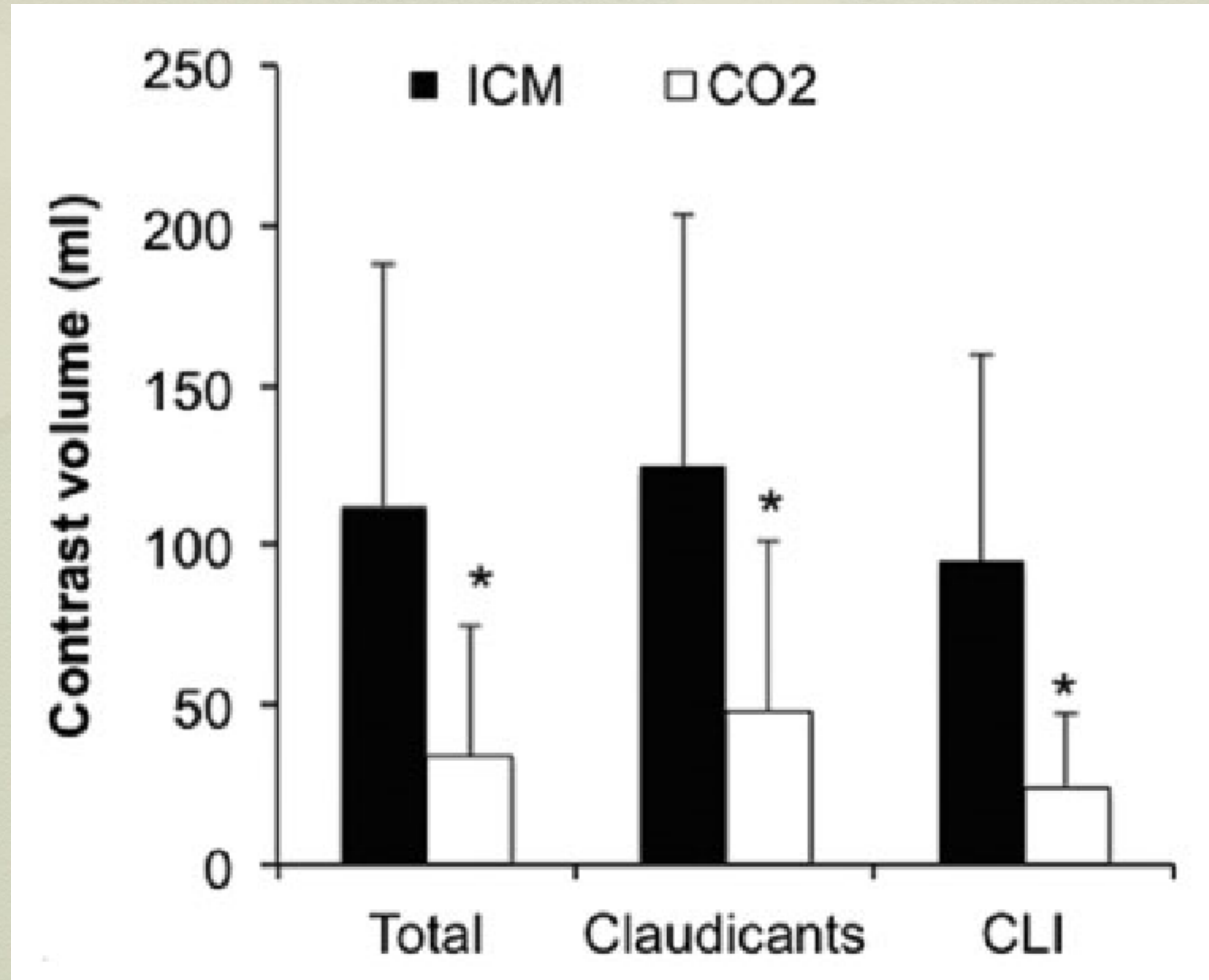
# CO2 in Peripheral Angiography

- Key studies in CO2 angiography of the lower extremities
  - Limitations
  - Safety
  - Benefits
- Strategies for Improving CO2 imaging in peripheral arterial disease

# Combined CO<sub>2</sub> and Iodinated Contrast (ICM)

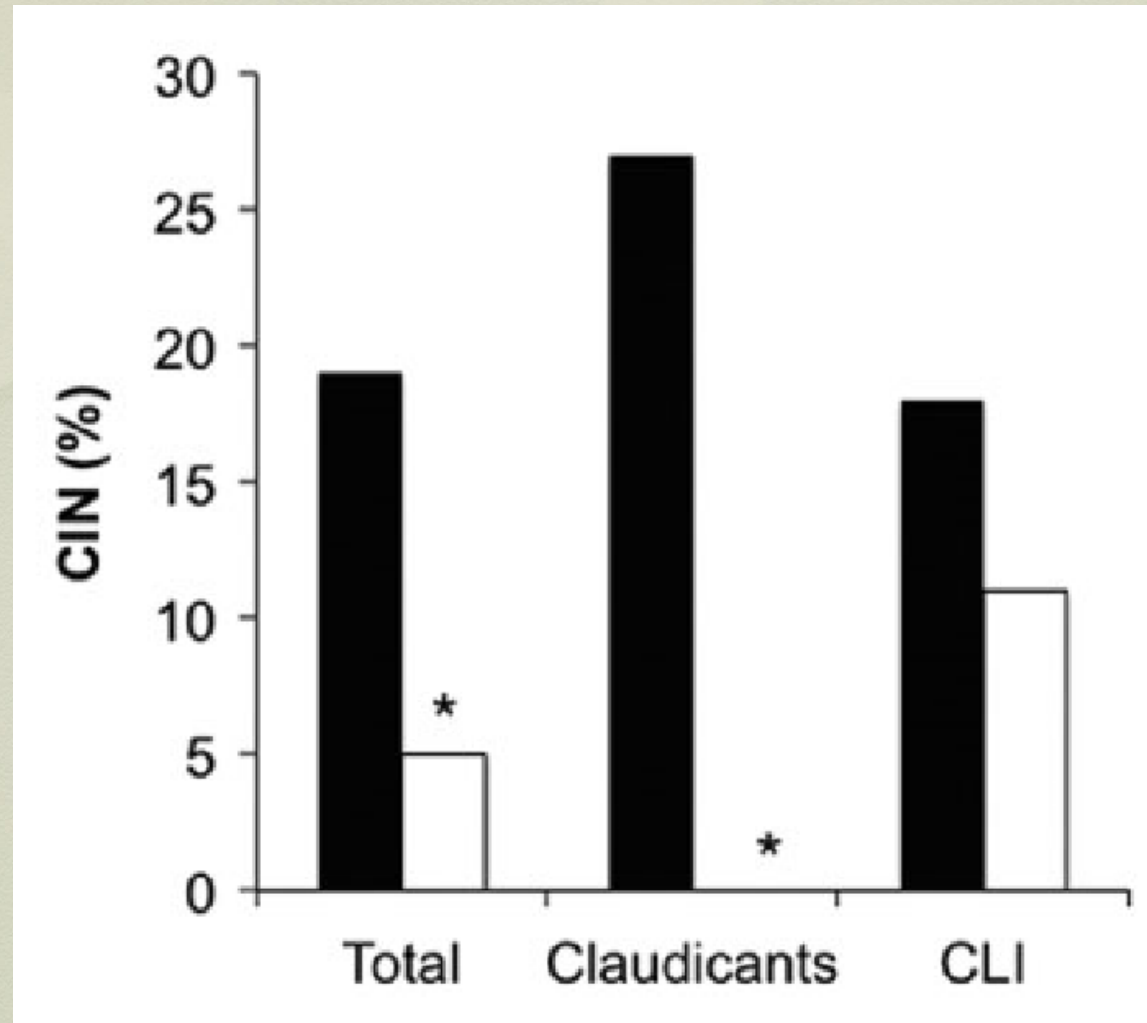
- 191 patients with peripheral artery disease
- 154 with iodine contrast only versus 37 with CO<sub>2</sub>/iodine hybrid

# Combined CO2 and Iodinated Contrast (ICM)



Stegemann et al. Angiology. 2015 Nov 3.

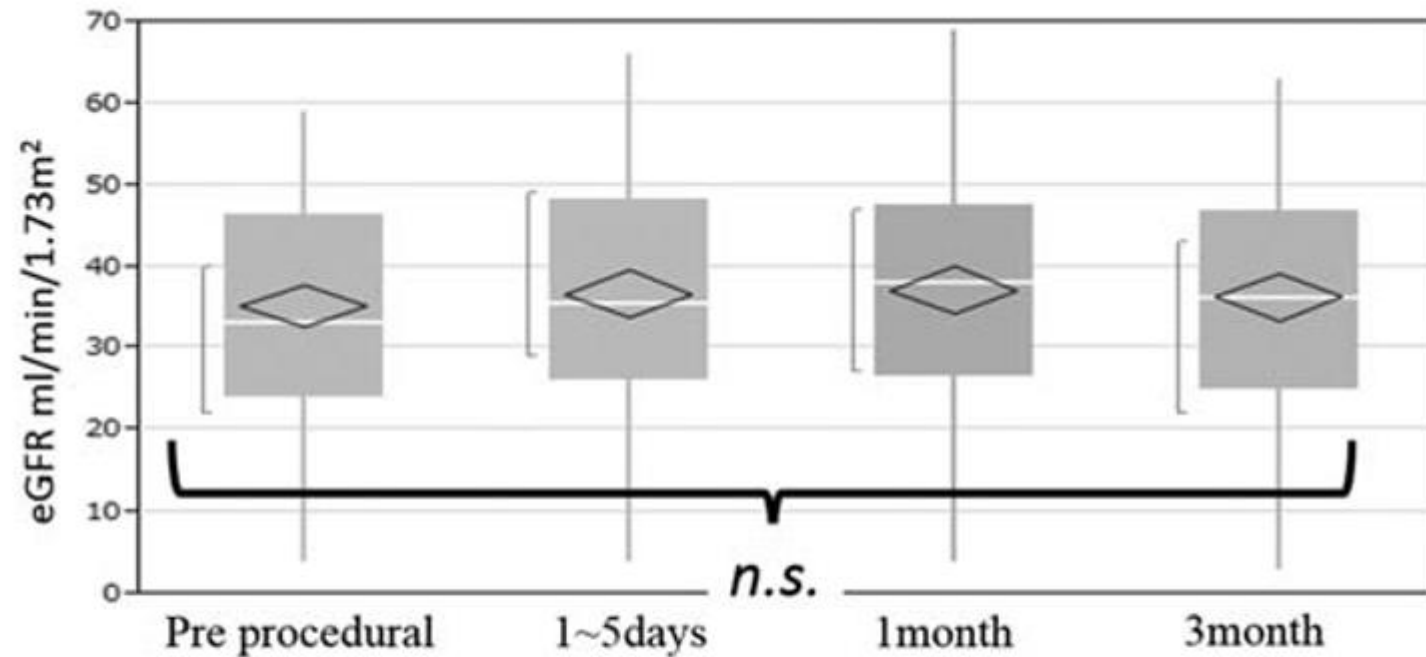
# Combined CO2 and Iodinated Contrast (ICM)



Stegemann et al. Angiology. 2015 Nov 3.

