Carbon Dioxide Angiography for peripheral interventional procedures In Renal Insufficiency

Emilio Calabrese MD
National Center for Limb Salvage
Pavia - Italy

Luigi Inglese MD
San Donato Milanese Hospital
Milan - Italy

CO_2
Specific Advantages

- ✓ **Non Allergenic**
- ✓ ***20 times* more soluble than O_2 in blood**
- ✓ **Non Toxic**
- ✓ ***400 times* less viscous than iodinated contrast**

CO_2-Angiography issues

- Readability
- Operating time
- Nephrotoxicity
- Risk
- Neurotoxicity

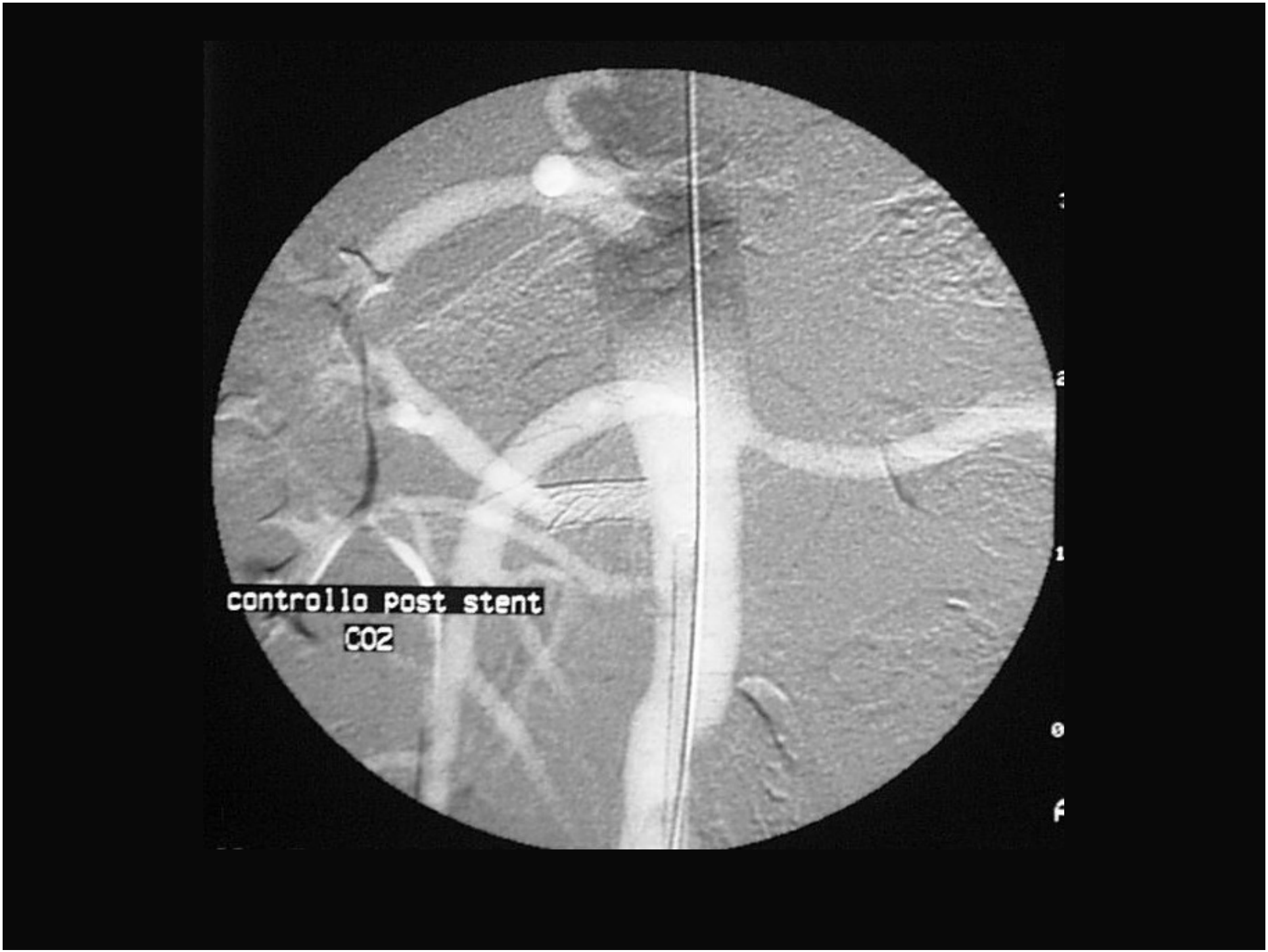
Is CO_2 adequate for readability?

