

*Ultra-low iodine doses iso-attenuating
with Gd-doses proven diagnostic in CTA &
angiography/interventions in azotemia*

NSF

TO AVOID BOTH

and

CIN



*Nyman U, Elmståhl B,
Geijer H, Leander P,
Almén T, Nilsson M
Univ. of Lund & Örebro
Eur Radiol. 2010 Aug 29,
[Epub ahead of print]*



NSF

Nephrogenic systemic fibrosis

CIN

Contrast medium-induced nephropathy

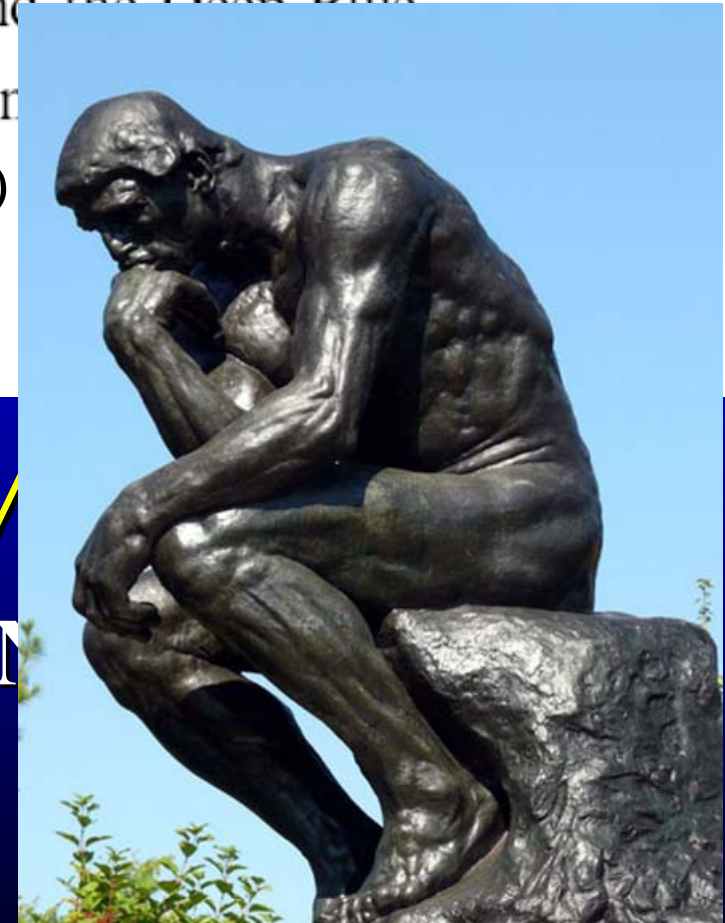
Nephrogenic Systemic Fibrosis and Contrast Medium-Induced Nephropathy: A Choice between the Devil and the Deep Blue Sea for Patients with Reduced Renal Function (“pest and cholera”, “Scylla and Charybdis”)

“A man’s got to do what a man’s got to do”

John Wayne

GFR <30 mL/min/

- **Gd-enhanced MR**
- **Iodine-enhanced CT**
 - dose-dependence not discussed



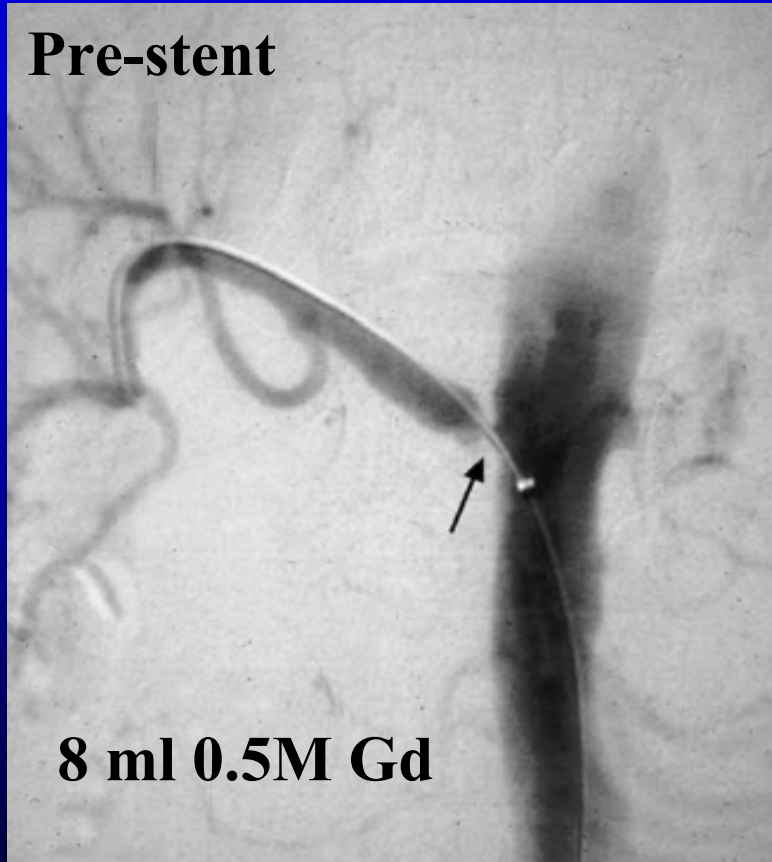
The Thinker, Auguste Rodin

Gadolinium CM for x-rays

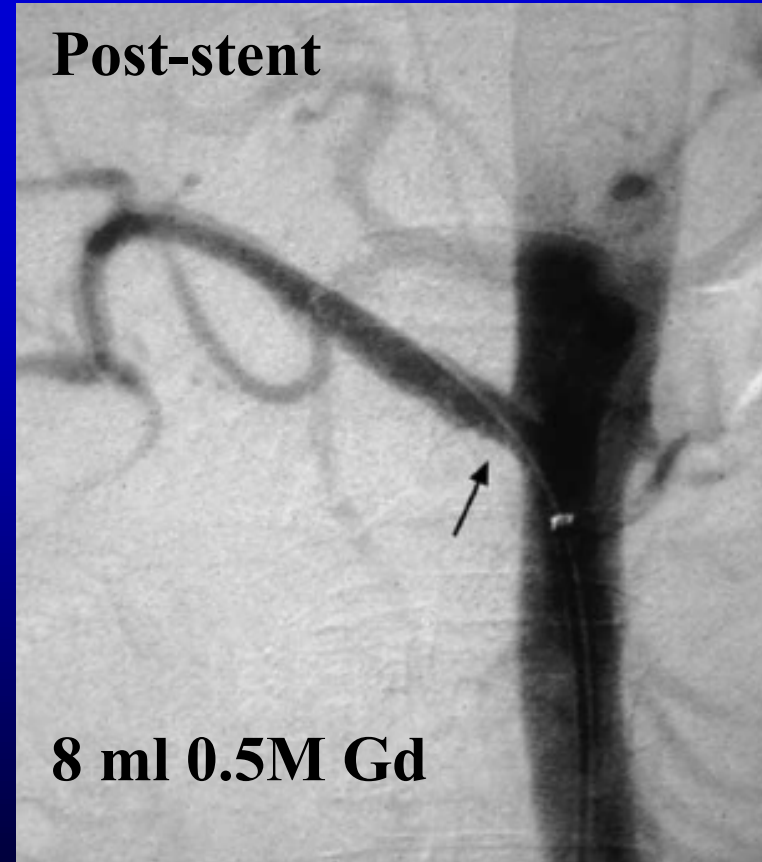
Before the advent of NSF, Gd-CM were used for CTA & angiography/interventions in patients at risk of CIN, since they were regarded as non-nephrotoxic by the general radiological community