# Combined CO2 and Iodinated Contrast (ICM)

- Prospective study of 98 patients with CKD
  - 31 Aortoiliac
  - 62 fem/pop
  - 16 renal artery
- Technical Success rate of 97.9%
- Mean iodinated contrast use  $15.0 \pm 18.1$  ml (range 0–70 ml).



<b>N</b>	98	98	93	88
<b>eGFR (ml/min/1.73m<sup>2</sup>)</b>	35.2 ± 12.8	36.7 ± 14.4	37.1 ± 13.8	36.3 ± 13.9

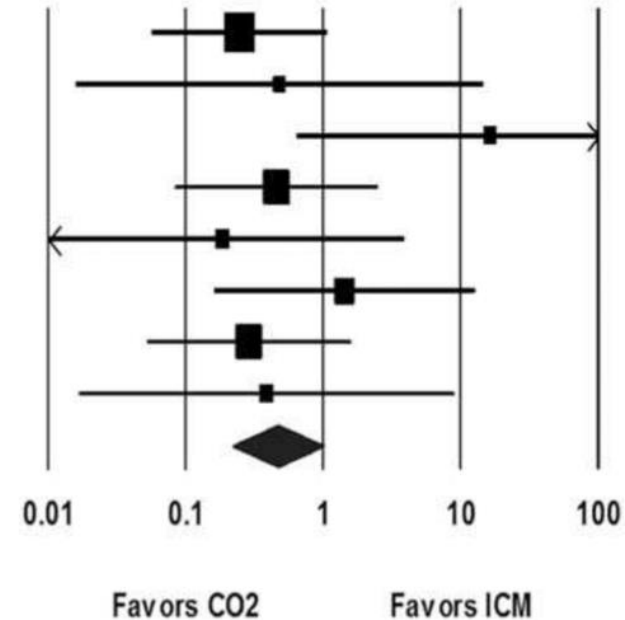
**Fig. 3. eGFR following CO<sub>2</sub> angiography.**



# CO2 and Iodinated Contrast (ICM)

## CI-AKI in patients undergoing angiography with CO2 vs ICM

Study name	Statistics for each study					CO2	ICM	(n)	Odds ratio and 95% CI
	Odds ratio	Lower limit	Upper limit	Z-Value	p-Value				
Stegemann et al 2015	0.246	0.056	1.083	-1.854	0.064	2/37	29/154	191	
Knipp et al 2010	0.481	0.016	14.702	-0.419	0.675	0/4	1/7	11	
Chao et al 2007	16.355	0.637	420.156	1.687	0.092	1/16	0/84	100	
Liss et al 2005	0.457	0.083	2.506	-0.902	0.367	2/37	5/45	82	
Dowling 2003	0.184	0.009	3.942	-1.082	0.279	0/51	2/49	100	
Sternier et al 2001	1.429	0.159	12.813	0.319	0.750	1/8	10/110	118	
Spinosa et al 1999	0.288	0.052	1.598	-1.424	0.154	2/24	6/25	49	
Frankhouse et al 1995	0.388	0.017	9.034	-0.589	0.556	0/8	2/18	26	
	0.465	0.218	0.992	-1.981	0.048				



# CO2 in Peripheral Angiography

- 50 consecutive patients with peripheral arterial disease
- Patients had both full CO2 followed by Iodinated contrast studies

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Vascular Bed	Stenosis(CO2)/Normal (ICM)
Aorta	3
Pelvis	6
Thighs	3
Knees	4
Legs	1
Feet	1

# CO2 in Peripheral Angiography

Total Patients (50)	N (%)
Pain with injection	24 (48%)
Discontinued due to pain	9 (18%)
Unable to visualize feet vessels	37 (75%)
“Complete” Angiograms	18 (36%)

# Safety of CO2 in peripheral angiography

- 527 aortograms with or without extremity runoff
- 31 were extremity only
- iodinated contrast media used in 52%
- Median iodinated contrast used was **15 ml**

# Safety of CO2 in peripheral angiography

Complications	% (N)
Puncture site hematoma	8 (13)
Transient abdominal pain	6 (10)
Pancreatitis	4 (7)
Chest pain	1 (2)
Intimal dissection	1 (2)
Tachyarrhythmia	1 (2)
Diarrhea	1 (2)
Severe hypertension	1 (2)
Hives	1 (2)
Seizure	1 (2)
Death	1 (2)

Moos et al. Arch Surg. 2011;146(12):1428-1432.

# Procedural Creatinine

Quartiles of CKD	Before mg/dL, Mean (SD)	After mg/dL, Mean (SD)	P value
<1.2	0.9 (0.2)	0.9 (0.3)	.16
1.3-1.9	1.6 (0.2)	1.6 (0.5)	.13
>2	3.1 (1.3)	3.2 (1.6)	.30
Total	2.1 (1.2)	2.1 (1.4)	.25

# Prospective CO<sub>2</sub> Angiography Registry

- Japanese registry of 98 patients with aorto-iliac, fem-pop, renal cases

**TABLE III. Prevention of CIN and CO<sub>2</sub>-Related Complications**

	Total; N = 98	AI group; N = 31	SFA group; N = 64	RAS group; N = 16
CIN <i>n</i> (%)	5 (5.1)	2 (6.4)	5 (7.8)	0 (0.0)
<b><i>Complications related to CO<sub>2</sub> injection</i></b>				
Total <i>n</i> (%)	17 (17.3)	7 (22.6)	10 (15.6)	3 (18.8)
<b><i>Minor complications</i></b>				
Leg pain <i>n</i> (%)	8 (8.1)	2 (6.4)	7 (10.9)	0 (0)
Abdominal pain <i>n</i> (%)	6 (6.1)	3 (9.7)	1 (1.6)	3 (18.8)
Diarrhea	1 (1.0)	1 (3.2)	0 (0)	0 (0)
<b><i>Major complications</i></b>				
Non-occlusive mesenteric ischemia (NOMI)	2 (2.0)	1 (3.2)	2 (3.1)	0 (0)



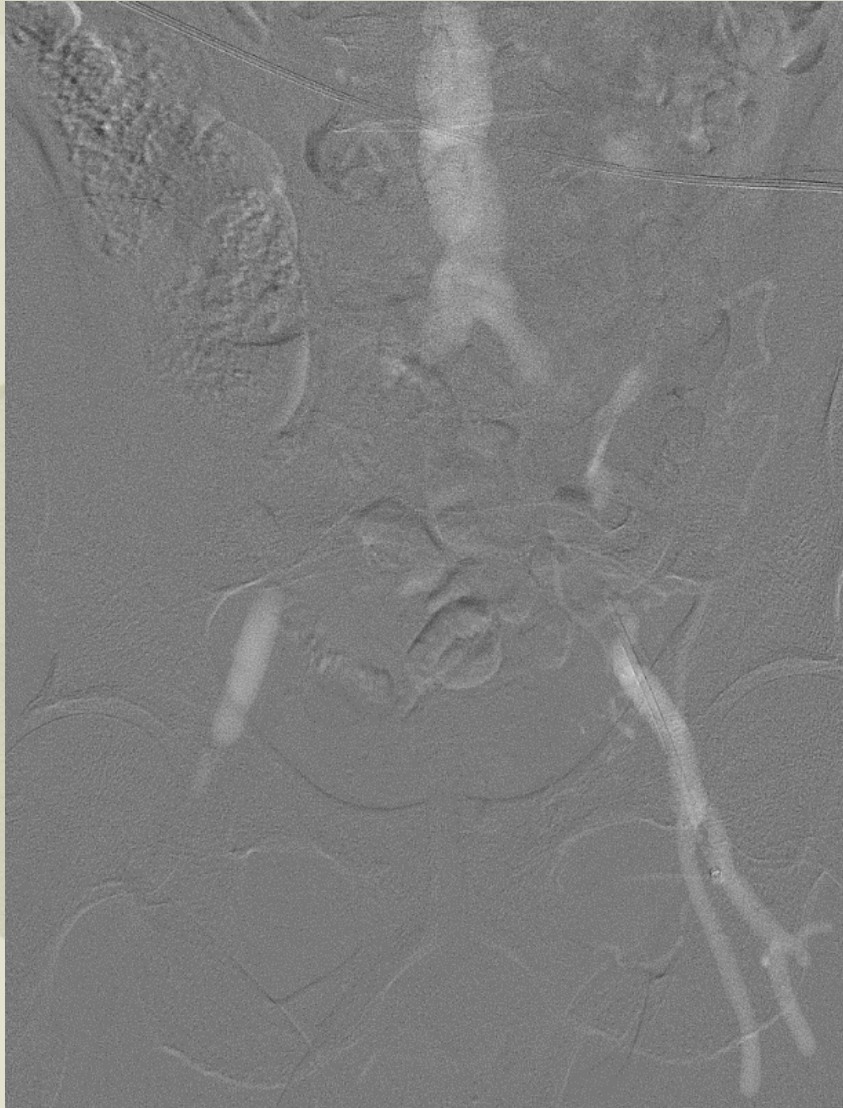
# **Strategies for Optimizing CO2 Peripheral Angiograms**

