How to do **EVARs with no Contrast** and **without FORS / IOPS**

Vascular Surgery
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Statement of financial interest

Enrico Gallitto

- ✓ Cook Medical - Clinical proctor for F/B-EVAR
- ✓ No disclosure for the present talk

Why EVARs with no Contrast ?

✓ **Acute Kidney Injury**

after endovascular aortic procedure

EVAR / F-BEVAR

review www.kidney-international.org

Endovascular aneurysm repair (EVAR)– and transcatheter aortic valve replacement (TAVR)–associated acute kidney injury

Kenar D. Jhaveri[1,4], Athanasios N. Saratzis[2,4], Rimda Wanchoo[1] and Pantelis A. Sarafidis[3]

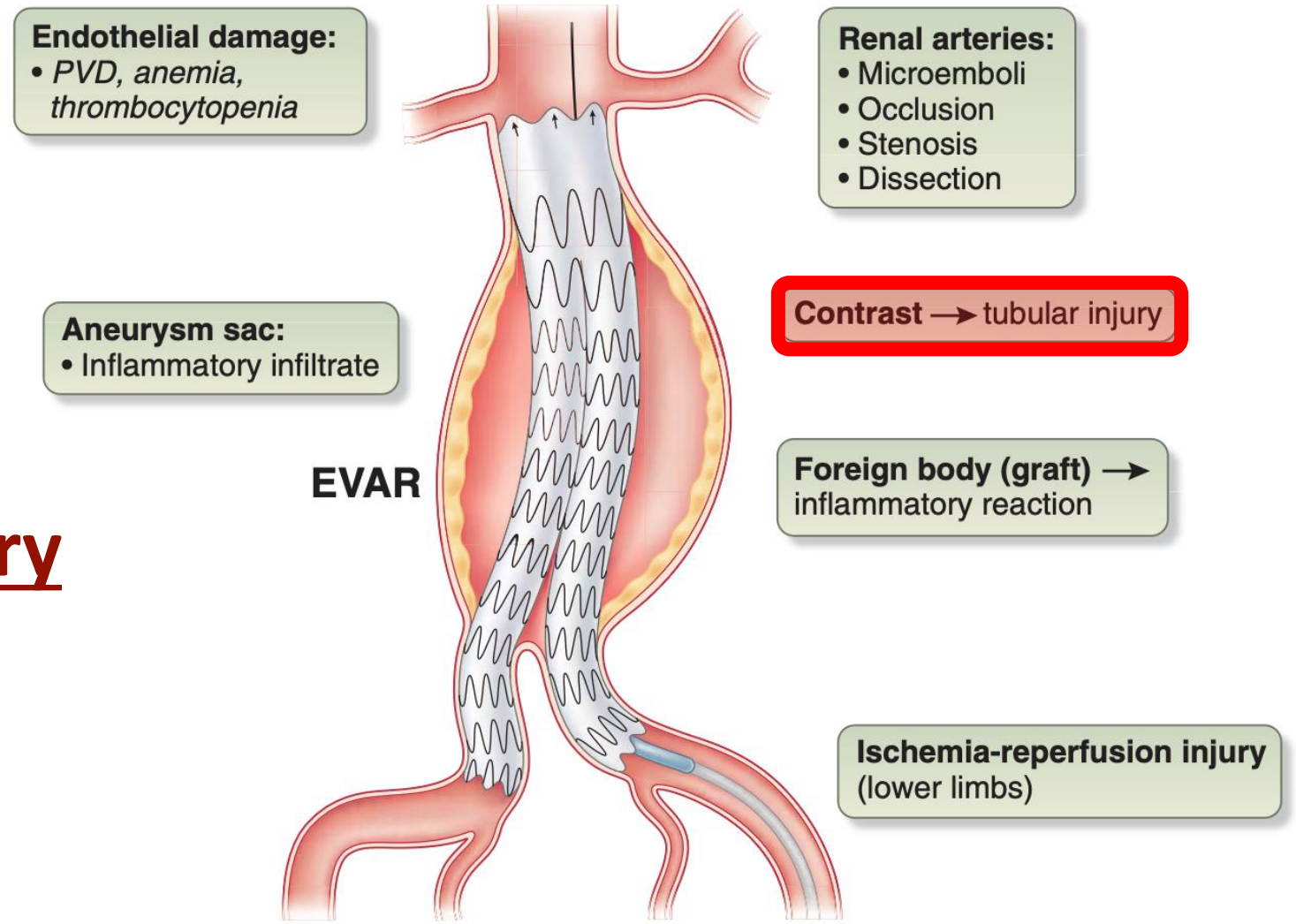
[1]Division of Nephrology, Northwell Health, Hofstra Northwell School of Medicine, Great Neck, New York, USA; [2]Leicester NIHR Cardiovascular Biomedical Research Unit, University of Leicester, UK; and [3]Department of Nephrology, Hippokration Hospital, Aristotle University of Thessaloniki, Greece