Gadolinium x-ray angiography

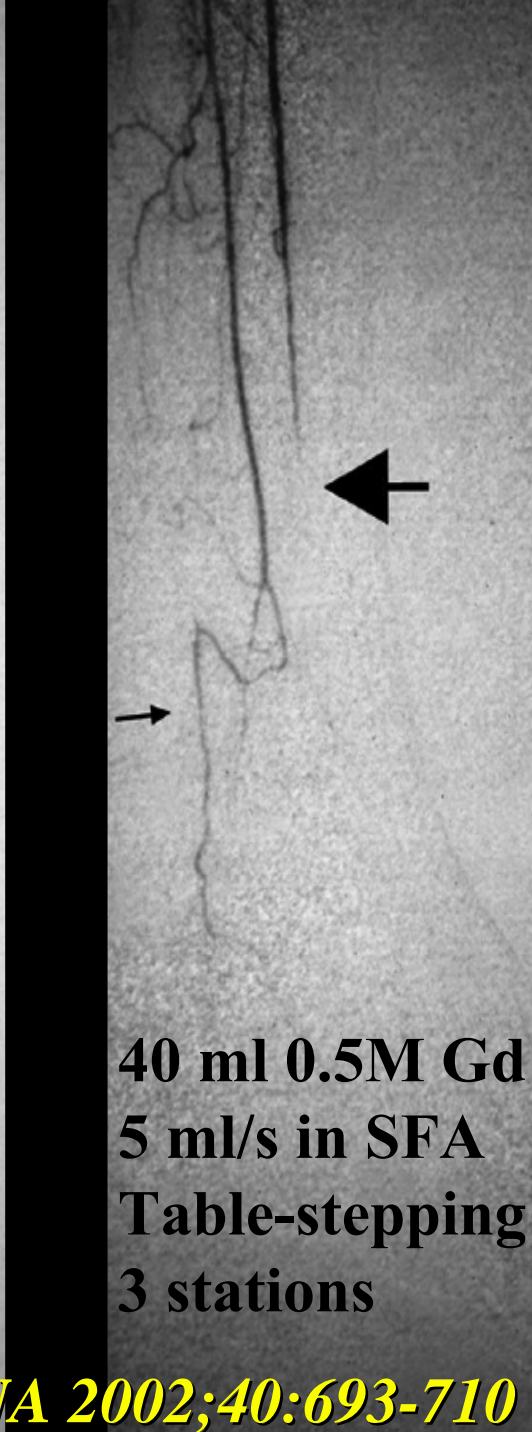
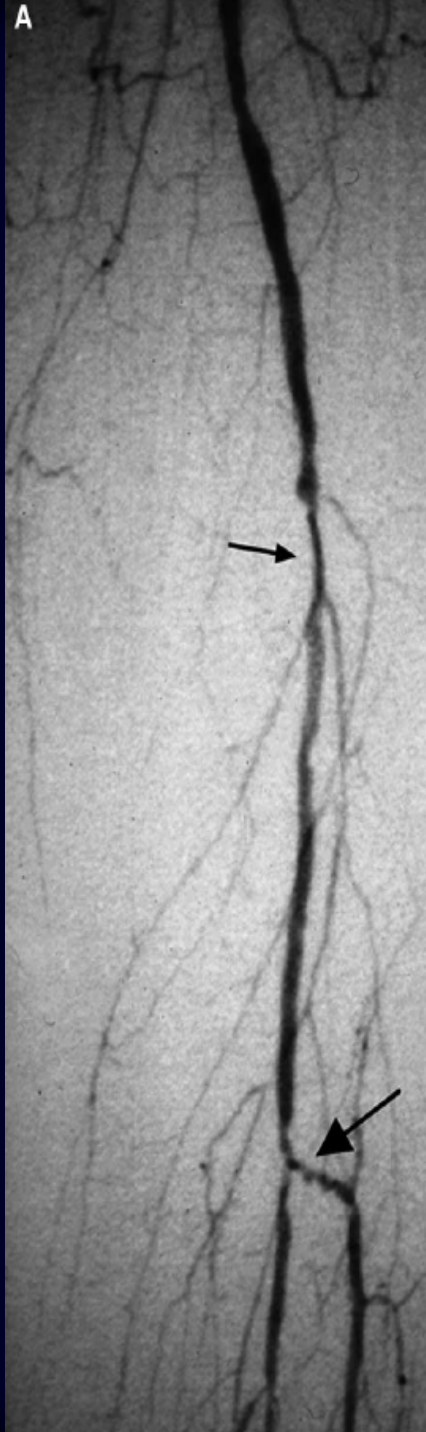
Pre-stent



Post-stent



A



40 ml 0.5M Gd
5 ml/s in SFA
Table-stepping
3 stations

Spinosa et al. RCNA 2002;40:693-710

Use of Gadobutrol in Coronary Angiography

Reinhard Voss,* MD, PhD, Mathias Grebe, MD, Martin Heidt, MD, and Ali Erdogan, MD



Angiography in three
renal comp
three patien
good. Cath



8-10 mL 1M Gd-CM



190 HU

150 HU

GADOLINIUM-CTA

≈0.4 mmol/kg

(mean 30 mL,

1.0M Gadovist®)

4 mL/s,

7.5 s injection time

Mean aortic density

190-220 HU

Esteban et al. Eur Radiol 2007



396 HU

209 HU

Gadolinium CTA and angiography

Literature conclusions

**Attenuation of Gd-CM inferior to
routinely used I-CM doses,
but examinations still reported as
being diagnostically acceptable**

Iodine CM iso-attenuating with Gd

**So why not use iodine CM in concentrations
and doses iso-attenuating with Gd-CM for
CTA and angiography/interventions?**

Department of Clinical Sciences, Malmö / Medical Radiology
Lund University
Malmö University Hospital

Are gadolinium contrast media really less nephrotoxic than iodine agents in radiographic examinations?

A comparison in relation to their ability to attenuate x-rays in a pig model

Iso-attenuating doses of I-CM should be less nephrotoxic than the “non-nephrotoxic” Gd-CM and with no risk of NSF