## **Aorto-Iliac Angiography**



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# Image Stacking is Essential



# End Hole Catheters are Better





# The Paddle

BORAH

Louisiana Medical

Al

39  
-1953

24-

L

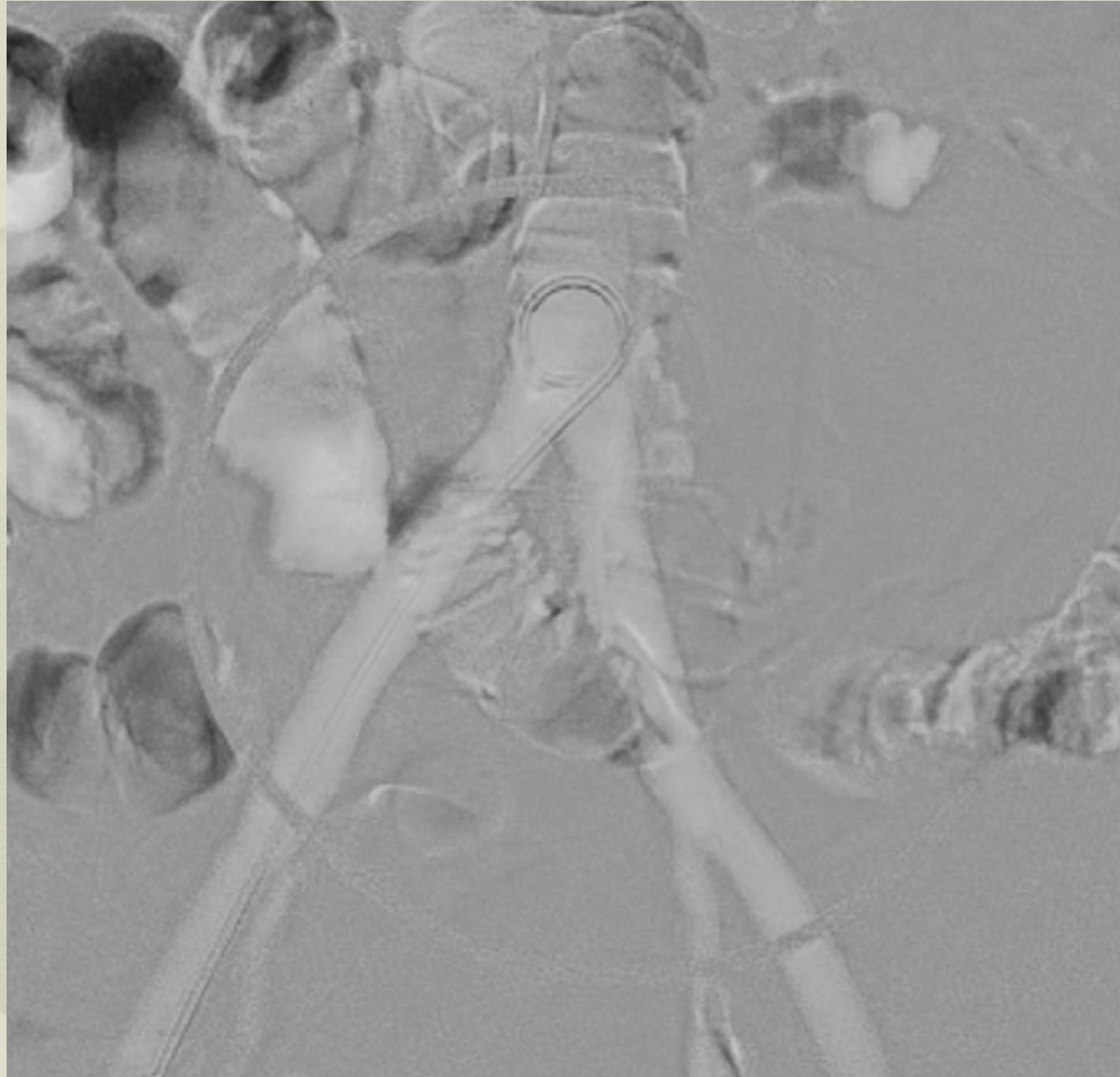
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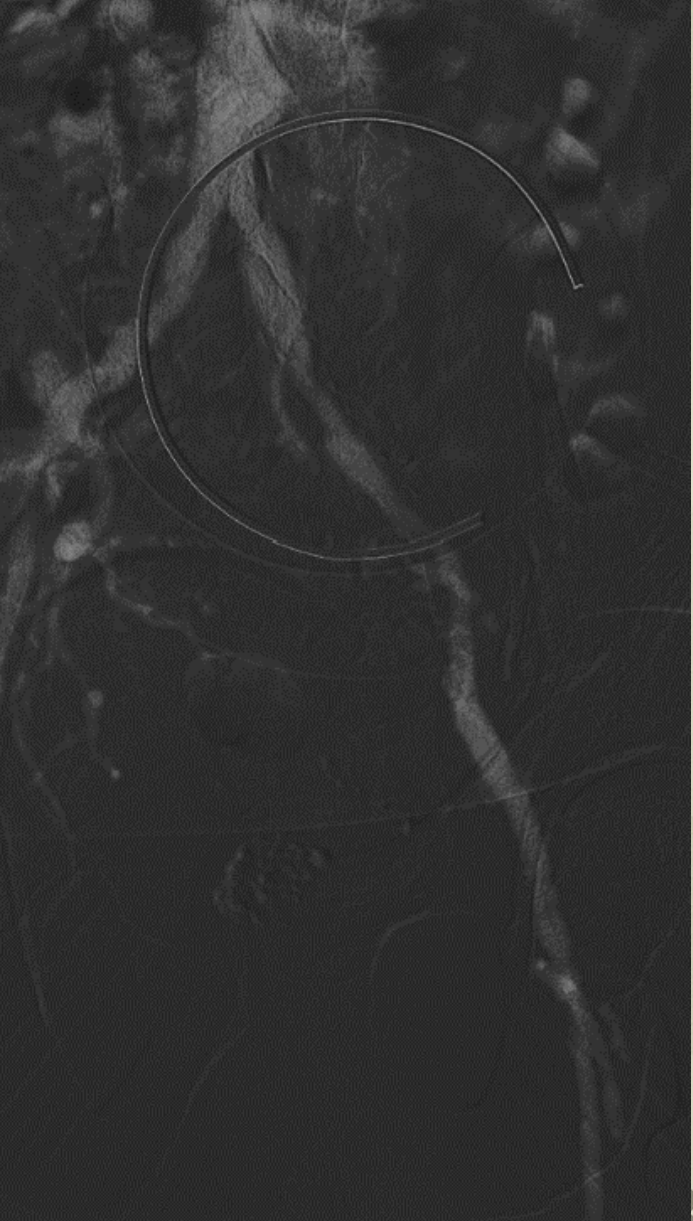
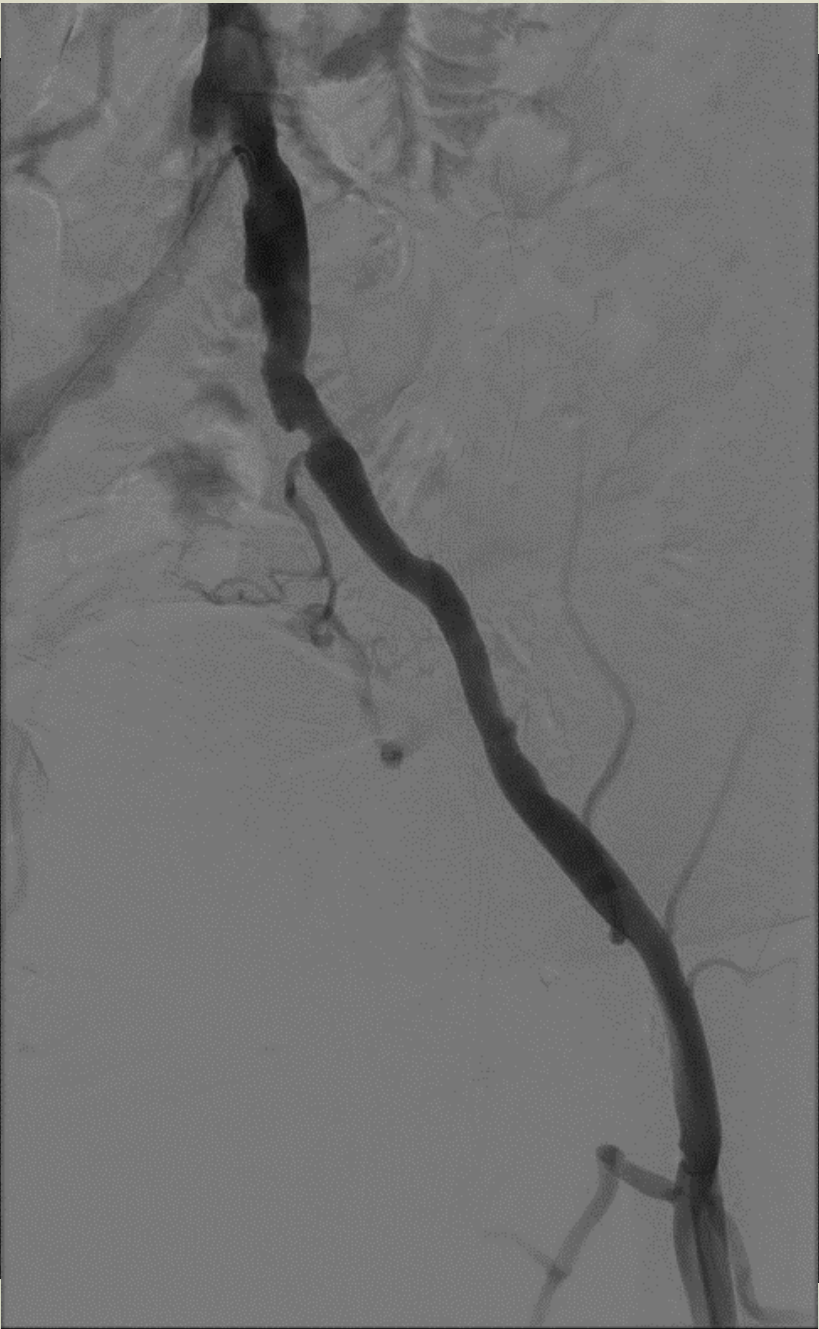
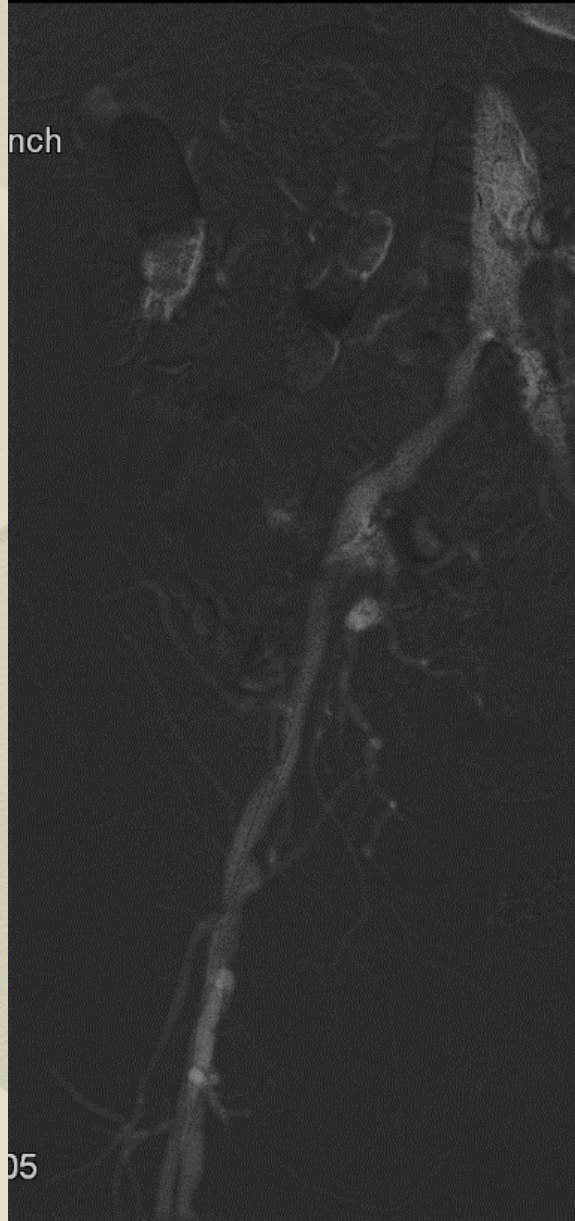