- 50 cases - Retrospective study PTA-PTRA
  - 88% CO2 only
  - 12% additional iodinated contrast needed

Kessel DO et al: Cardiovasc Interv Rad 25(6):476-83 2002

- 100 cases – Retrospective study EVAR
  - CO2 versus Iodinated
    - Longer operating time
    - Longer fluoroscopy
    - Higher radiation exposure
    - Similar procedural success
    - No change in creatinine levels
    - 81% additional iodinated contrast needed

Chao, Major, Weaver et al. :J Vascular Surgery 45(3);451-60 2007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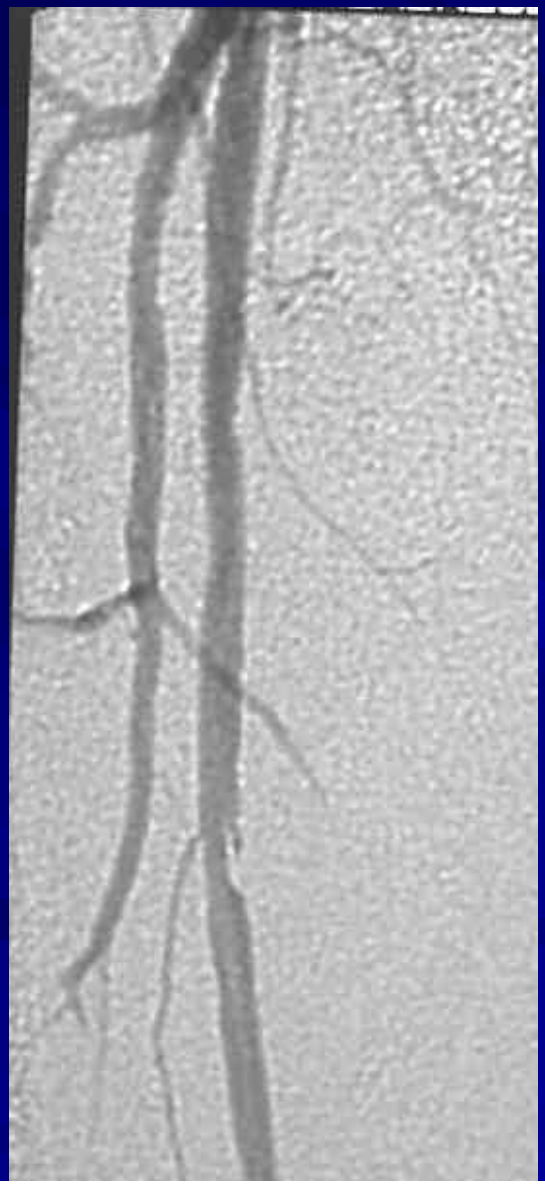
CO2