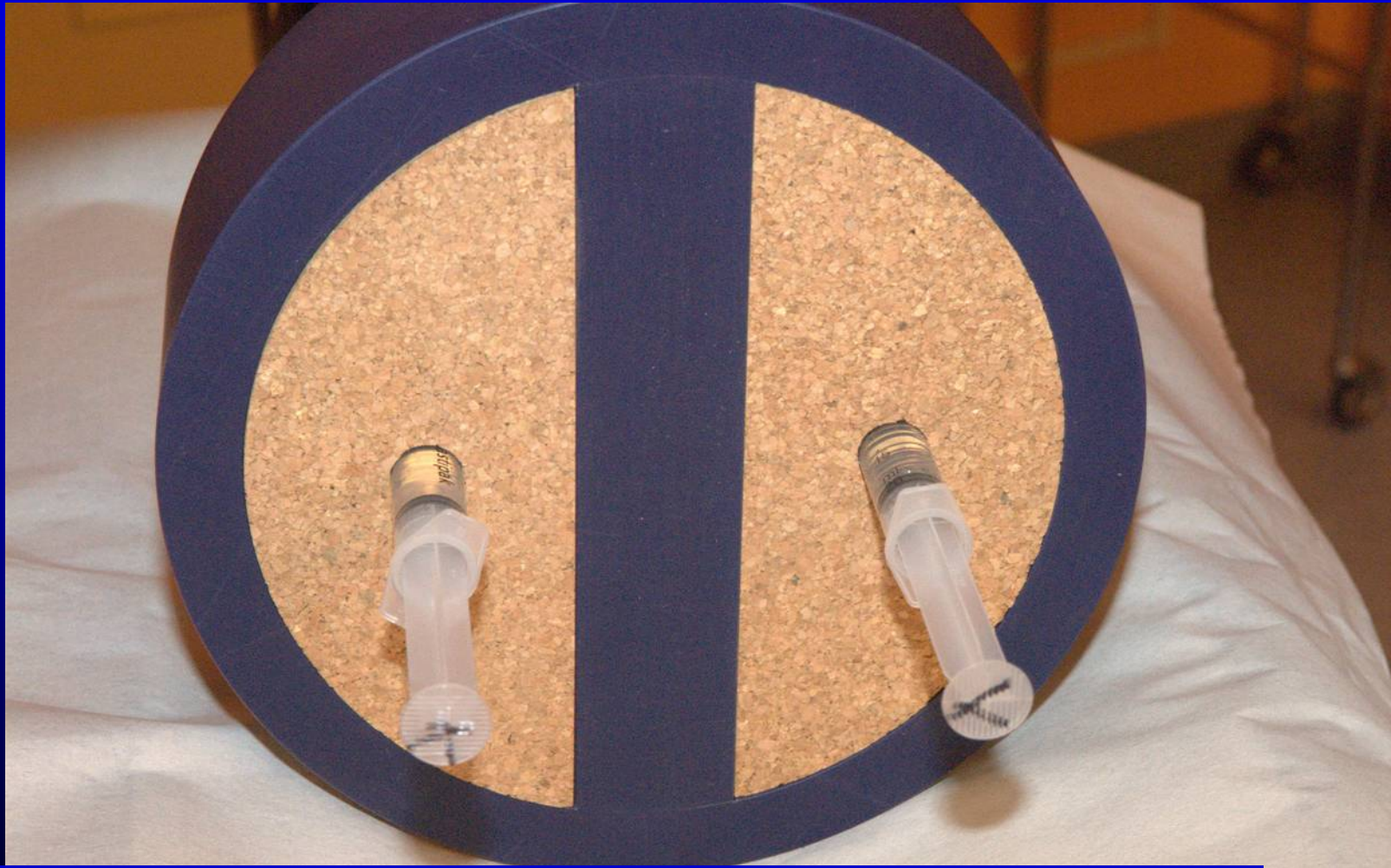
Iodine CM iso-attenuating with Gd

**What are the iso-attenuating
concentrations and doses of iodine?**

Clinical iodine doses \Rightarrow CIN

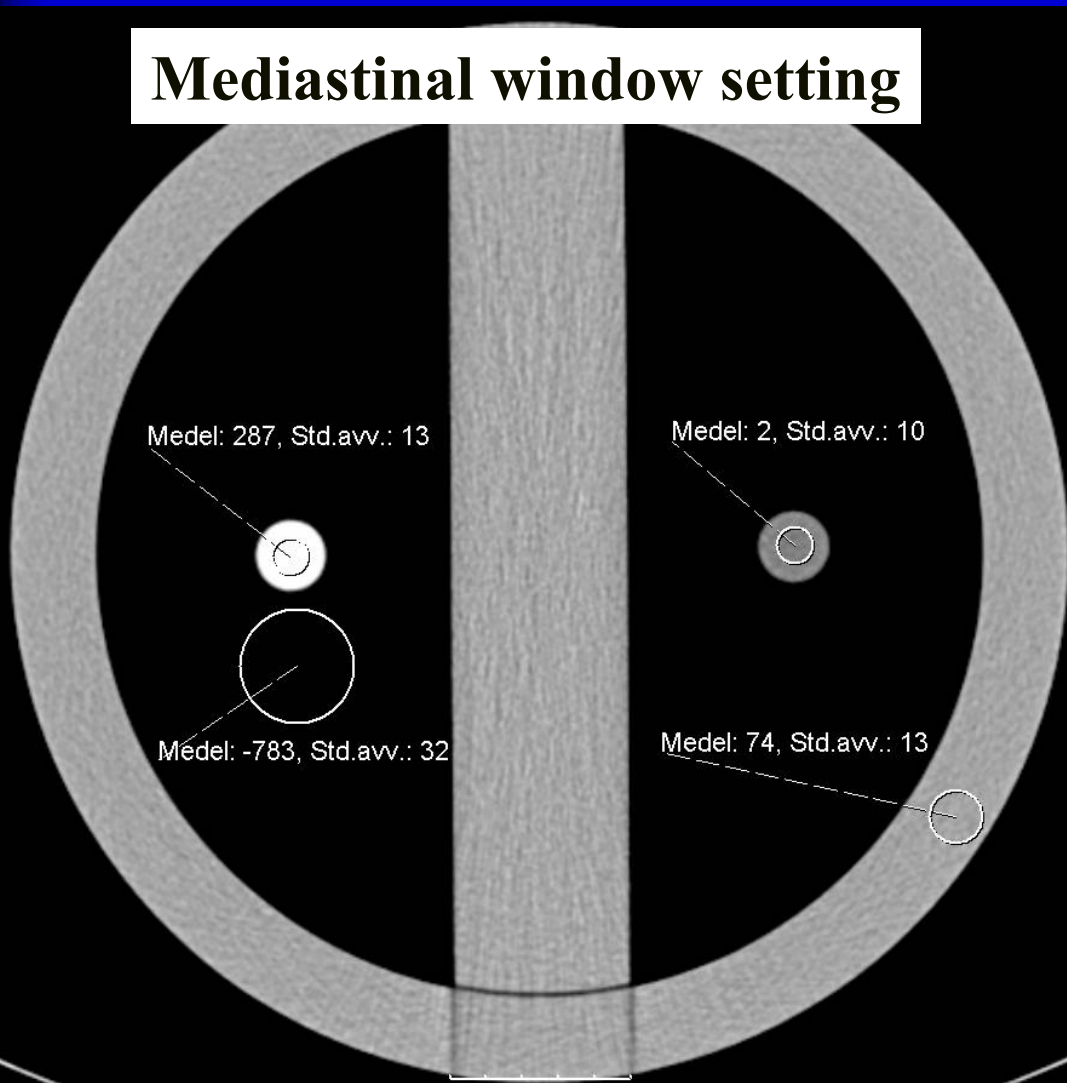
	<i>Volume</i> (mL)	<i>Conc</i> (mg I/mL)	<i>Gram-I</i>
• CT	100-125	300-400	30-50
• Angiography/ intervention	100-300	300-370	30-110
• DSA	200-300	150-200	30-60