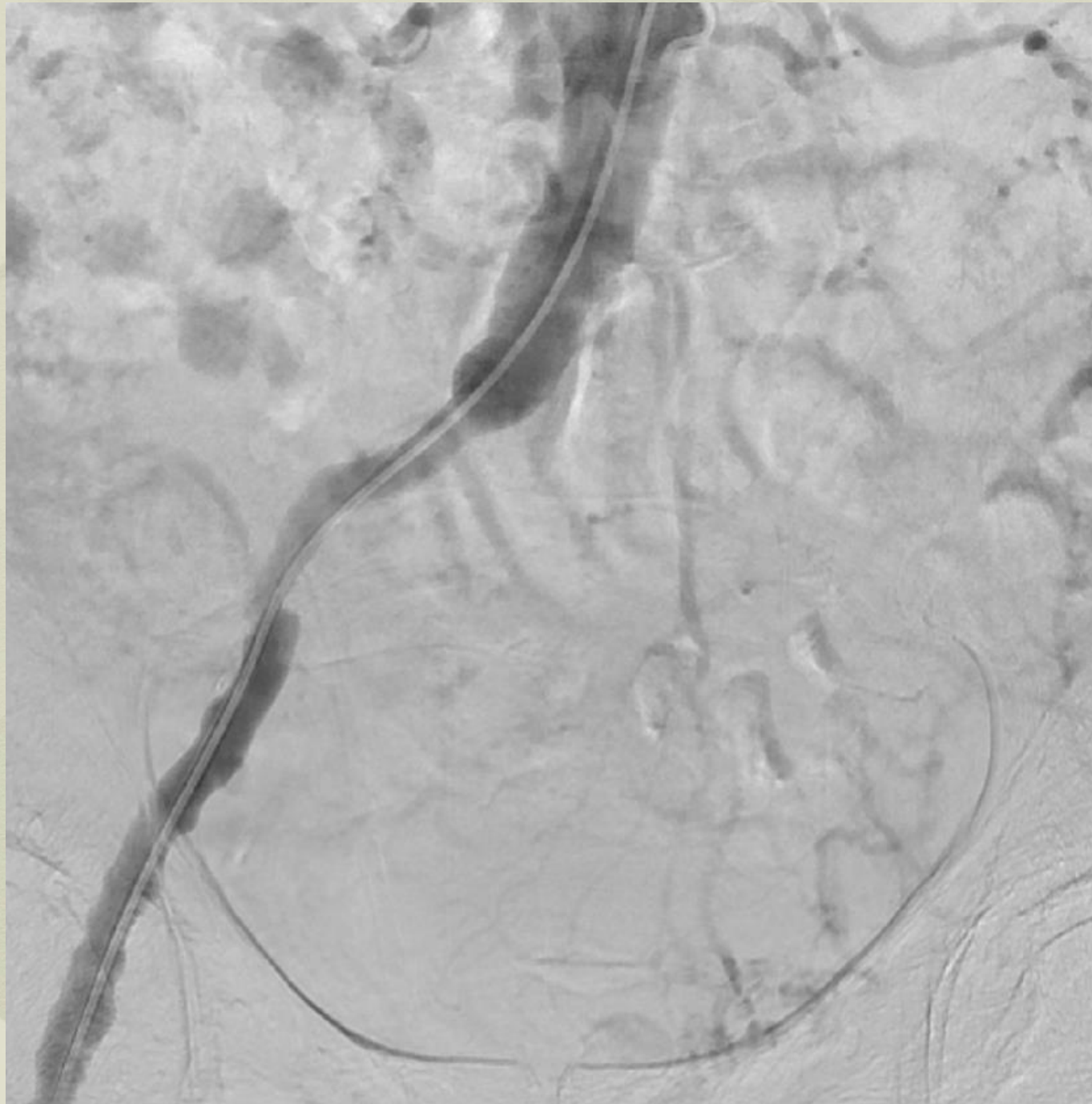


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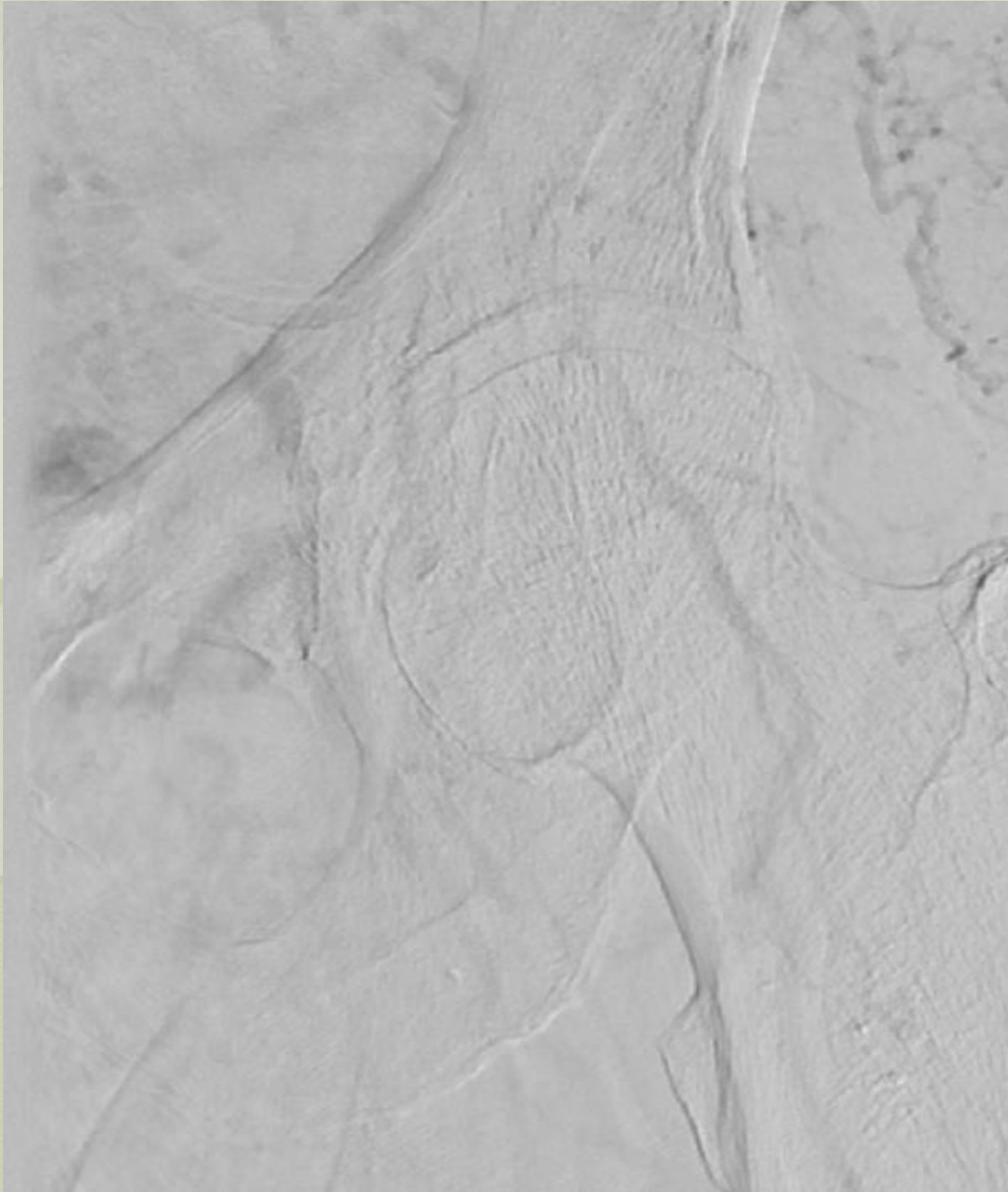