Kidney International, 2017

Mechanisms of **Renal damage**

Contrast - induced injury

Tubular



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Kidney International, 2017

Acute Kidney Injury post EVAR

5.5% - 19%

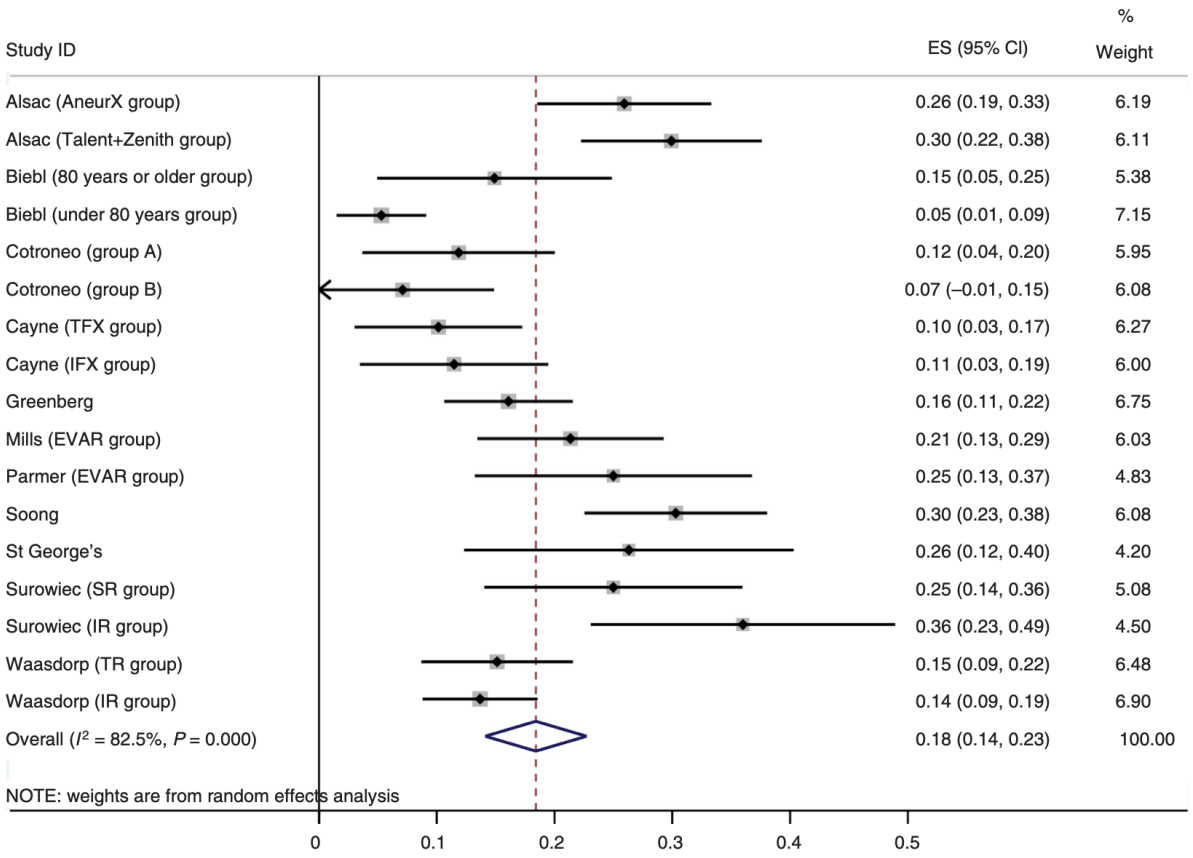
Reference	Type	Date	EVAR (n)	AKI criterion	AKI incidence	AKI (n)	AKI stage > 2 (n)	Dialysis	Urine output available
Pirgakis *et al.*[37]	Retrospective	2014	87	AKIN	17%	15	None	1	No
Ueta *et al.*[39]	Prospective	2014	47	AKIN	14%	6	Stage 2: 1	None	No
Pisimisis *et al.*[38]	Retrospective	2013	208	RIFLE	17%	36	NA	NA	No
Saratzis *et al.*[4]	Prospective	2015	149	AKIN & KDIGO	19%	28	Stage 2: 3	None	Yes
Saratzis *et al.*[49]	Retrospective	2015	484	AKIN	12%	58	NA	None	No
Saratzis *et al.*[5]	Retrospective	2015	947	KDIGO	18%	167	Stage 2: 12; Stage 3: 2	None	No
Castagno *et al.*[130]	Retrospective	2016	146	Aneurysm Score	5.5%	8	NA	None	No
Obata *et al.*[131]	Prospective	2016	95	AKIN	9.4%	9	Stage 2: 1	None	No

AKI, acute kidney injury; AKIN, Acute Kidney Injury Network Criteria; EVAR, endovascular aneurysm repair; KDIGO, Kidney Disease Improving Global Outcomes; NA, not available; RIFLE, risk, injury, failure, loss, end-stage renal disease.