30 cm thoracic phantom - Nylatron and cork

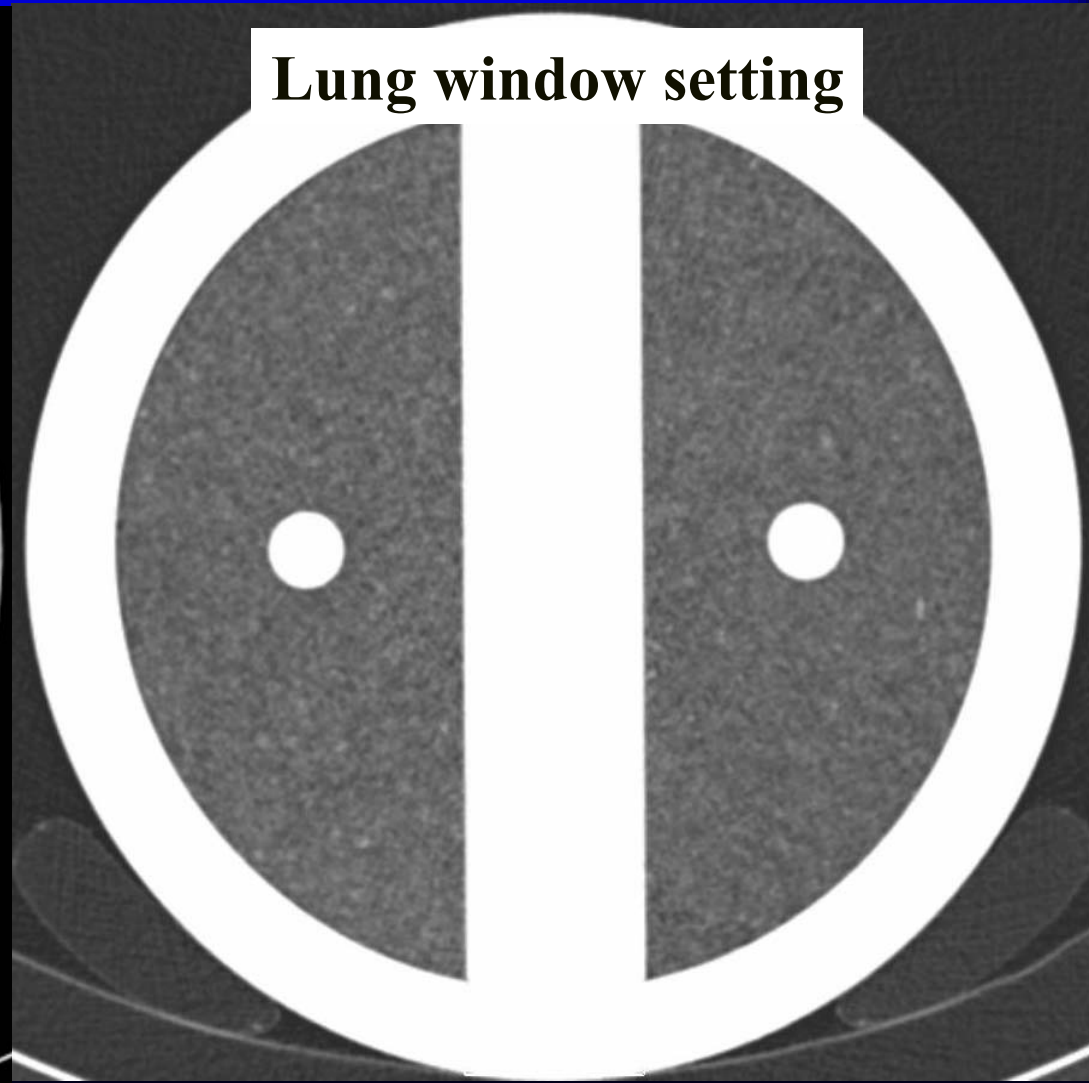


30 cm thoracic phantom - Nylatron and cork

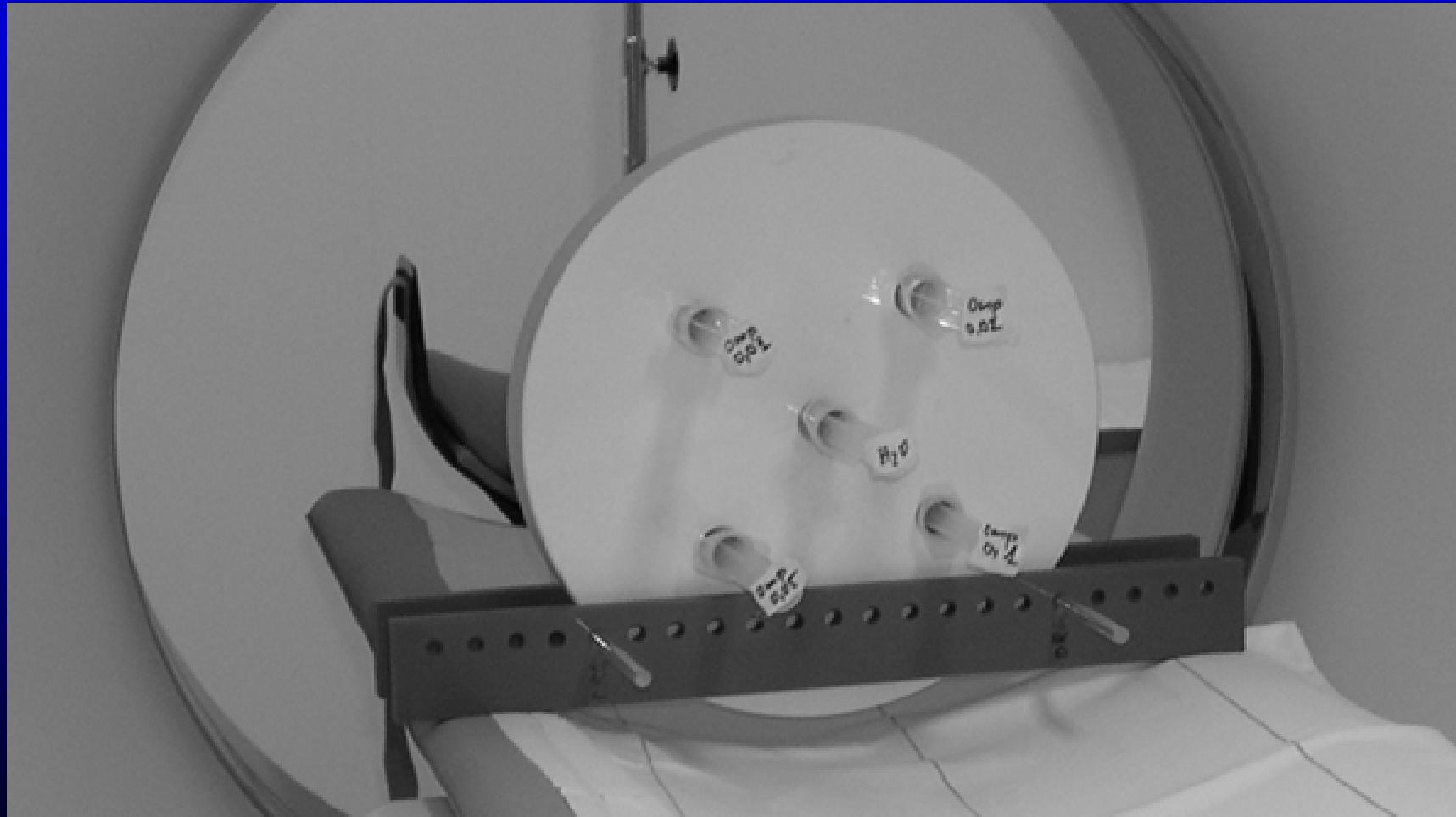
Mediastinal window setting



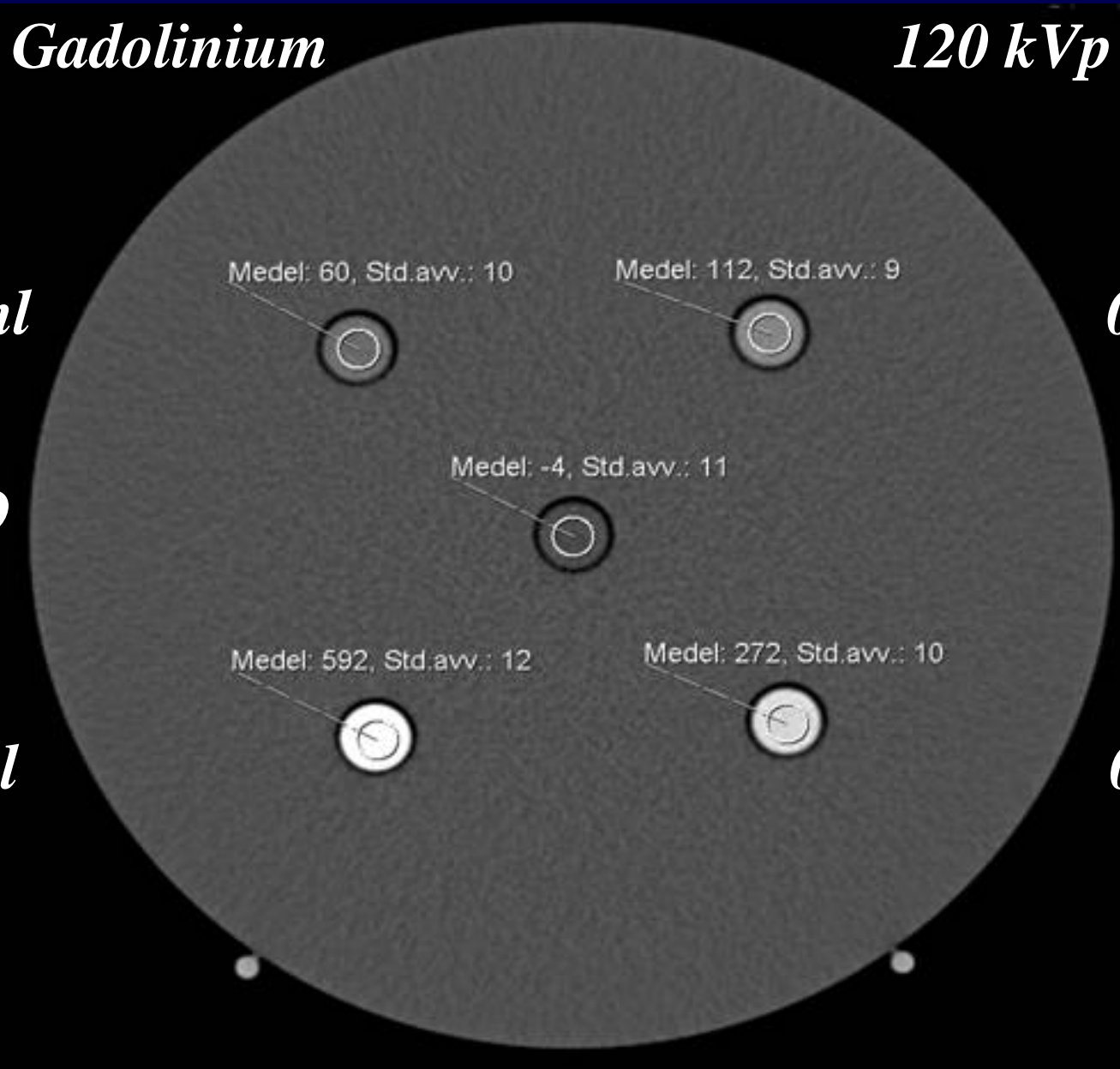
Lung window setting



30-cm H_2O_{equiv} abdominal phantom



30 cm abdominal phantom - I/Gd iso-attenuating concentrations



0.01 mmol/ml

0.02 mmol/ml

Distilled H₂O

0.1 mmol/ml

0.05 mmol/ml

Iodine iso-attenuating with 0.5M Gd

Computed tomography *Chest* *Abdomen*
mg I/mL

• 80 kVp	<i>100 mg I/mL</i>	
• 100 kVp	106	117
• 120 kVp	113	122
• 140 kVp	116	125

Iodine iso-attenuating with 0.5M Gd

- **CTA literature:** 40-70 mL 0.5M Gd
 - 100-230 HU mean arterial density
- **Iodine-CM at 80 kVp CTA**
 - 40-70 mL \approx 100 mg I/mL 4-7 gram iodine
 - conventional doses 30-50 gram iodine

Iodine iso-attenuat w. 0.4 mmol Gd/kg

Computed tomography

Chest Abdomen

mg I/kg

• 80 kVp	PE?	73	83
• 100 kVp		85	94
• 120 kVp		90	97
• 140 kVp		93	100

Pulmonary Gd-angiography

16-slice, 80 kVp, 0.4 mmol/kg



- 73 mg I/kg
- 75 kg
- 5.5 gram iodine
- 18 ml, 300 mg I/mL

80 kVp 16-MDCT for PE



*87 yrs, 43 kg, 156 cm
113 μ mol, eGFR 21*

*150 mg I/kg,
12 sec inj time*

*20 ml, 320 mg I/mL
6.4 gram-iodine
1.7 mL/s*

*Eur Radiol 2010;
20:1321-1330*

CHEST

150 mg I/kg

**Ultralow contrast medium doses at CT
to diagnose pulmonary embolism in patients
with moderate to severe renal impairment:
a feasibility study**

Mattias Kristiansson
Fredrik Holmquist
Ulf Nyman

CT pulmonary embolism

Patient characteristics	80 kVp (n=50)		120 kVp (n=50)	
	Median value	2.5 & 97.5 percentiles	Median value	2.5 & 97.5 percentiles
Age	84	67-96	67	35-88
Weight (kg)	65	43-84	73	50-113
eGFR	37	21-60	≥50	NR
Gram iodine	9.6	6.4-12.8	22	15-24
mg I/kg/s	13	11-13	25	18-27

Arterial enhancement

- Age ↗ ⇔ Renal ↘ ⇔ Cardiac disease
- Cardiac output ↘ ⇔ enhancement ↗

16-channel MDCT for PE

Bae et al. Radiology 2005;236:677-684 (120 ml 350 mg I/ml, 3-4 ml/s; 30-40 sec)

	kVp	Dose	Density	Noise	CNR
		gram I	HU	HU (1 SD)	
Bae et al.	120	42	366	24	13
<i>Holmquist</i>	120	23	345	21	13
<i>Kristiansson</i>					
<i>200 mg I/kg</i>	80	13	359	24	13
<i>150 mg I/kg</i>	80	10	353	25	11



Aortic dissection?