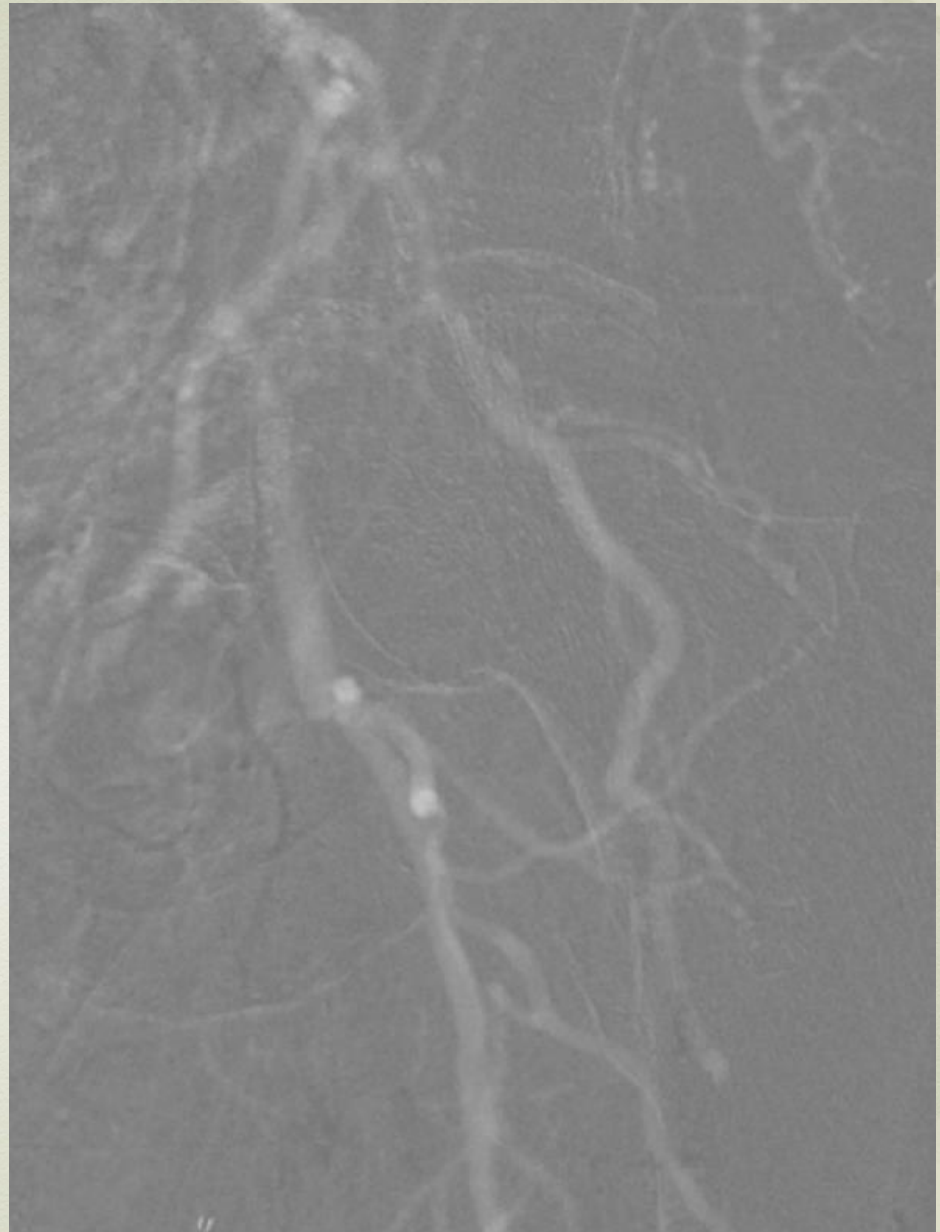
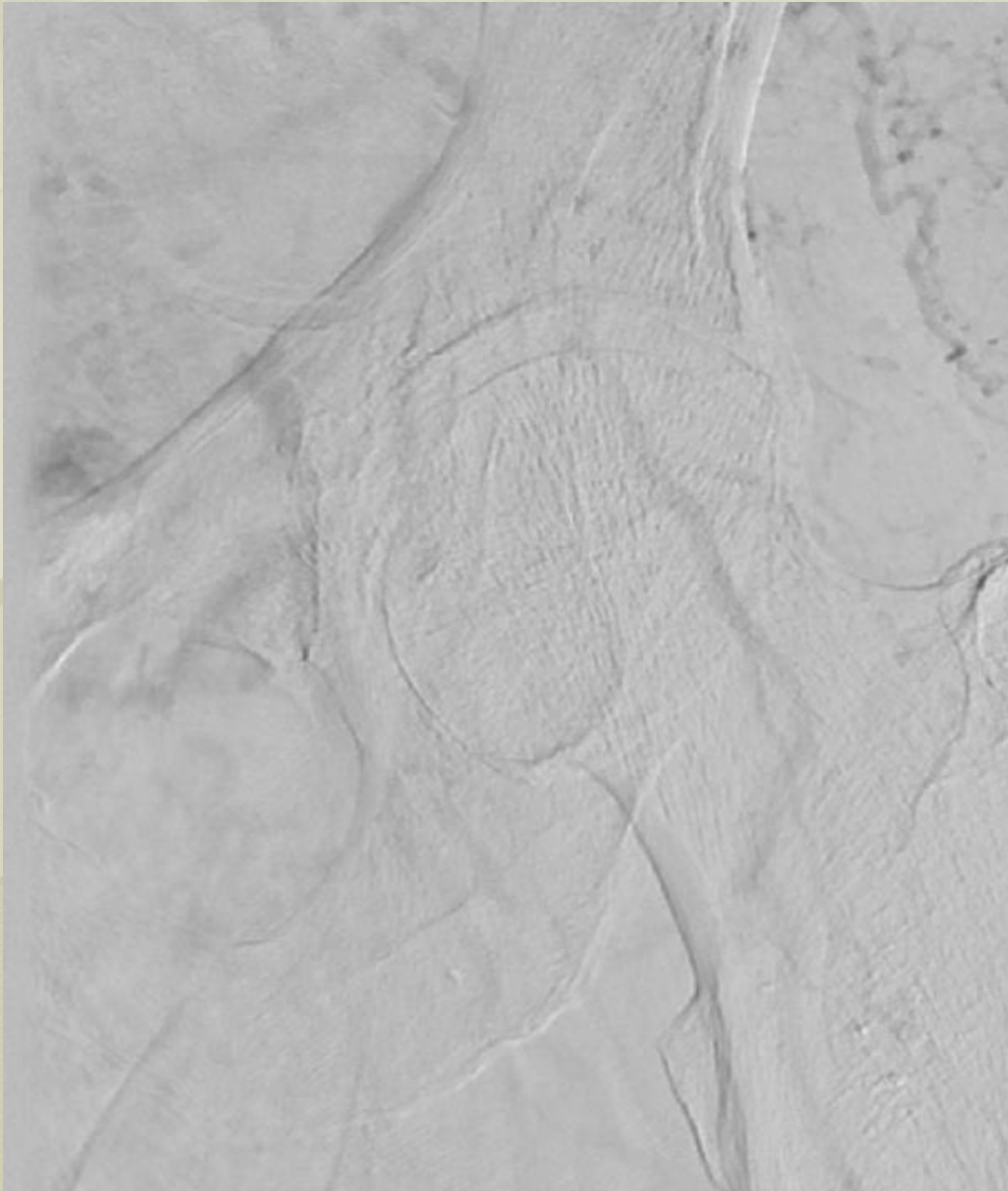
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# **Strategies for Optimizing CO2 Peripheral Angiograms**