Iliac artery angiogram

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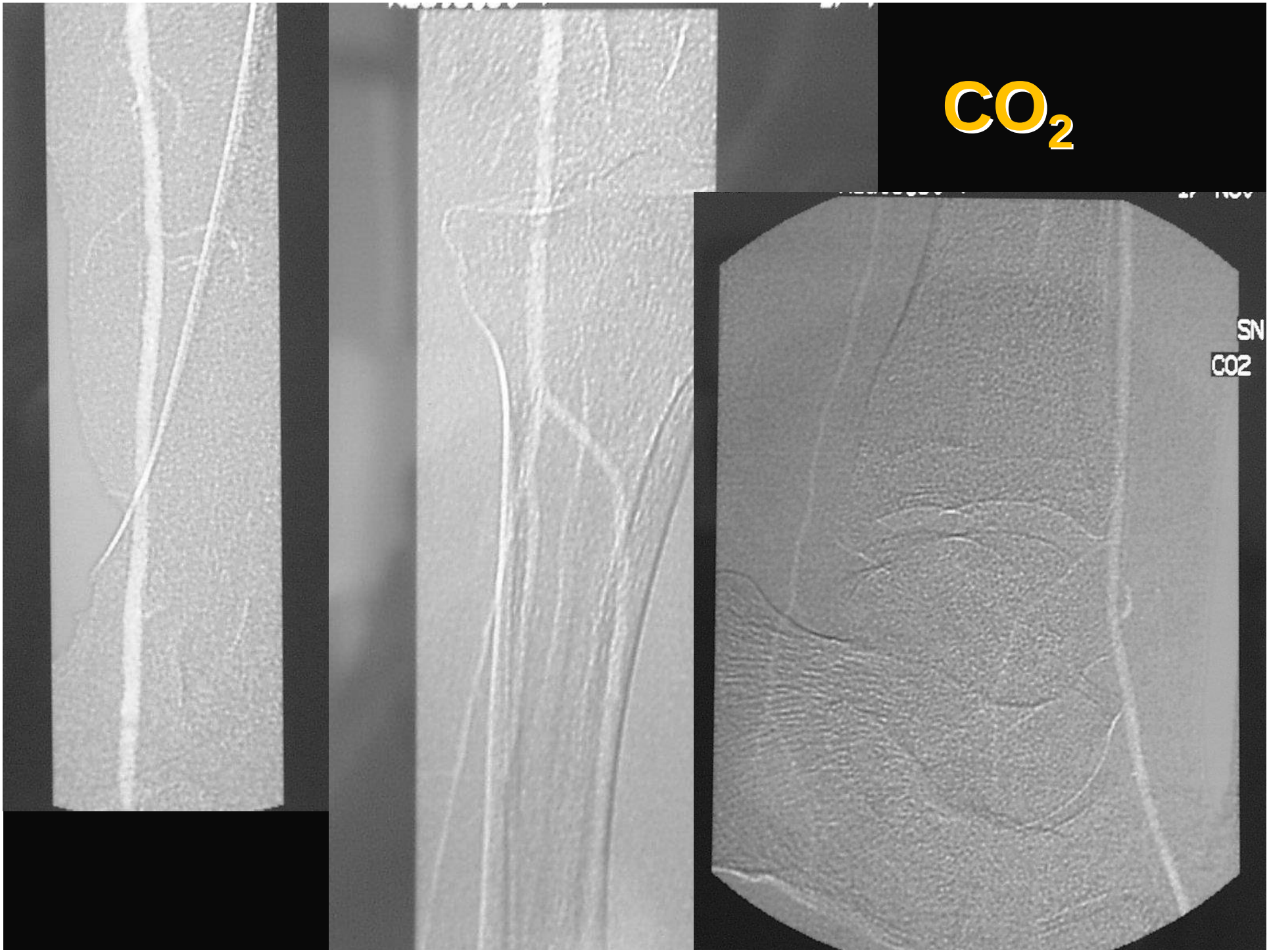
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