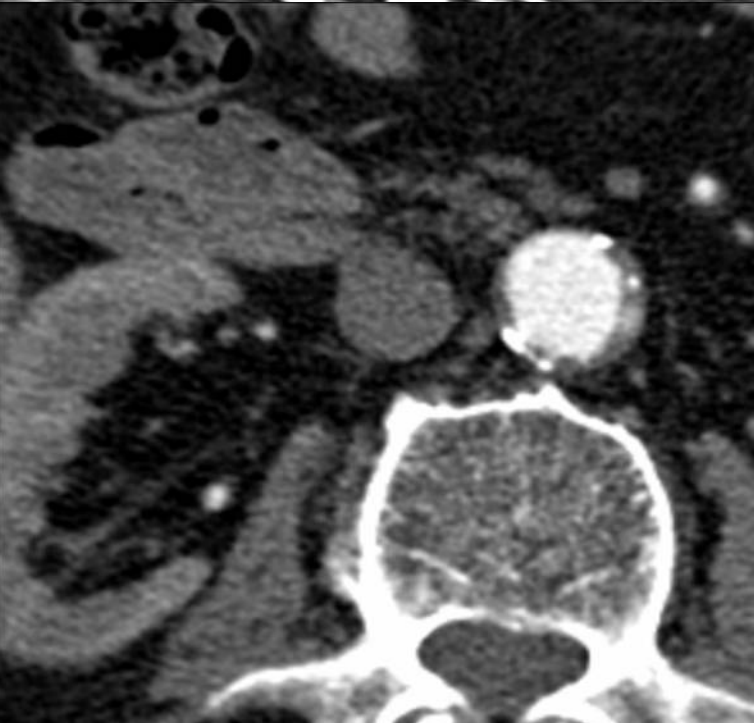
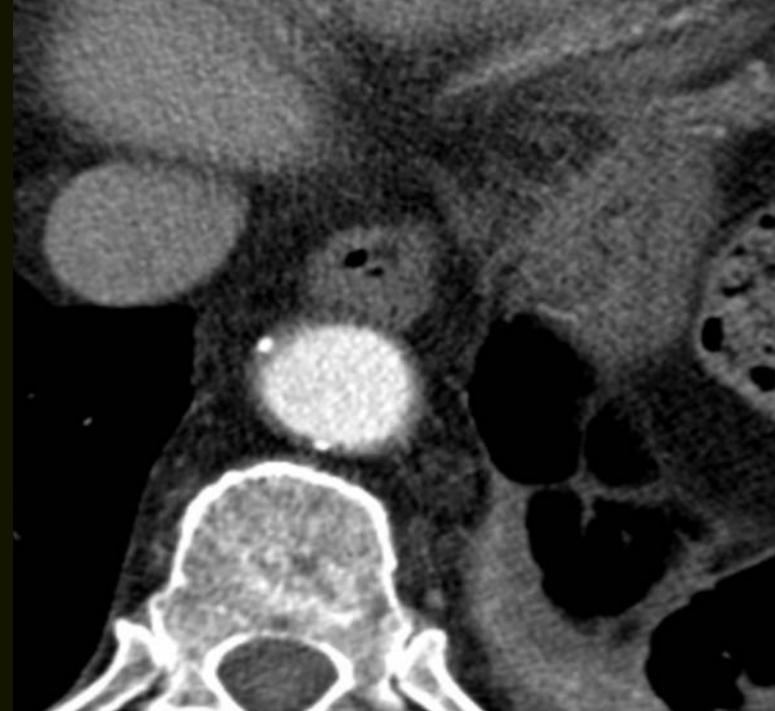
88 years, 65 kg

eGFR 26 mL/min

200 mg I/kg, 15 sec

40 mL 320 mg I/ml

13 gram I



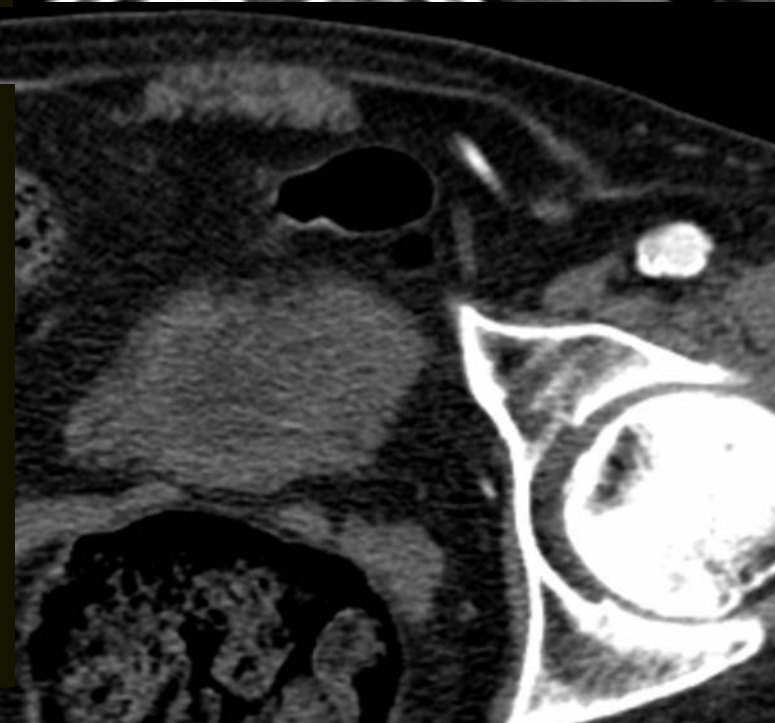
100 mg I/kg, 8 sec?

20 mL 320 mg I/ml

6.4 gram I

Sufficient to cover

thoracic aorta

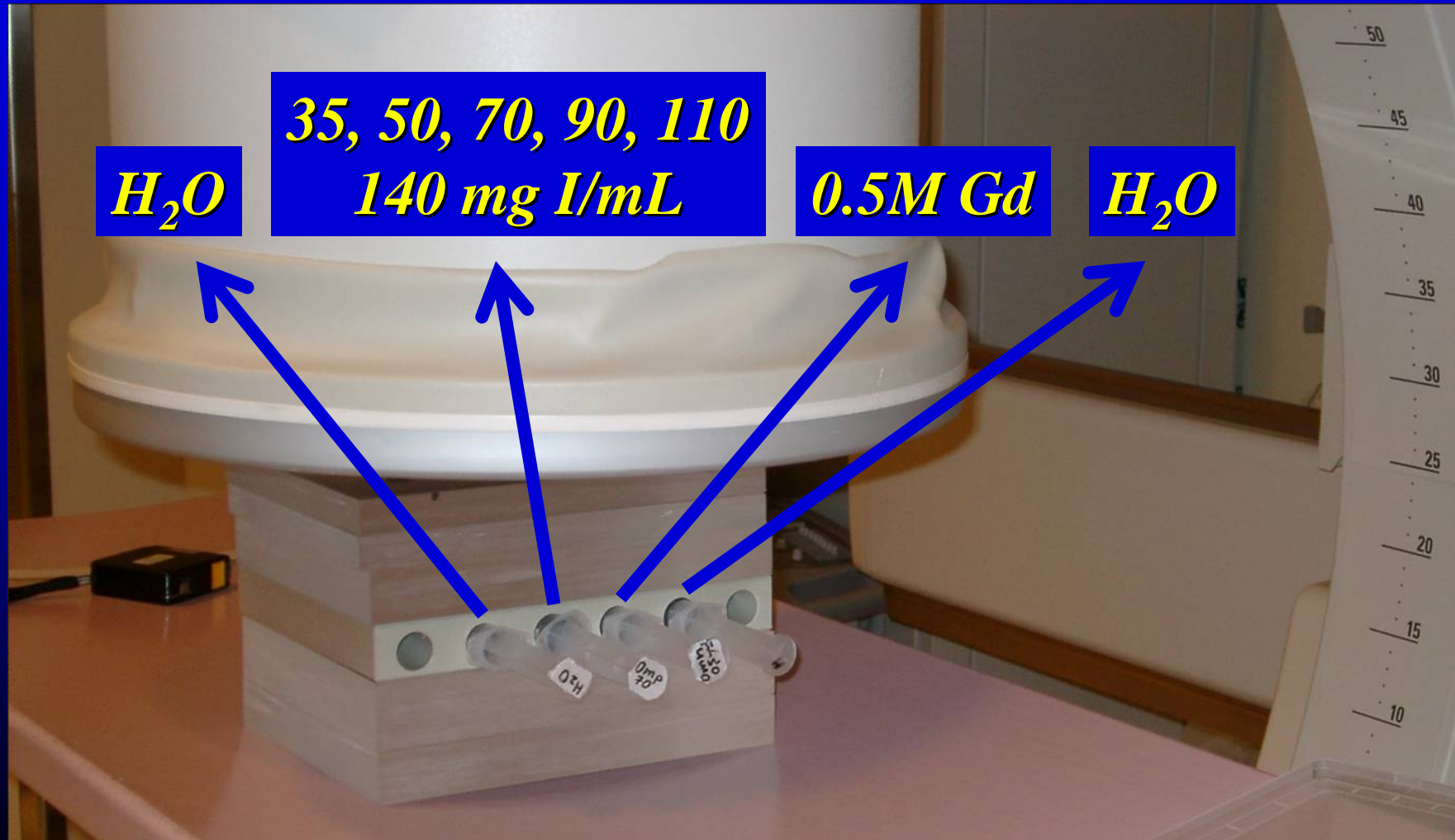


Spin: 90
Tilt: -56

429 HU

- 200 mg I/kg, 15 second injection time
- 34 ml, 320 mg I/ml (11 gram-I), 3.5 ml/sec
- 80 kVp, 375 mAs,
 - CTDI 9.8, DLP 166, 2.5 mSv
- 100 mg I/kg, 8 second injection time?