A systematic review and meta-analysis indicates underreporting of renal dysfunction following endovascular aneurysm repair

Alan Karthikesalingam[1], Sandeep S. Bahia[1], Shaneel R. Patel[1], Bilal Azhar[1], Dan Jackson[2], Lynne Cresswell[2], Robert J. Hinchliffe[1], Peter J.E. Holt[1] and Matt M. Thompson[1]

Kidney International, 2014



Clinically relevant

Renal function deterioration

@ 1 year 18%

(95% CI: 14 - 23%; I_2 of 82.5%)

Incidence, Prognostic Significance, and Risk Factors of Acute Kidney Injury Following Elective Infrarenal and Complex Endovascular Aneurysm Repair

Vinamr Rastogi [a,b,*], Jorg L. de Bruin [a], Elke Bouwens [a,c], Sanne E. Hoeks [c], Sander ten Raa [a], Marie Josee van Rijn [a], Bram Fioole [d], Marc L. Schermerhorn [b], Hence J.M. Verhagen [a]

EJVS, 2022

	Post EVAR (%)	Post F/B-EVAR (%)
AKI	9	23

Iodinated contrast media
independent risk factors for **AKI**

	Odds ratio (95% CI)	*p* value
AKI development following infrarenal EVAR		
Prior CKD, eGFR <60 mL/min/1.73 m^2	2.2 (1.03–4.8)	.042
Neck diameter per 10 mm	2.9 (1.1–8.4)	.019
Neck length per 10 mm	1.0 (0.82–1.3)	.86
Infrarenal fixation (ref.: suprarenal fixation)	0.51 (0.11–1.6)	.30
Contrast use per 10 mL	0.98 (0.84–1.1)	.80
AKI development following complex EVAR		
Prior CKD, eGFR <60 mL/min/1.73 m^2	1.6 (0.6–4.2)	.35
Suprarenal/TAAA (ref.: juxtarenal)	2.0 (0.25–12)	.45
Branched device (ref.: fenestrated)	1.4 (0.23–11)	.74
Contrast use per 10 mL	1.1 (1.01–1.2)	.034

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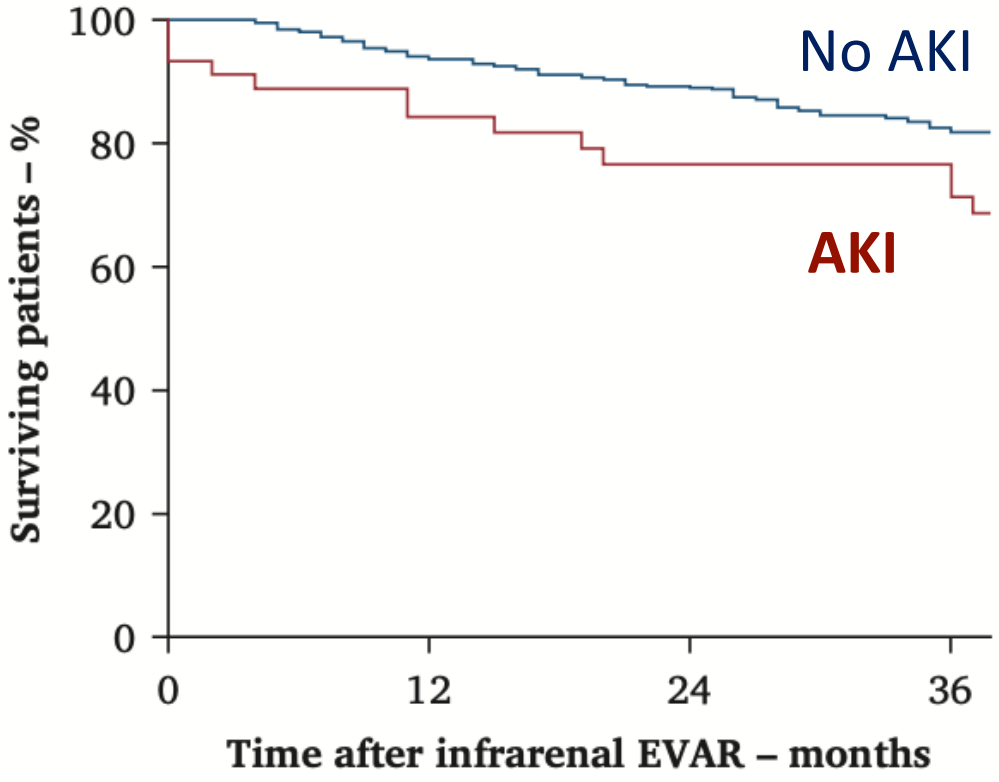
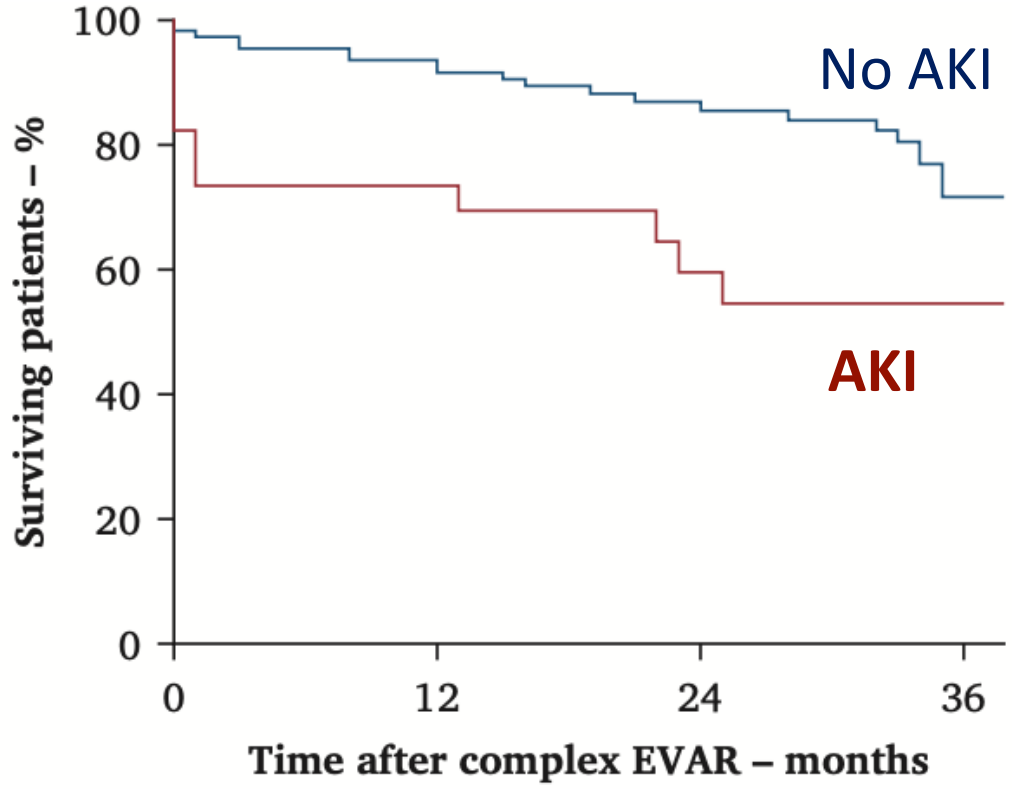
EJVS, 2022