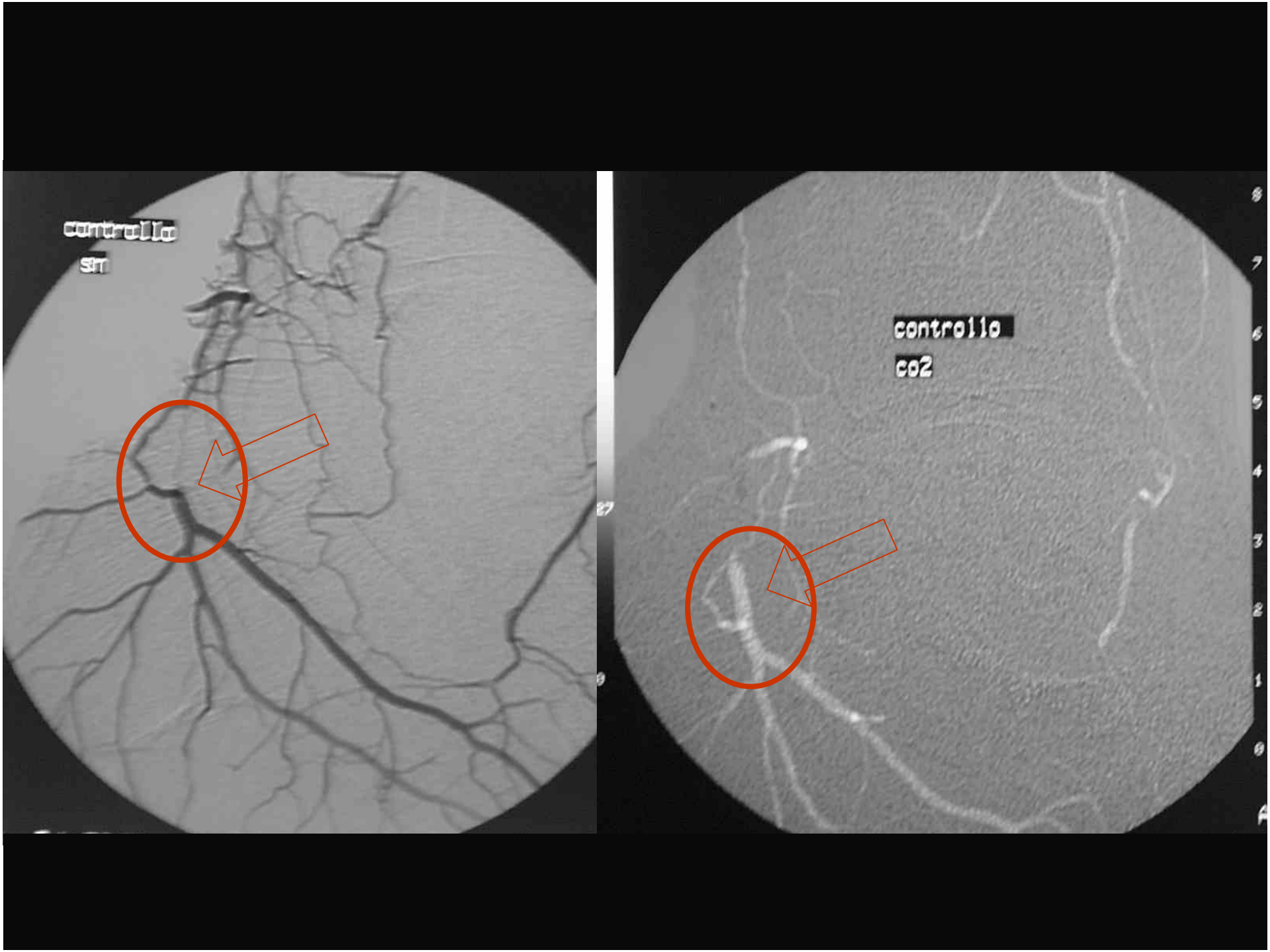
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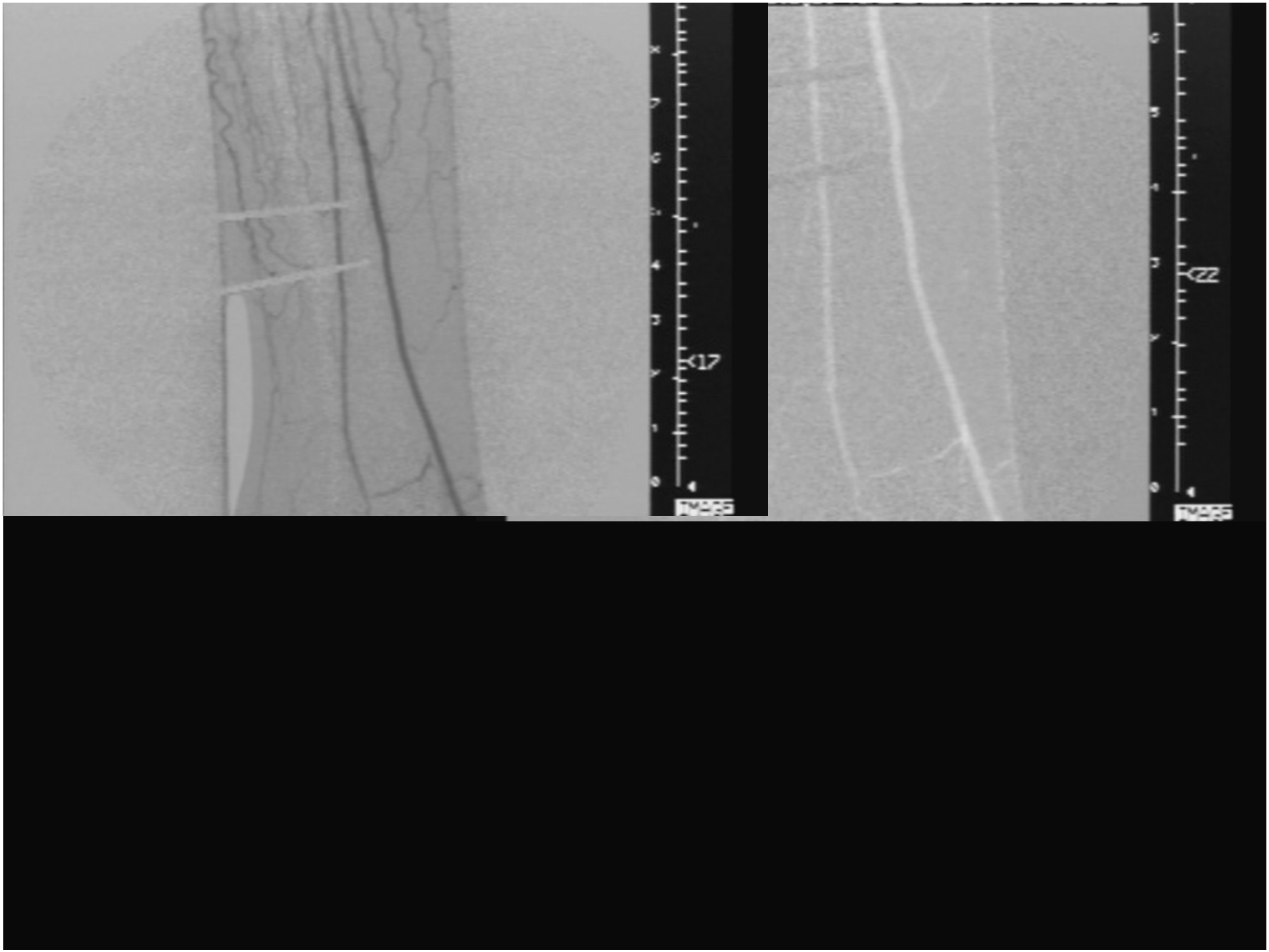