Water-equivalent angiography phantom 20/13 cm thick



Iodine iso-attenuating with 0.5M Gd

Angiography

mg I/mL

- 60 kVp 35
- 70 kVp 60
- 80 kVp 70
- 95 kVp 80
- 115 kVp 90

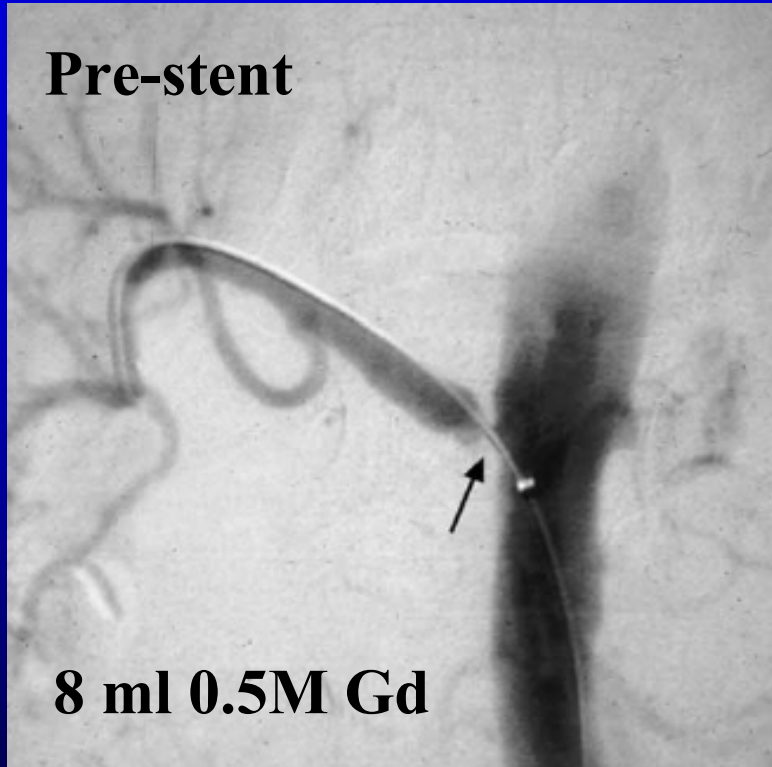
Iodine iso-attenuating with 0.5M Gd

70 mg I/mL at 80 kVp angiography/interventions

- Mean Gd-CM dose (literature) 0.2-0.8 mmol/kg
- $75 \text{ kg} * 0.2-0.8 = 15-60 \text{ mmol}$ 30-120 mL
- $30-120 \text{ mL} * 70 \text{ mg I/ml}$ 2.1-8.4 gram iodine
 - dilute commercial 140 mg I/mL w. saline 1:1
- Common angio/interv. doses 30-110 gram iodine