## **Femoral and Popliteal**

Contrast



Carbon Dioxide

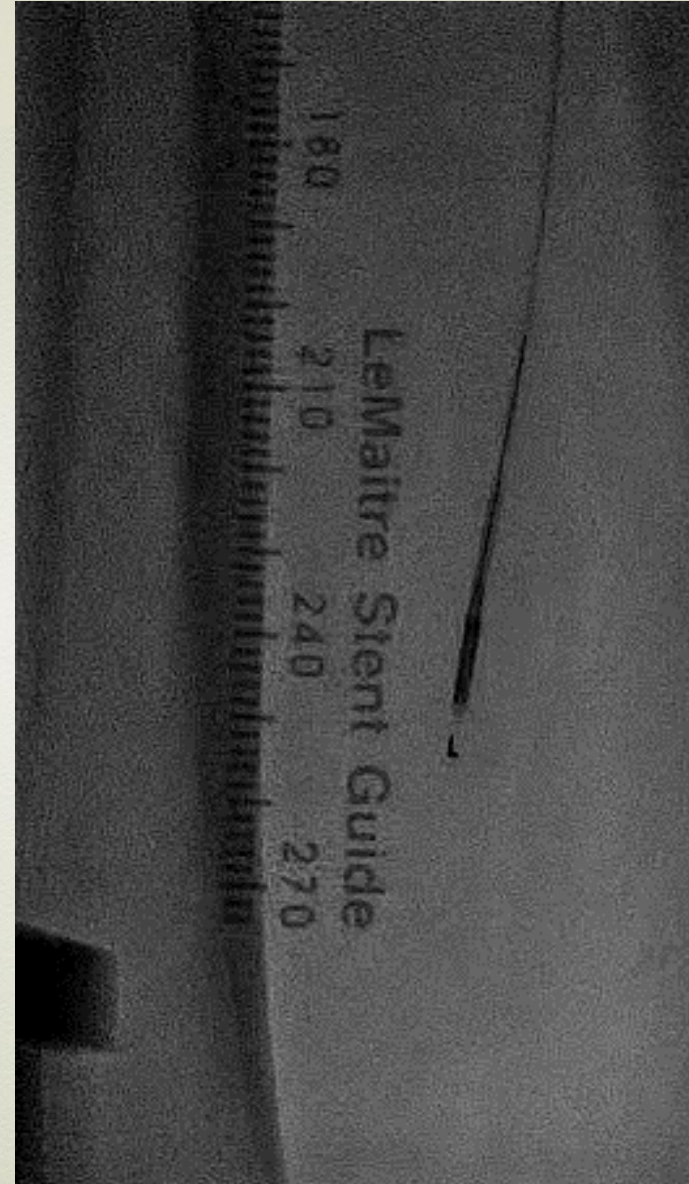
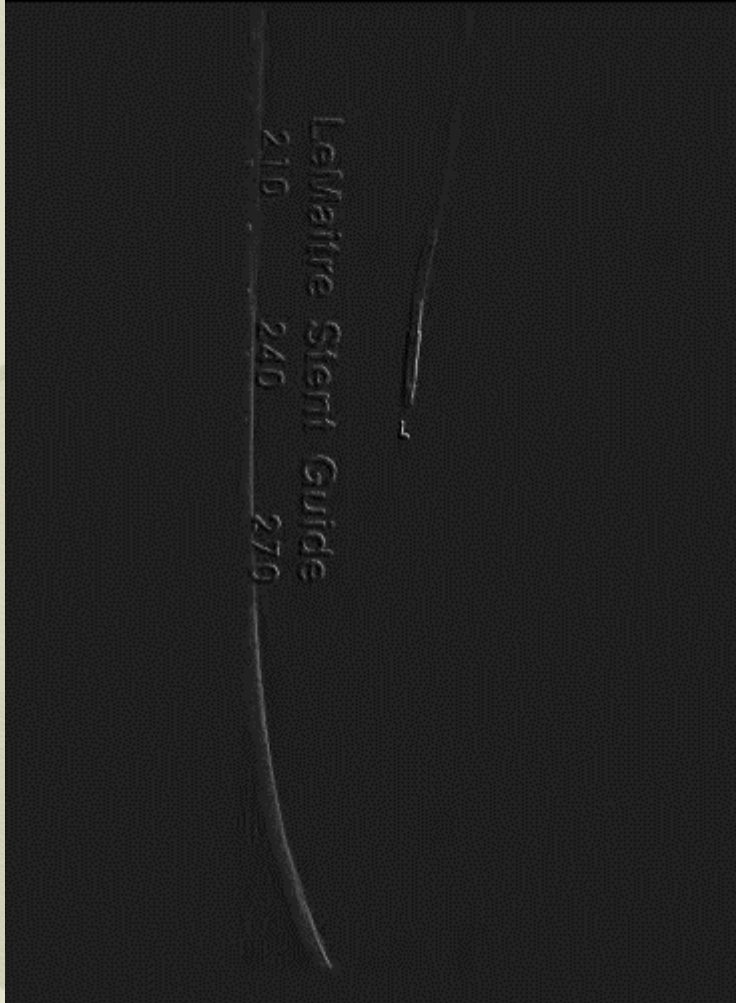




# CO2 Guided Re-Entry Device



# CO2 Guided Re-Entry Device

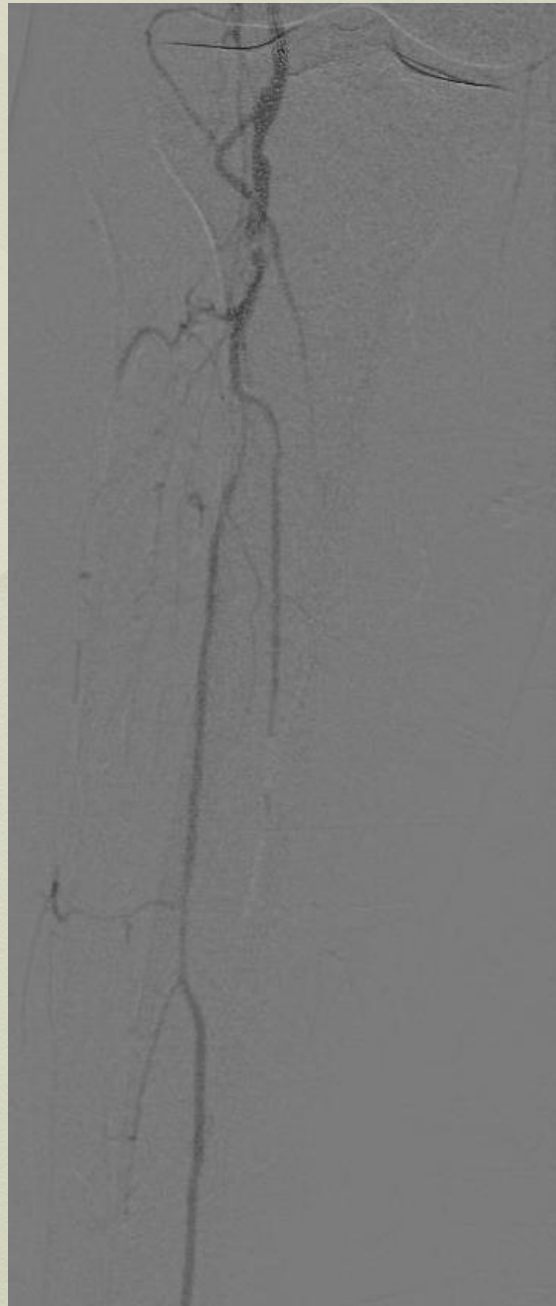


# **Strategies for Optimizing CO2 Peripheral Angiograms Below the Knee**



R runoff

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ID 0°  
3.0 inch

CO2

:00  
:33  
5:38:25

7



NOV 2018

# **CO2 versus contrast in bleeding**

# CO2 versus contrast in bleeding





# CO2 versus contrast in bleeding



# Case

- 59 Man with claudication at <1 block, right leg
  - Former smoker
  - Hypertension
  - Creatinine 2.5
  - ABI Right 0.3 Left 0.6

D1174407  
6-October-10 6  
XA

FD 17.0 inch

Alluraxper  
VA^DOC  
9-February-2017  
9:34:52

0:00  
3:47 iliac no gradient  
10:41:52

Moderate disease  
w/o gradient

23-8..12

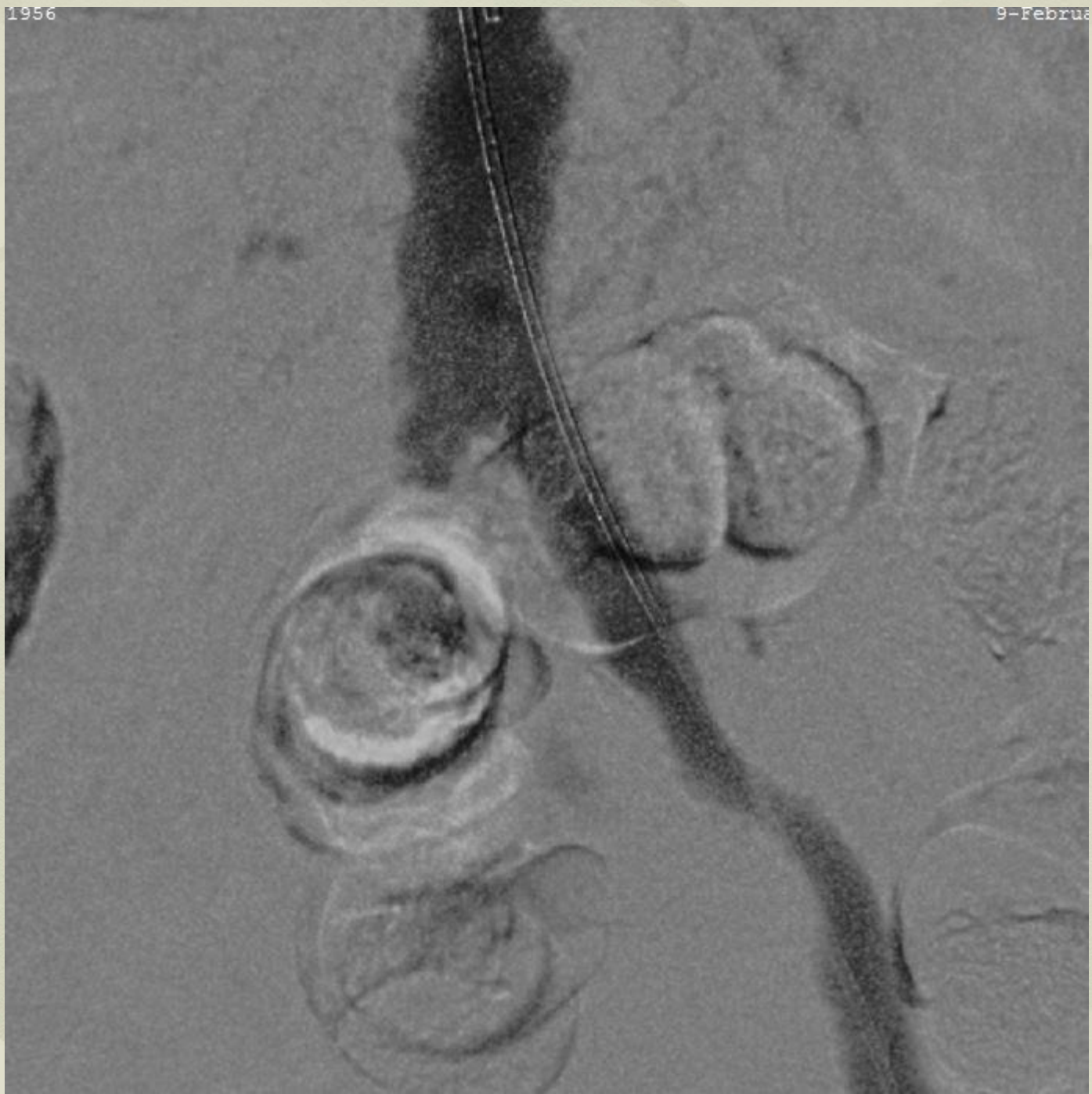
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LowerExtremities CO2 3fps