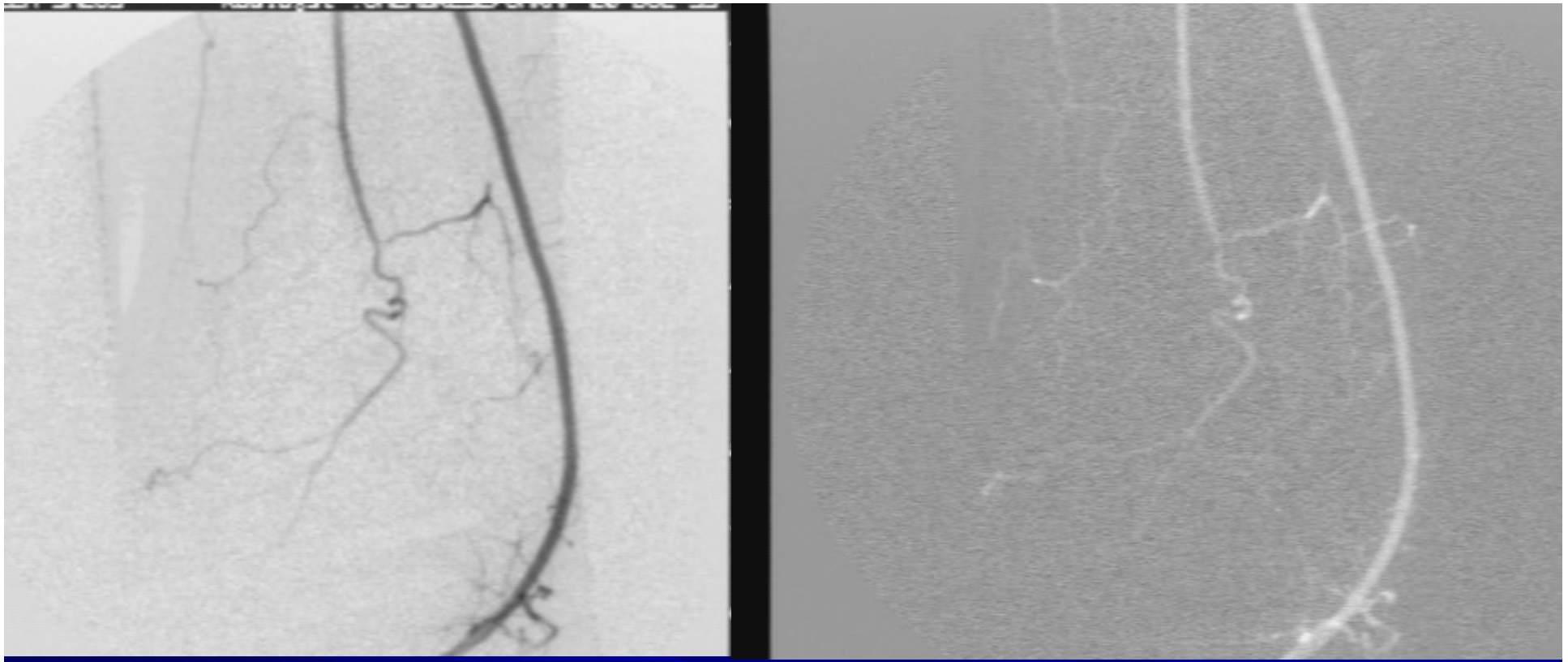

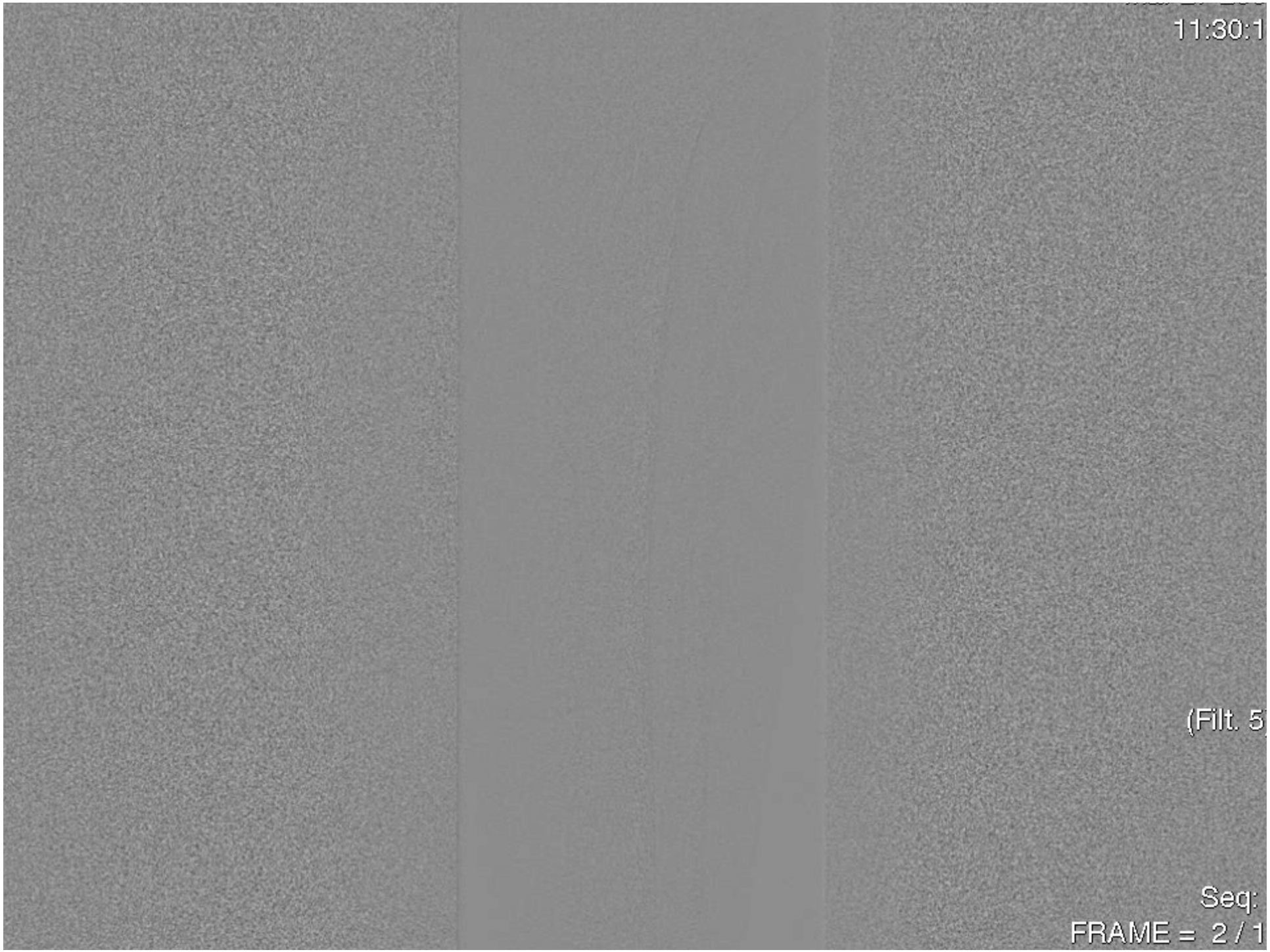