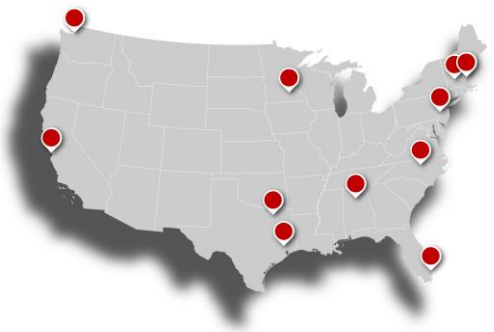




Severity of acute kidney injury is associated with decreased survival after fenestrated and branched endovascular aortic aneurysm repair

Eric J. Finnesgard, MD, MS,[a] Adam W. Beck, MD,[b] Matthew J. Eagleton, MD,[c] Mark A. Farber, MD,[d] Warren J. Gasper, MD,[e] W. Anthony Lee, MD,[f] Gustavo S. Oderich, MD,[g] Darren B. Schneider, MD,[h] Matthew P. Sweet, MD, MS,[i] Carlos H. Timaran, MD,[j] Jessica P. Simons, MD, MPH,[a] *and* Andres Schanzer, MD,[a] on Behalf of the United States Aortic Research Consortium, *Worcester and Boston, MA; Birmingham, AL; Chapel Hill, NC; San Francisco, CA; Boca Raton, FL; Houston and Dallas, TX; Philadelphia, PA; and Seattle, WA*

JVS, 2023



- ✓ Acute Kidney Injury **18%** of cases
- ✓ Grade of Severity related to amount of Iodinated Contrast Media

Variable	No injury (n = 1981)	Stage 1 (n = 316)	Stage 2 (n = 42)	Stage 3 (n = 74)	*P* value
Contrast, mL	105 [70.5-150]	106 [75-160]	132.5 [80.8-197.1]	134 [99.5-201.2]	<.0001