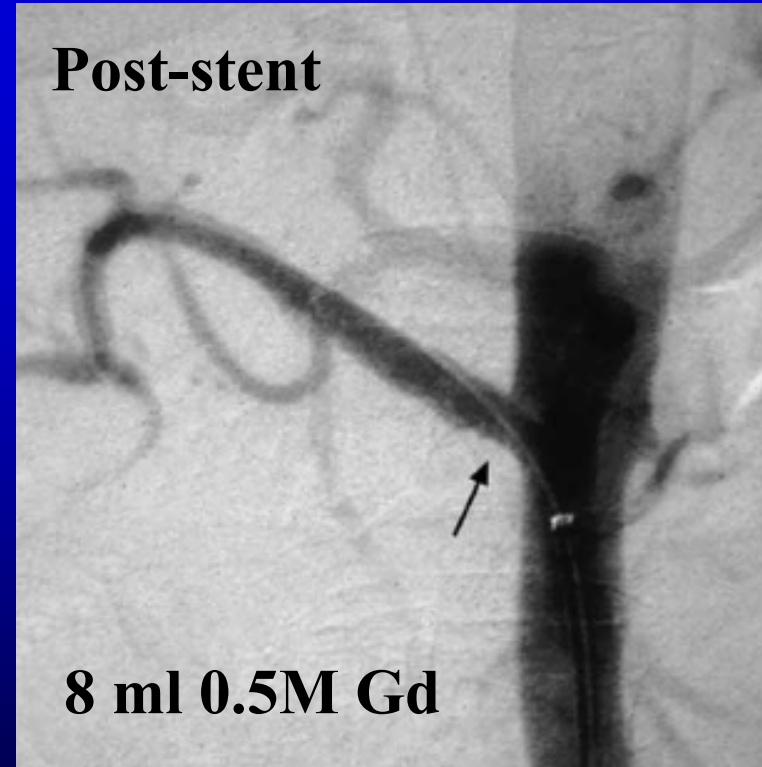
Gadolinium x-ray angiography

Pre-stent



8 ml 0.5M Gd

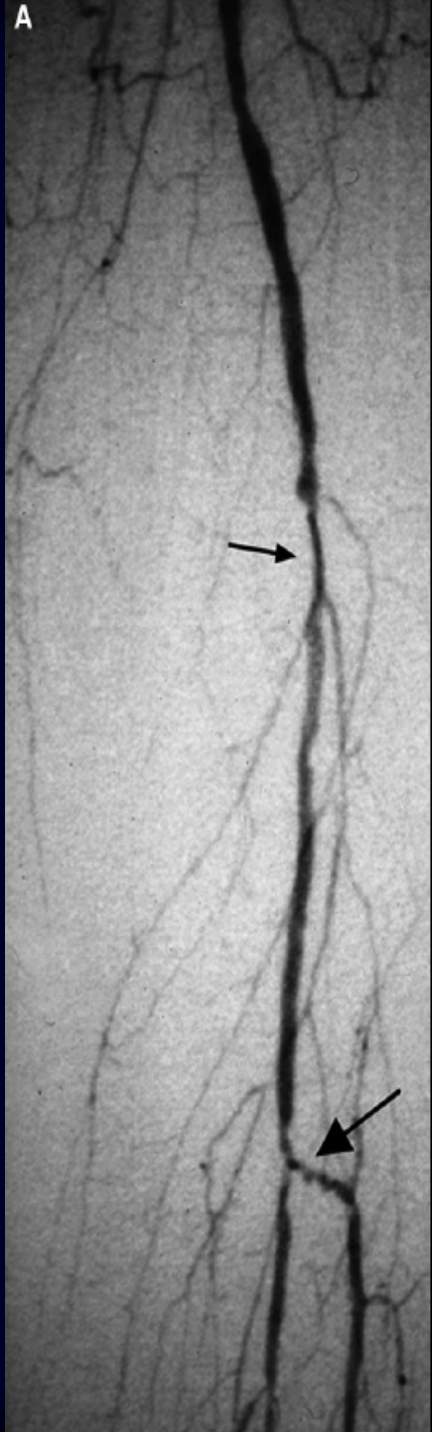
Post-stent



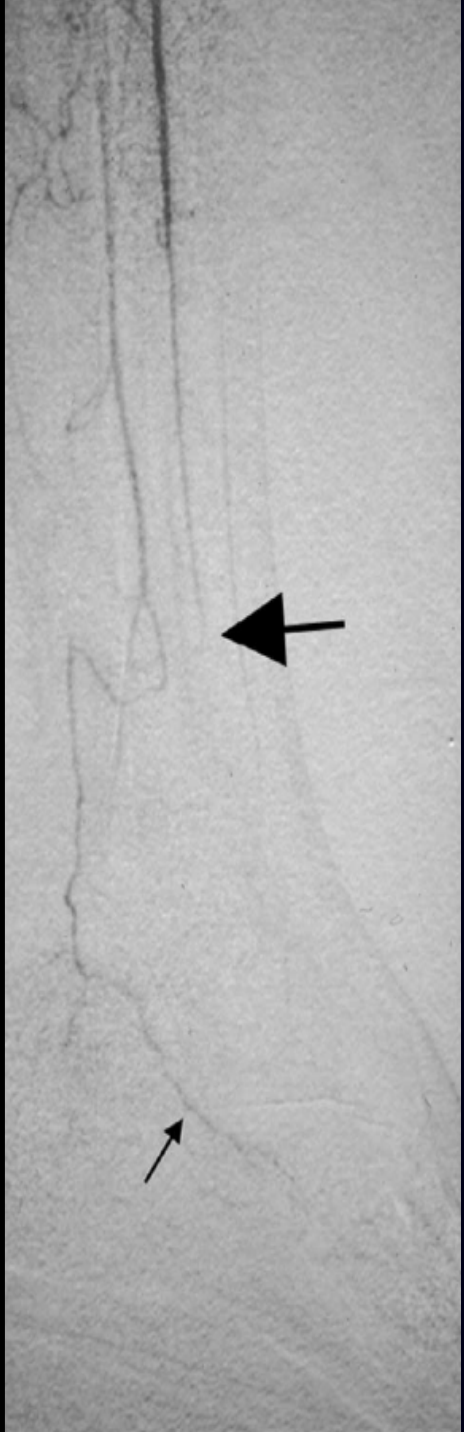
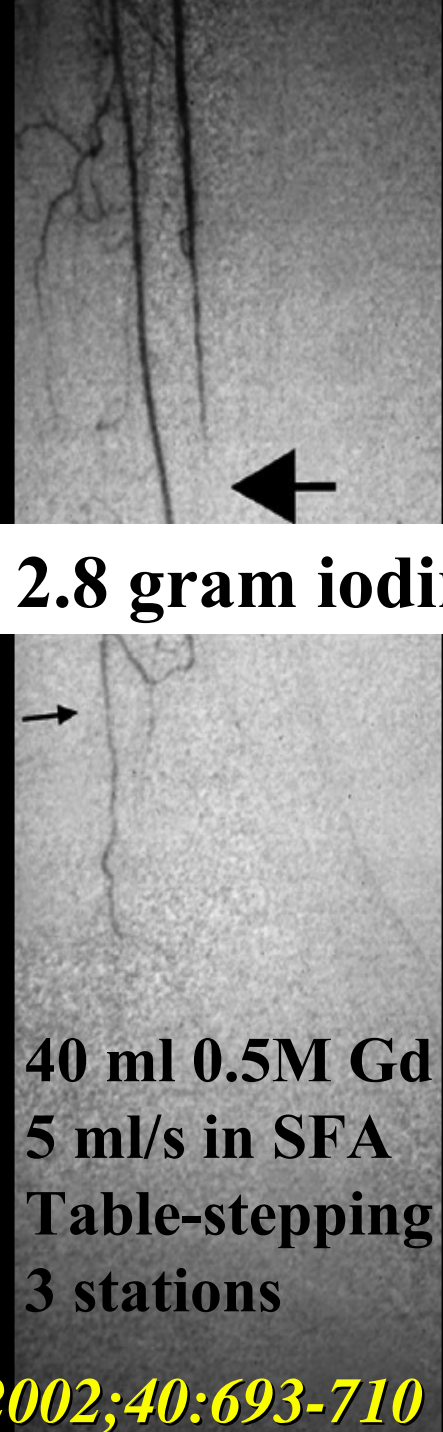
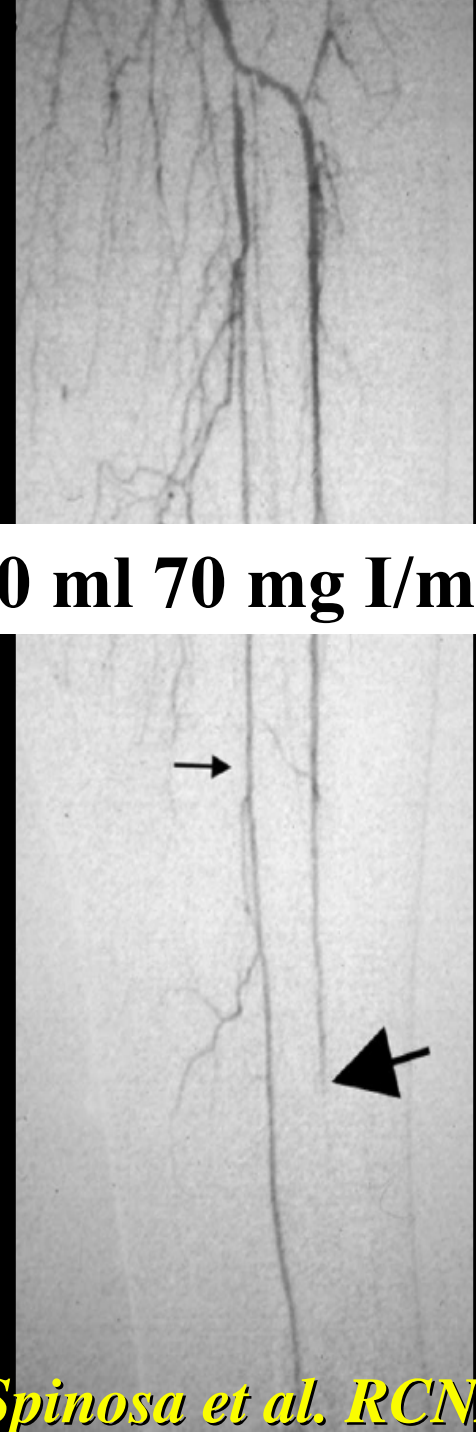
8 ml 0.5M Gd

8 ml 70 mg I/mL = 0.6 gram-I

A



40 ml 70 mg I/ml = 2.8 gram iodine



**40 ml 0.5M Gd
5 ml/s in SFA
Table-stepping
3 stations**

Renal DSA - gadolinium/iodine

0.5M MAGNEVIST



1960 mOsm/kg H₂O

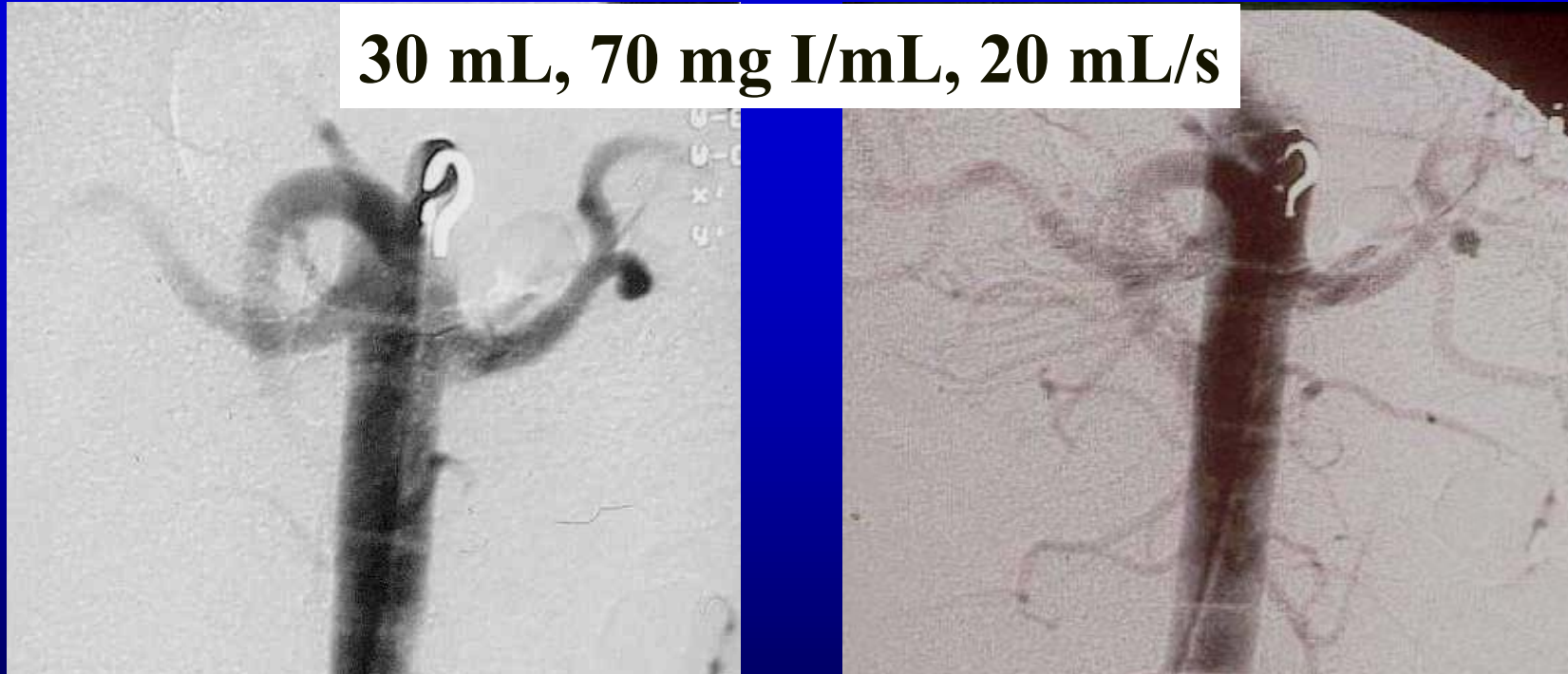
OMNIPAQUE 70 mg I/mL



300 mOsm/kg H₂O

Renal DSA - 70 mg I/mL

30 mL, 70 mg I/mL, 20 mL/s



*Digital compression of CFA or
Bilateral thigh tourniquets as modum Fariñas 1941
Cuban, 1st retrograde catheter aortography*