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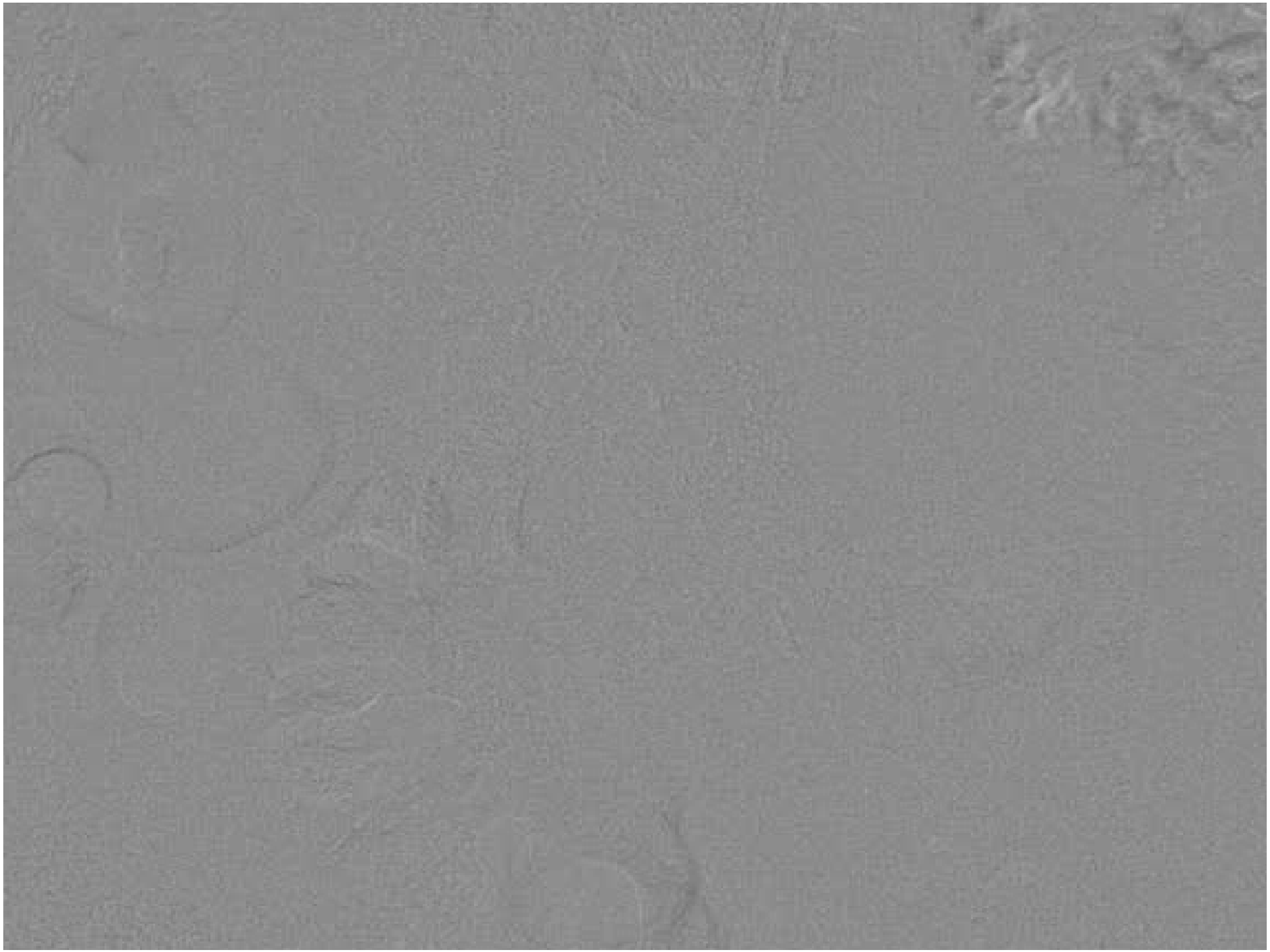