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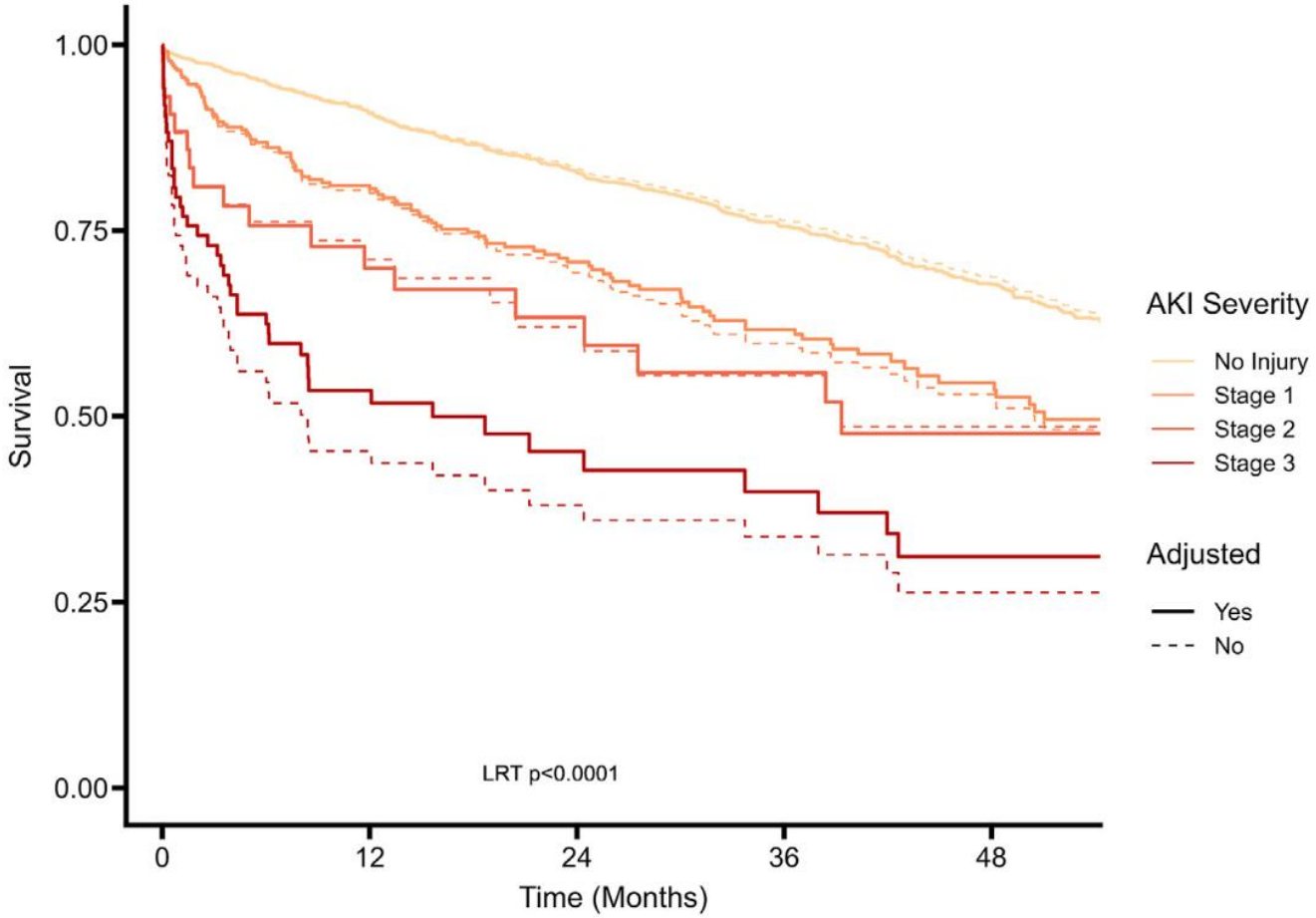

Mortality is related to different **stages of AKI**

Why EVARs with no Contrast ?

✓ **Acute Kidney Injury**
after endovascular aortic procedure
EVAR / F-BEVAR

✓ **Automated CO_2 angiography**
Feasible alternative to ICM

Renal Benefits of CO2 as a Contrast Media for EVAR Procedures: New Perspectives on 1 Year Outcomes

Journal of Endovascular Therapy
1–10
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sagepub.com/journals-permissions
DOI: 10.1177/15266028231162258
www.jevt.org
SAGE