L: 511.00  
W: 1023.00

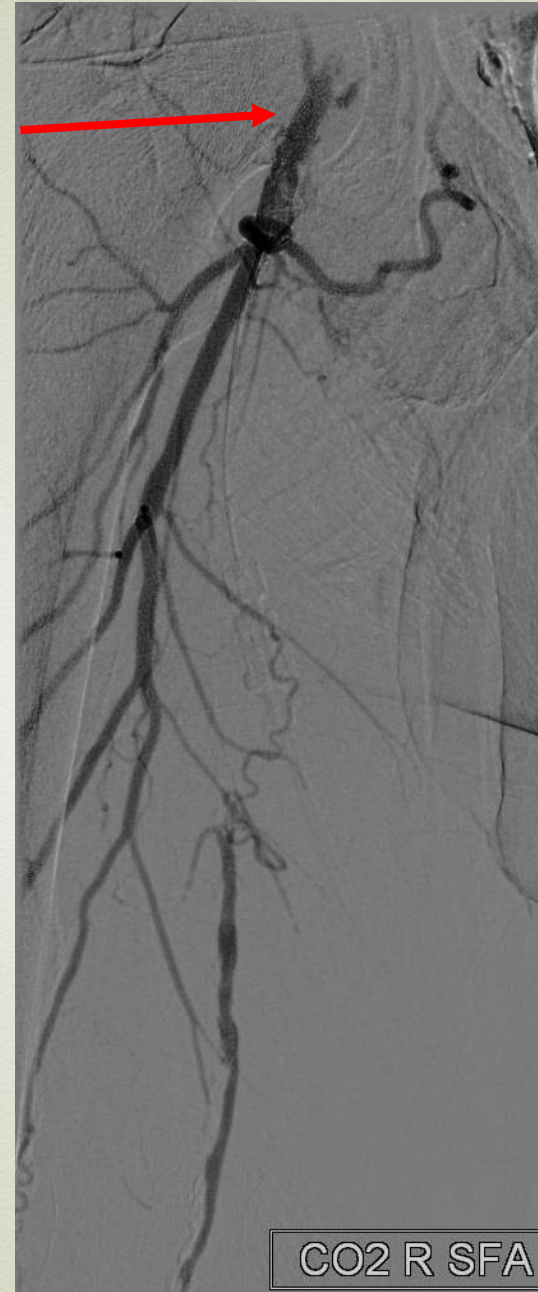
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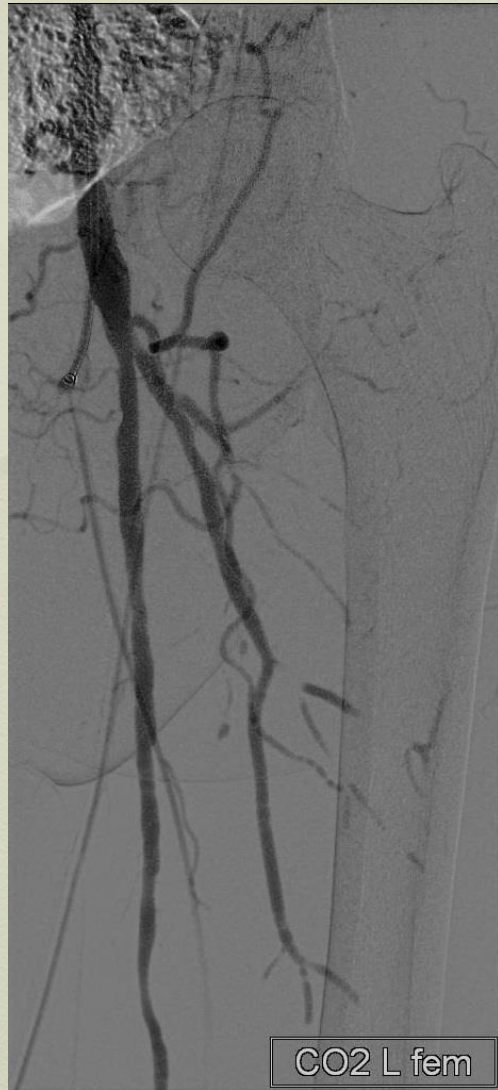
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A 2 Fr catheter,  
inner dilator of a  
micropuncture  
sheath is placed  
in the R CFA  
below the iliac  
occlusion under  
ultrasound and  
CO2 runoff  
pictures obtained