CO_2
versus
CO_2 + Iodine contrast

- 122 patients retrospective study
  - Pre-angio creatinine level (p= 0.46)
    - 2.8 ± 1.4 mg/dl in CO2 only group
    - 3.0 ± 1.4 mg/dl in CO2+Iodine group
  - Post-angio creatinine increase (p=0.27)
    - +0.17 ± 0.87 mg/dl in CO2 only group
    - +0.03 ± 0.98 mg/dl in CO2 + Iodine group

Dowling J Endovasc Ther 10(2):312-6 2003

CO_2 + small amount of iodinated contrast

versus

Iodinated contrast alone

- 82 patients
  - prospective randomized study of Renal angiography and PTRA

The amount of iodinated contrast
was significantly related to an increase in serum creatinine
2-days post-procedure (p=0.011)

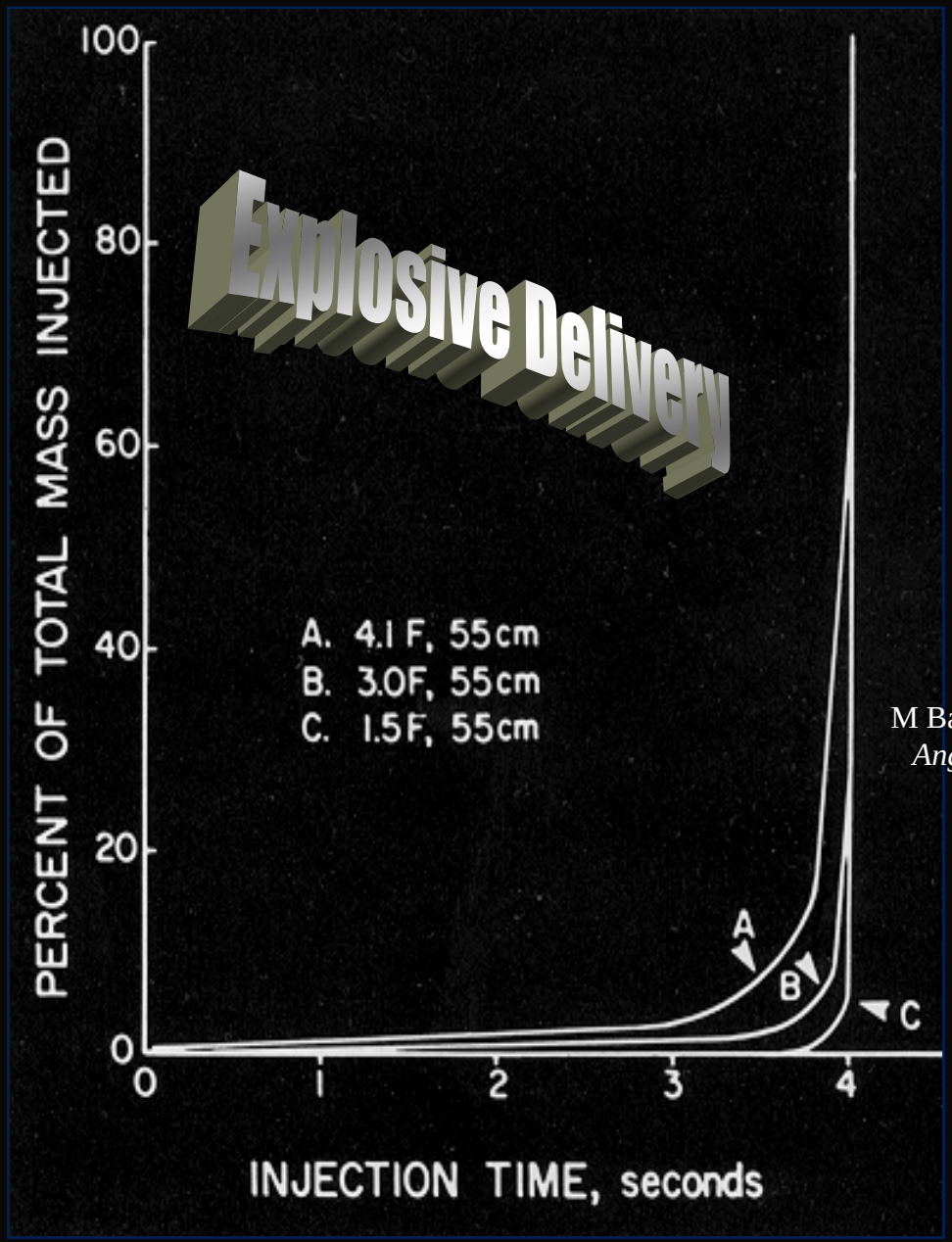
The larger the amount of iodinated contrast
The higher the risk of renal failure

Liss, Berqvist, Olsson, Nillson: J Vasc Interv Rad;16(1): 57-65 2005

CO_2 Injection

- Automatic injection:
  - Closed system
  - Self priming
  - No explosive delivery
  - No air contamination
  - Easily adjustable
  - Fast learning curve

- Hand injection:
  - Open or semi-open system
  - Risk of explosive delivery
  - Possible air contamination
  - Unprecise delivery of gas
  - Slow learning curve



M Back,J Caridi, I. Hawkins, J Seeger
Angiography with Carbon Dioxide

Syringe injection: 90% of CO2 is injected in the last 0.5 sec during a 4 sec. injection

Retrospective study

- Informed consent specific for CO_2 injection
- 1999 – 2007 - 8-year period
- 3 Institutions - 4 operators
- 654 procedures
  - 7290 CO2-injections
    - 245 diagnostic arteriographies
      - 64 CO_2 only
      - 181 CO_2 and Iopamiro-300
    - 409 PTA
      - 185 patients with **CO_2 only**
      - 224 patients with **CO_2 and Iopamiro-300**