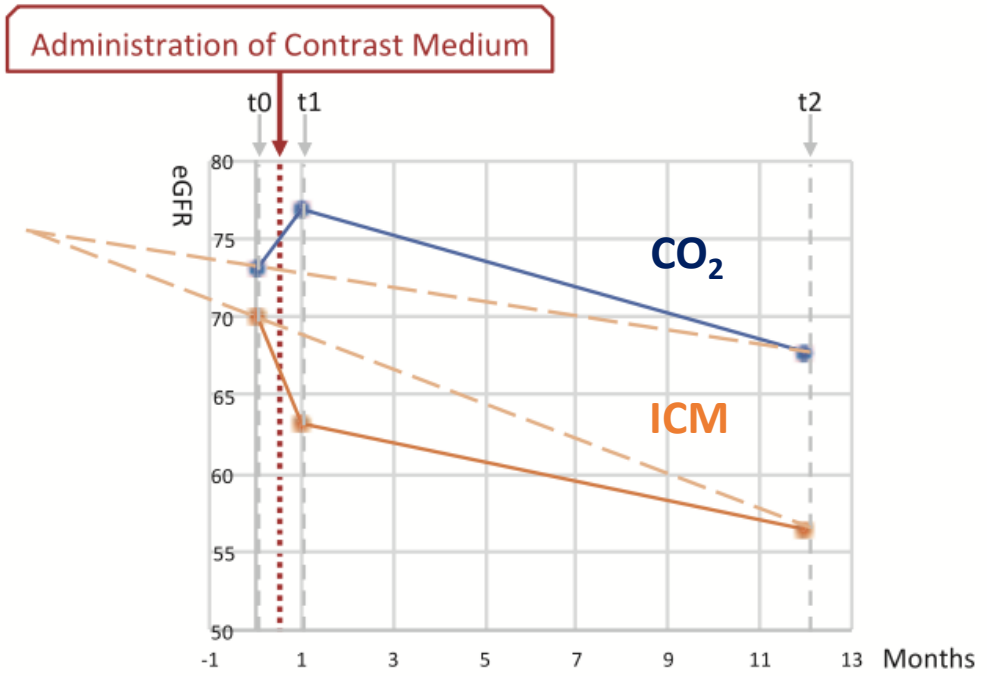
Marco Busutti, MD, PhD[1,2*], Alice Sensoni, MD[2**], Andrea Vacirca, MD, PhD[3,4], Chiara Abenavoli, MD[1], Chiara Donadei, PhD[2], Anna Laura Croci Chiocchini, MD, PhD[1], Matteo Righini, MD[5], Giorgia Comai, MD, PhD[1], Alessia Pini, MD[3], Gianluca Faggioli, MD, PhD[3,4], Enrico Gallitto, MD, PhD[3,4], Gaetano La Manna, MD, PhD[1,2], and Mauro Gargiulo, MD, PhD[3,4]

JET, 2023

Renal function worsening @1y

Postoperative

	ICM (%)	CO_2 + ICM (%)	P
AKI	27	9	.04



	eGFR t0	eGFR t1	eGFR t2 - 1 year FU
CO2/CO2+ICM	73 ± 21	77± 20	68 ± 21
ICM	70 ± 17	63 ± 16	57 ± 17

eGFR t0 = eGFR pre-treatment; eGFR t1 = eGFR post-treatment;
eGFR1 t2 = eGFR at 1 year follow up

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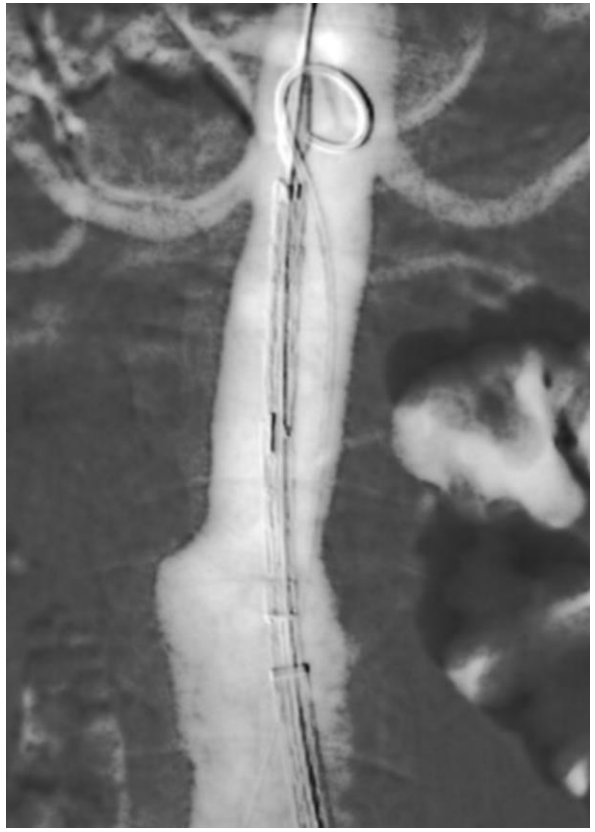
✓ **Acute Kidney Injury**
after endovascular aortic procedure
EVAR / F-BEVAR