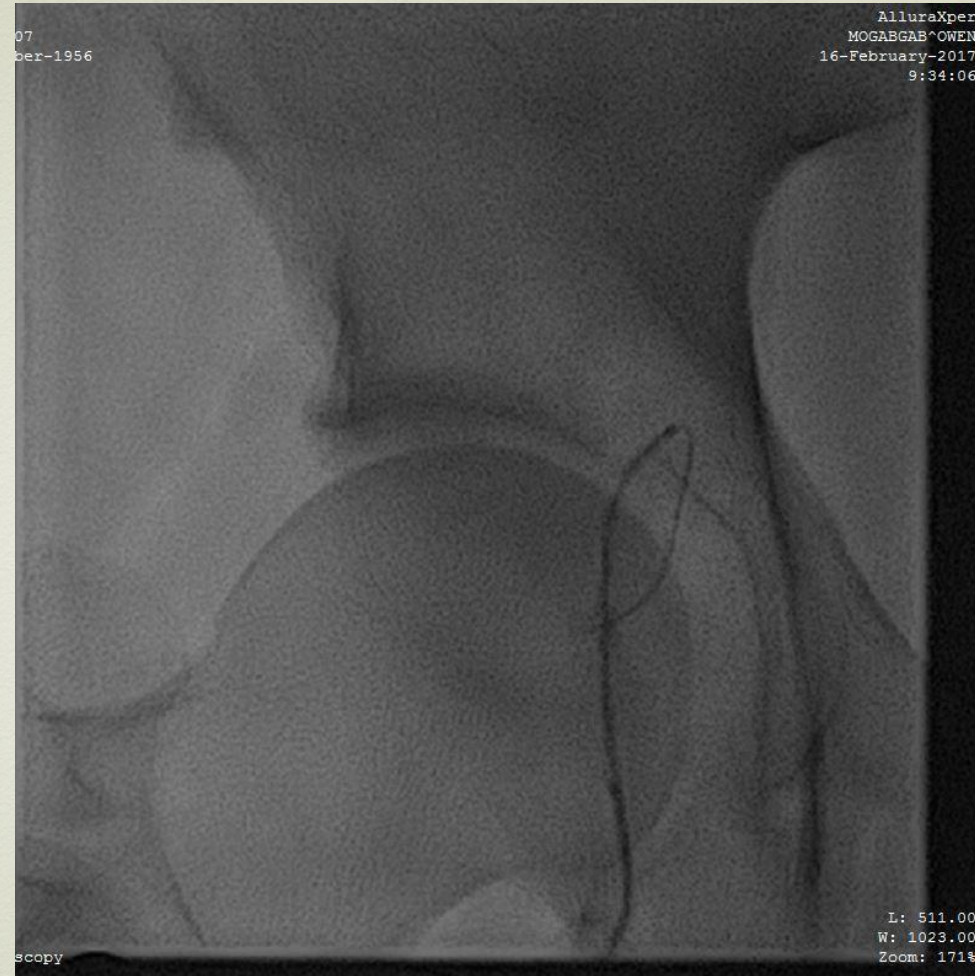


Left lower  
extremity  
angiography  
done  
through the  
4 Fr LCFA  
sheath



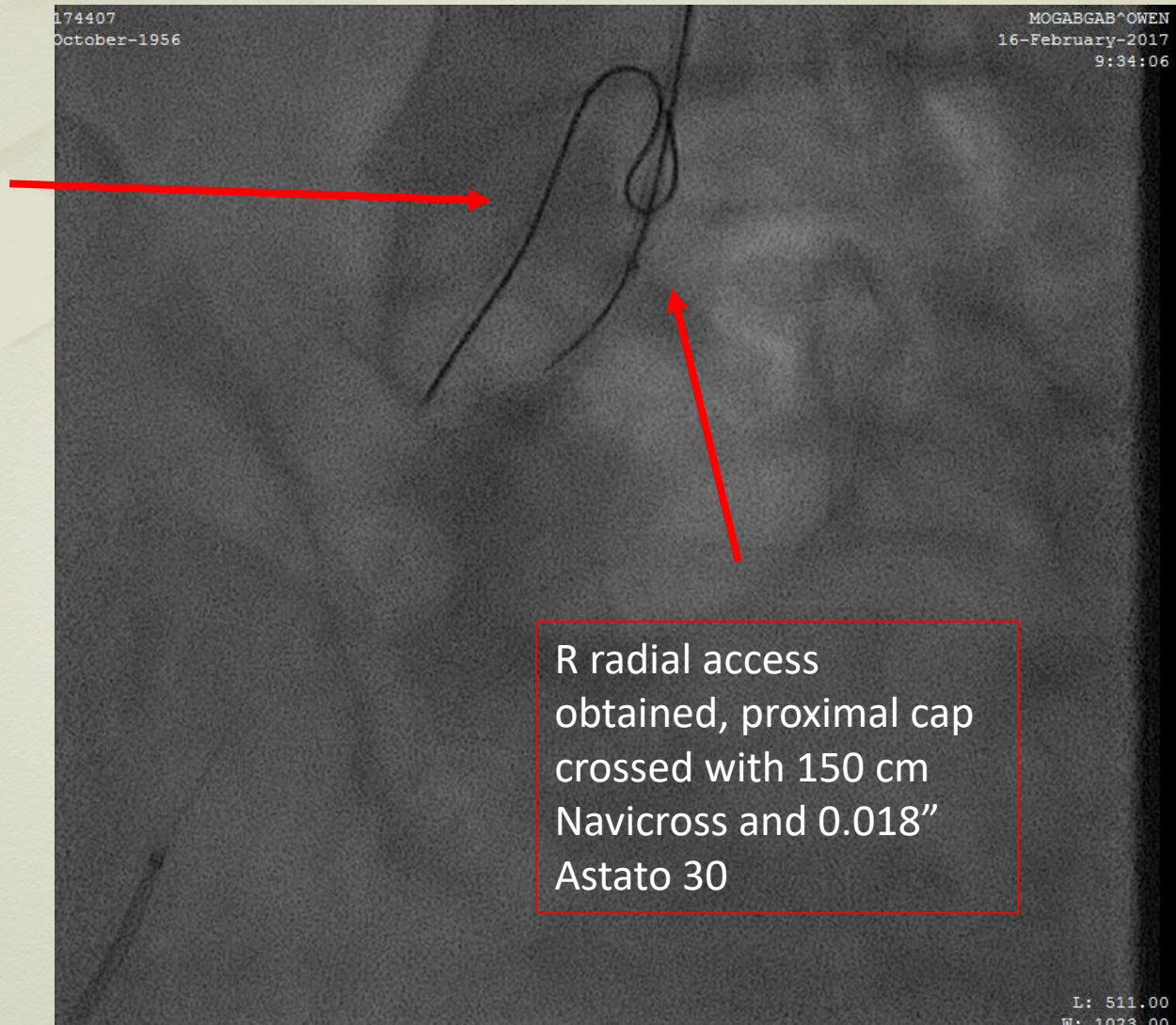
Ultrasound guided R  
CFA access below the  
occlusion

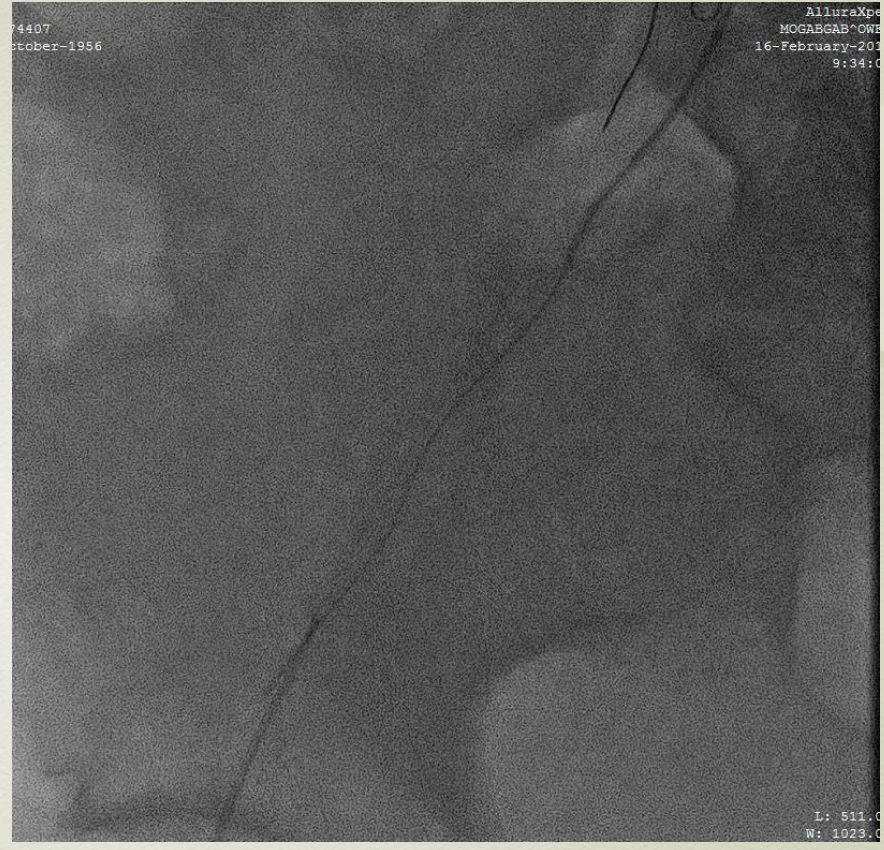
Iliac crossed with an  
0.035" Glidewire  
advantage and  
Navicross catheter



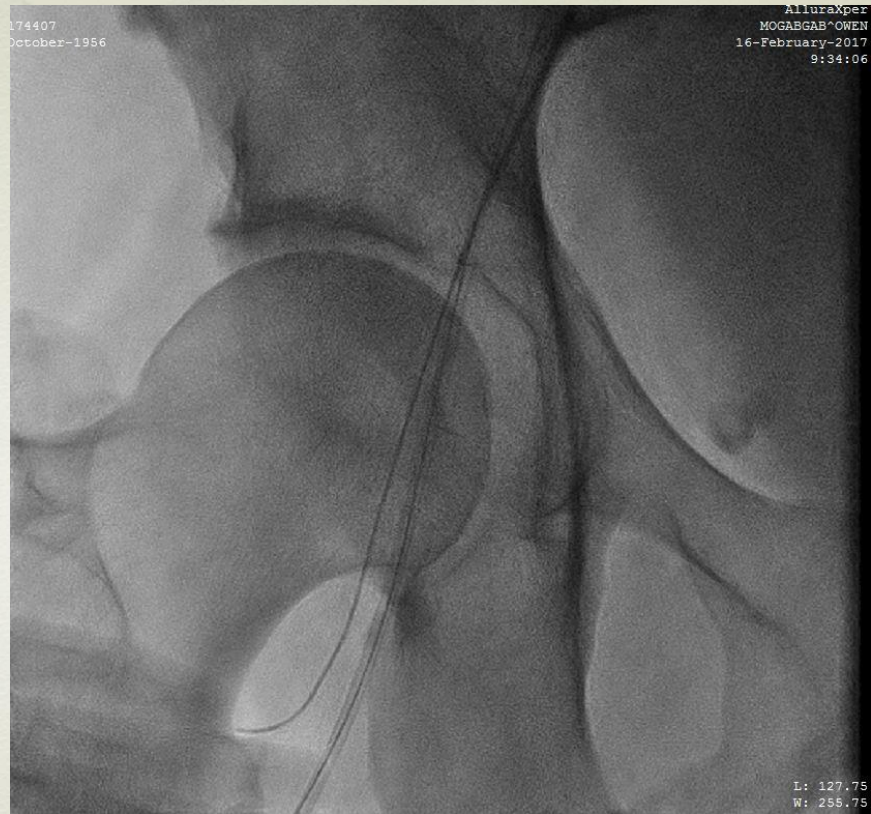
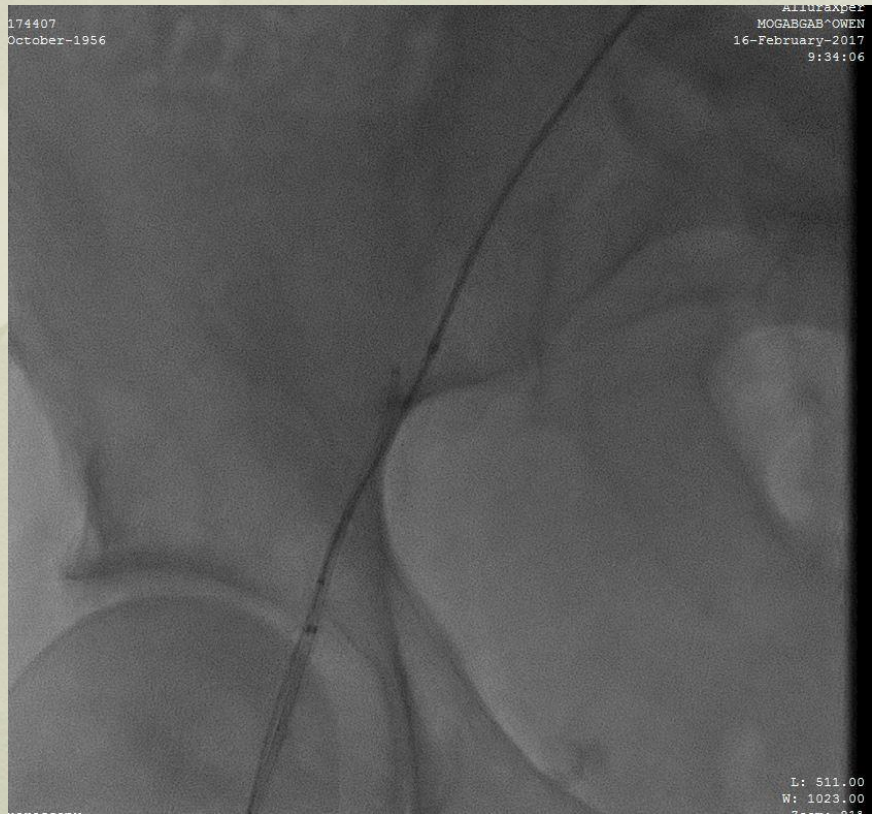


Retrograde wire left in subintimal space to guide antegrade crossing





Once past the proximal cap,  
antegrade crossing with 0.035"  
Glidewire advantage and  
Navicross



Re-entry into the true lumen distally, wire snared and externalized



Iliac ballooned and stented and one final picture with 8 mL of contrast (total amount used)

# Conclusions

- CO<sub>2</sub> is safe and effective at reducing contrast use in peripheral angiography and interventions
- Strategies can be used to improve angiogram quality

# CO2 Angiography Society Part 2



# Carbon Dioxide Angiography in Lower Extremity Interventions

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