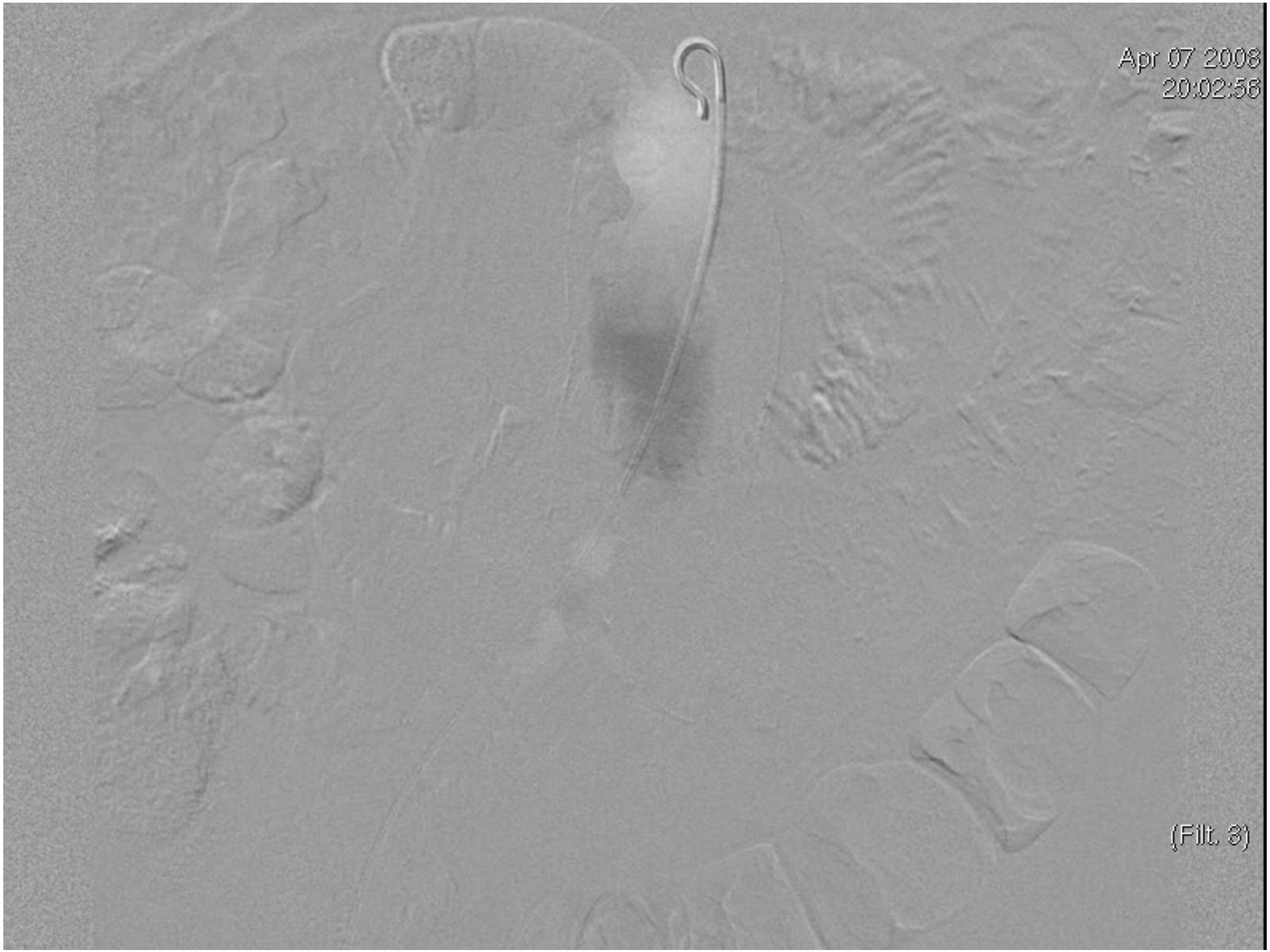
Results

- **15 complete failures** (>20 ml of iodinated contrast used) **(2.3%)**
  - **Uncooperative patient**
  - **Excessive bowel motility and air content**
  - **Unclear visualization of details**
- **157 partial failures** (<20 ml of iodinated contrast used) **(24%)**
  - **Good visualization of only a part of the arterial tree**
  - **Need for Iodine contrast integration in part of the exam**
- **482 complete success** (No iodinated contrast used) (73.7%)
  - Only Carbon Dioxide used to complete the exam
  - Satisfactory visualization and guidance

Complications and side effects

- **119** **episodes of** **Pain or discomfort** in 7290 injections
  - **75 out of the first 180 injections in 12 procedures** **(42%)**
  - **44 out of the subsequent 7110 injections in 642 procedures** **(0.6%)**

Mild intestinal discomfort		**(4%)**
Delayed CO_2 reabsorption	In 2 cases	**(0.3%)**
Missed renal artery	in 2 cases	
Missed popliteal aneurysm	in 1 case	
Neurological complications	none	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Procedure	Pre op	3 days Post	significance
Complete failure	1.8 ± 0.4	2.9 ± 0.9	$p < 0.05$
Partial failure	1.9 ± 0.6	2.0 ± 0.8	ns
Complete success	1.7 ± 0.8	1.8 ± 0.4	ns

CO_2 Arteriography
Why?

- Avoid allergic reactions to contrast
- Avoid renal toxicity
- Avoid fluid overload
- Reduce costs
- Utilize thinner catheters
- Visualize stents

CO_2 Arteriography
When?

- Borderline renal failure
- Chronic terminal renal failure
- Renal transplant vascular evaluation
- Previous reactions to contrast
- Evaluation of stent function and status
- Evaluation of GI bleed
- Evaluation of AV fistulas

CO_2 Arteriography

How?

Automatic Injector

Digital Subtraction

AVI or MPEG

CO_2 Arteriography
When Not?

- Neurovascular Studies
- Uncooperative patients
- Poor quality equipment
- Most studies above the diaphragm
- Untrained eye
- Learning Curve

An Integrated Approach

Carbon Dioxide

Borderline Renal failure
Terminal Renal Failure
Allergic Reactions
Load Reduction

Iodinated Contrast

Supradiaphragmatic Angio
Neurovascular Studies
Uncooperative Patients
Posterior Located Vessels

Peripheral Angiography
PTA
Endoprosthesis