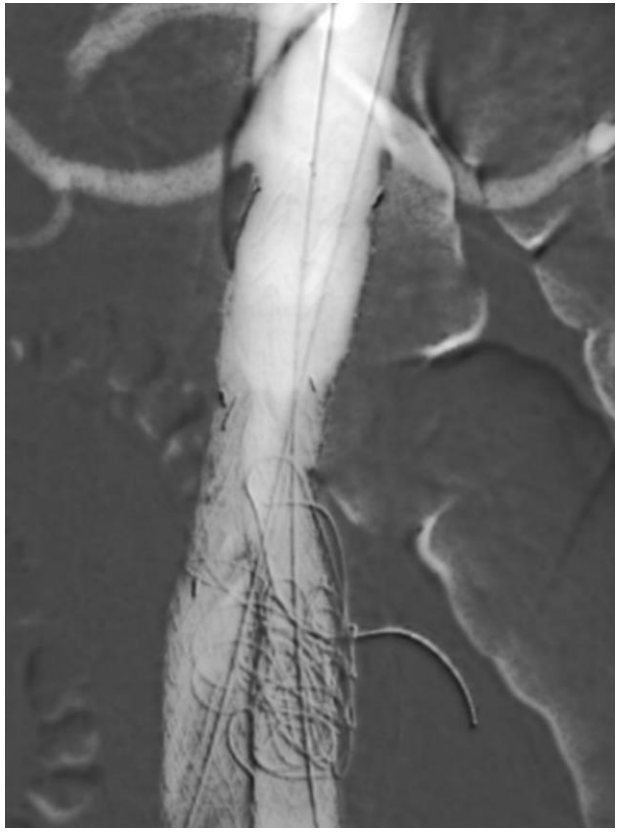
✓ **Automated CO_2 angiography**
Feasible alternative to ICM

How ?

CO_2 aortography for EVAR

- ✓ Volume 100 mL
- ✓ Pressure 600 mmHg

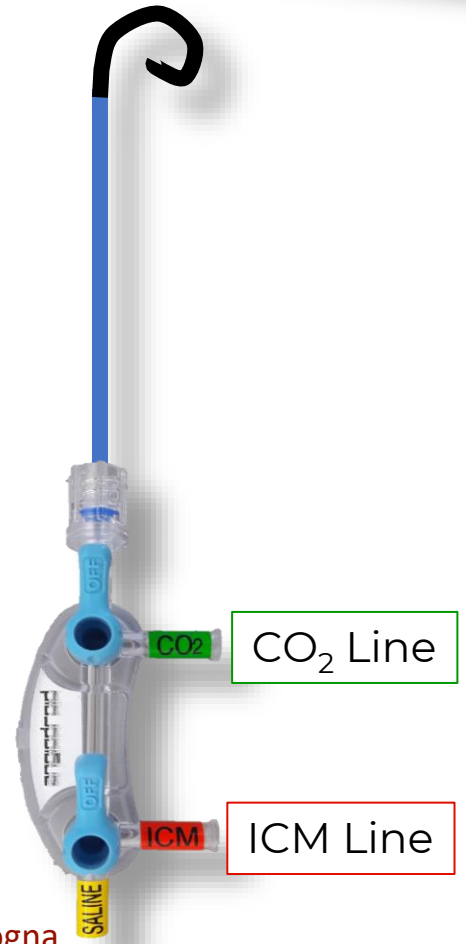




Standardization of a Carbon Dioxide Automated System for Endovascular Aortic Aneurysm Repair

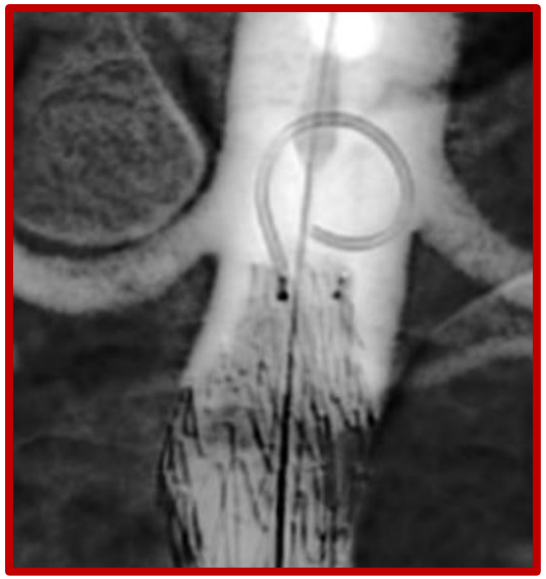
Chiara Mascoli, Gianluca Faggioli, Enrico Gallitto, Vincenzo Vento, Rodolfo Pini, Andrea Vacirca, Giuseppe Indelicato, Mauro Gargiulo, and Andrea Stella, Bologna, Italy