Gadolinium-Enhanced Coronary Angiography in Patients With Impaired Renal Function

Antoine Sarkis, MD, Georges Badaoui, MD, Rabih Azar, MD, Ghassan Sleilaty, MD,
Rania Bassil, MD, and Victor A. Jebara, MD

Am J Cardiol **2003**;91:974-5

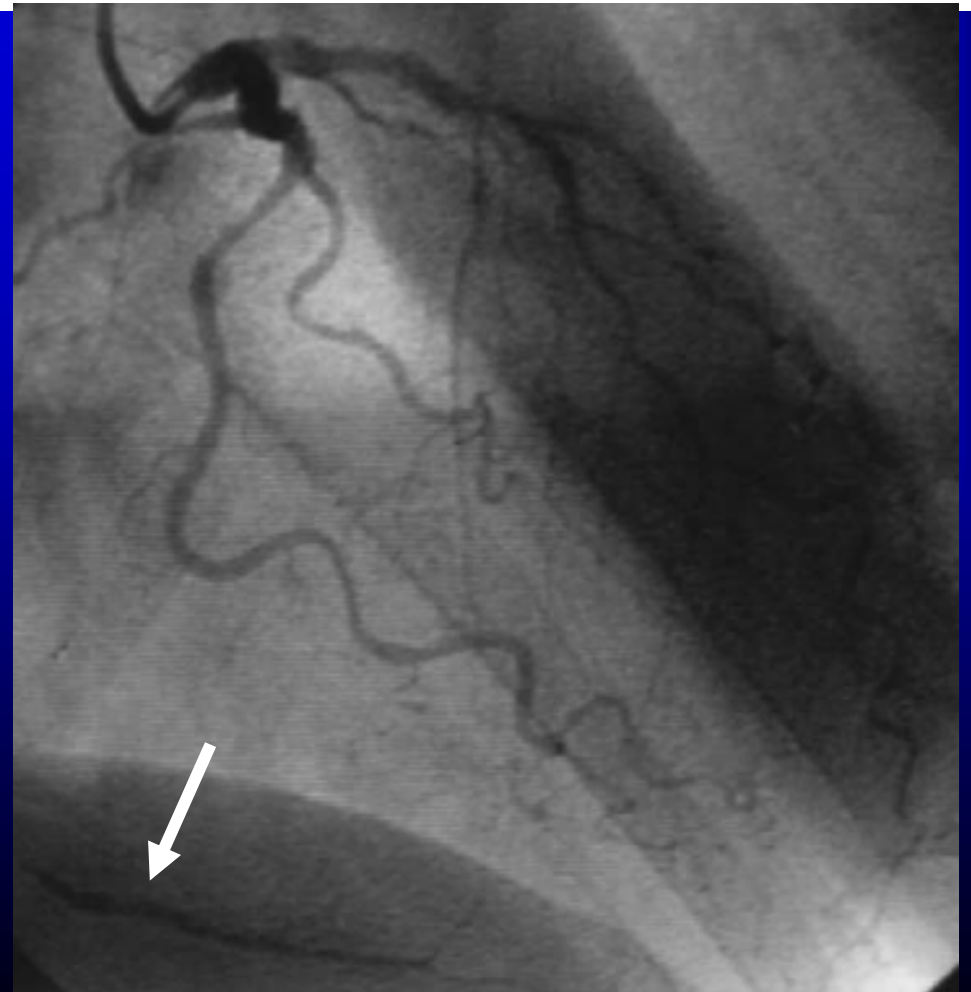
Omniscan:Omnipaque 2:1

0.5M Gd (80 kVp) 70 mg I/mL

Omnipaque 350 mg I/mL

(70+70+350)/3 = 160 mg I/mL

N=15; quality satisfactory in all



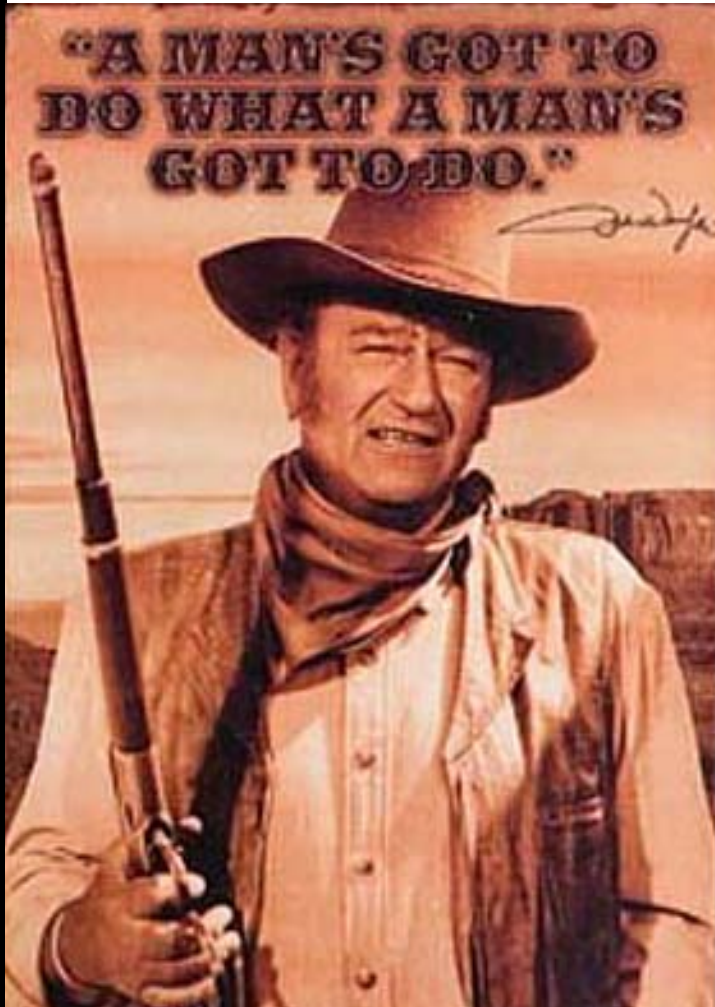
Conclusion

Meticulous examination technique and ultra-low I-CM doses iso-attenuating Gd-CM doses used in CTA and angio/-intervention may minimise the risk of nephrotoxicity in azotemic patients, while there is no risk of NSF.

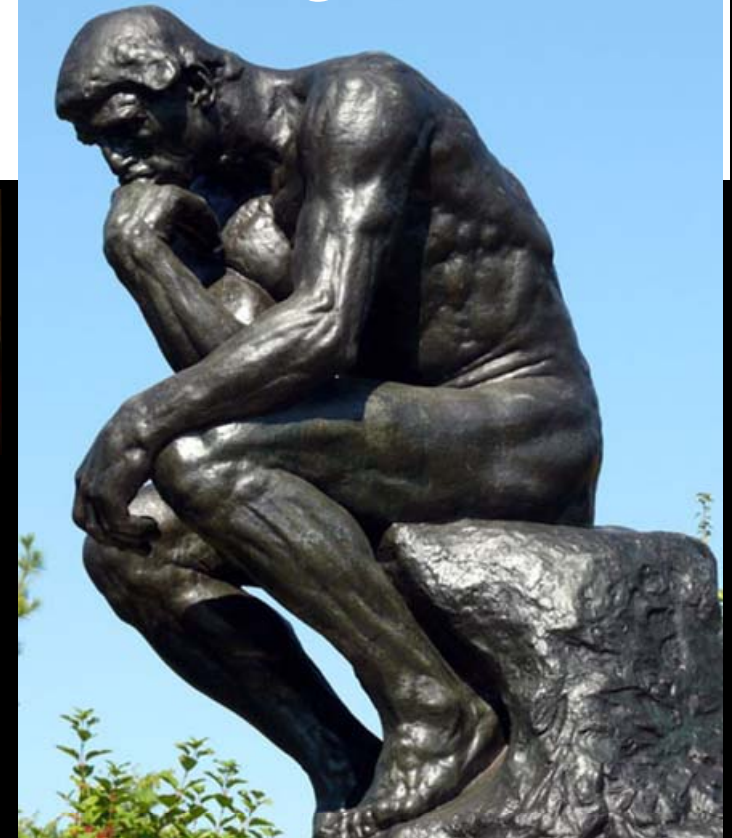
Conclusion

**There may be a way out of the
seemingly inescapable choice
between CIN (Scylla) and
NSF (Charybdis).**

Nephrogenic Systemic Fibrosis and Contrast Medium-Induced Nephropathy: A Choice between the Devil and the Deep Blue Sea for Patients with Reduced Renal Function?



A man's got to think!!



The Thinker, Auguste Rodin

Photo: Mattias Kristiansson



**BEWARE OF THE
DARTH "CONTRAST" VADER!**