AVS, 2018



CO_2 Line

ICM Line



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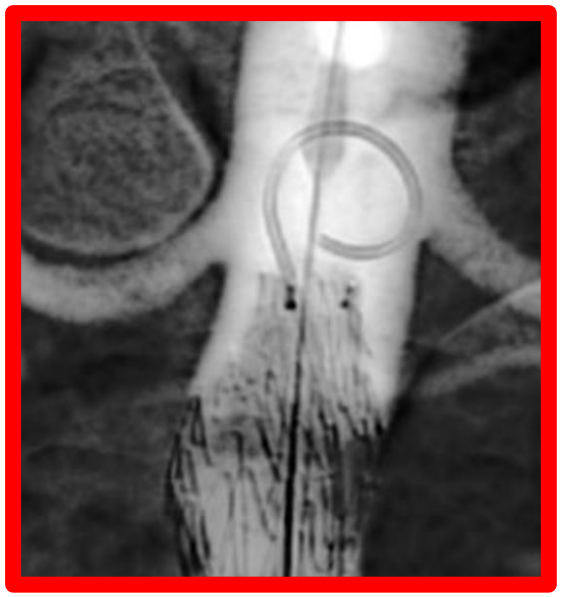
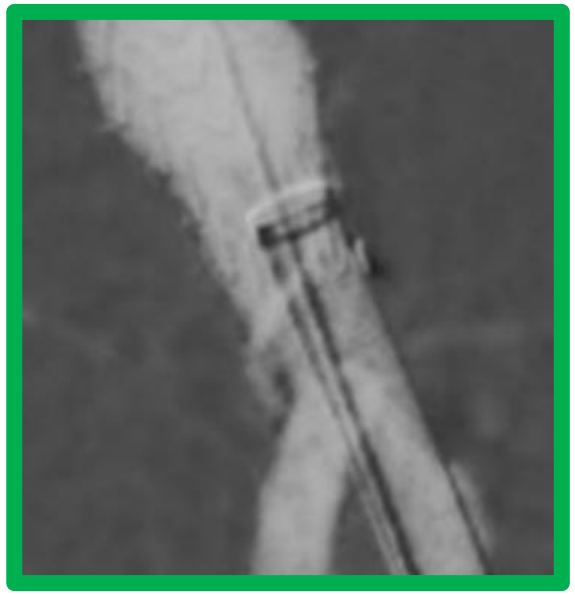
CO_2 angiography in EVAR

AVS, 2018

Feasible, Safe, Effective

Diagnostic angiography	%
Renal artery detection	61
Hypogastric detection	100





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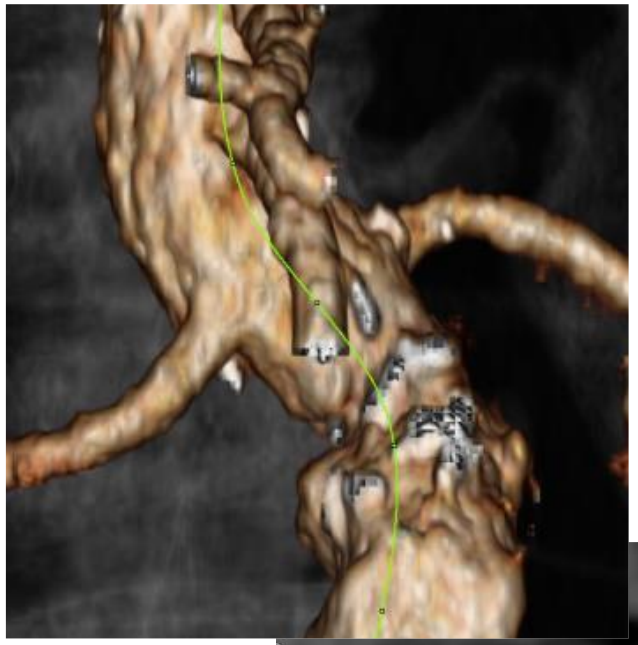
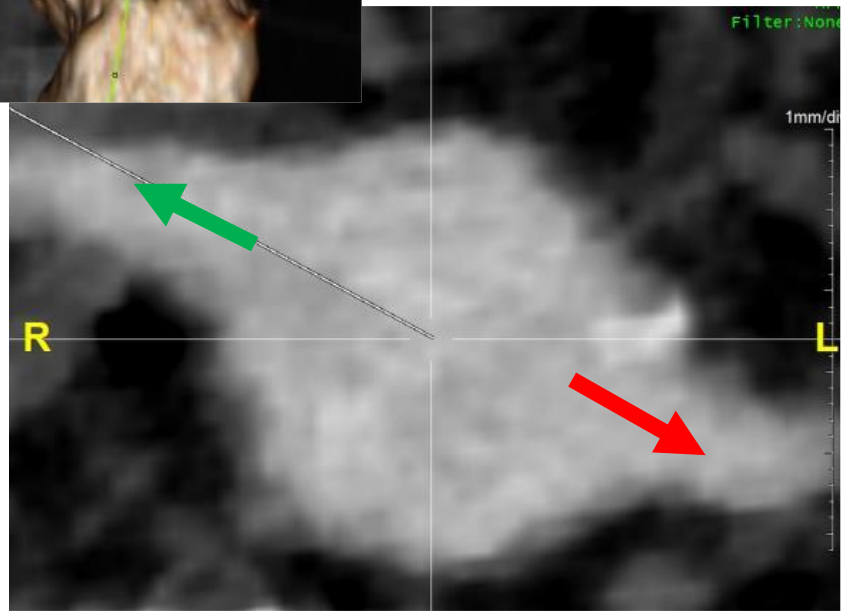
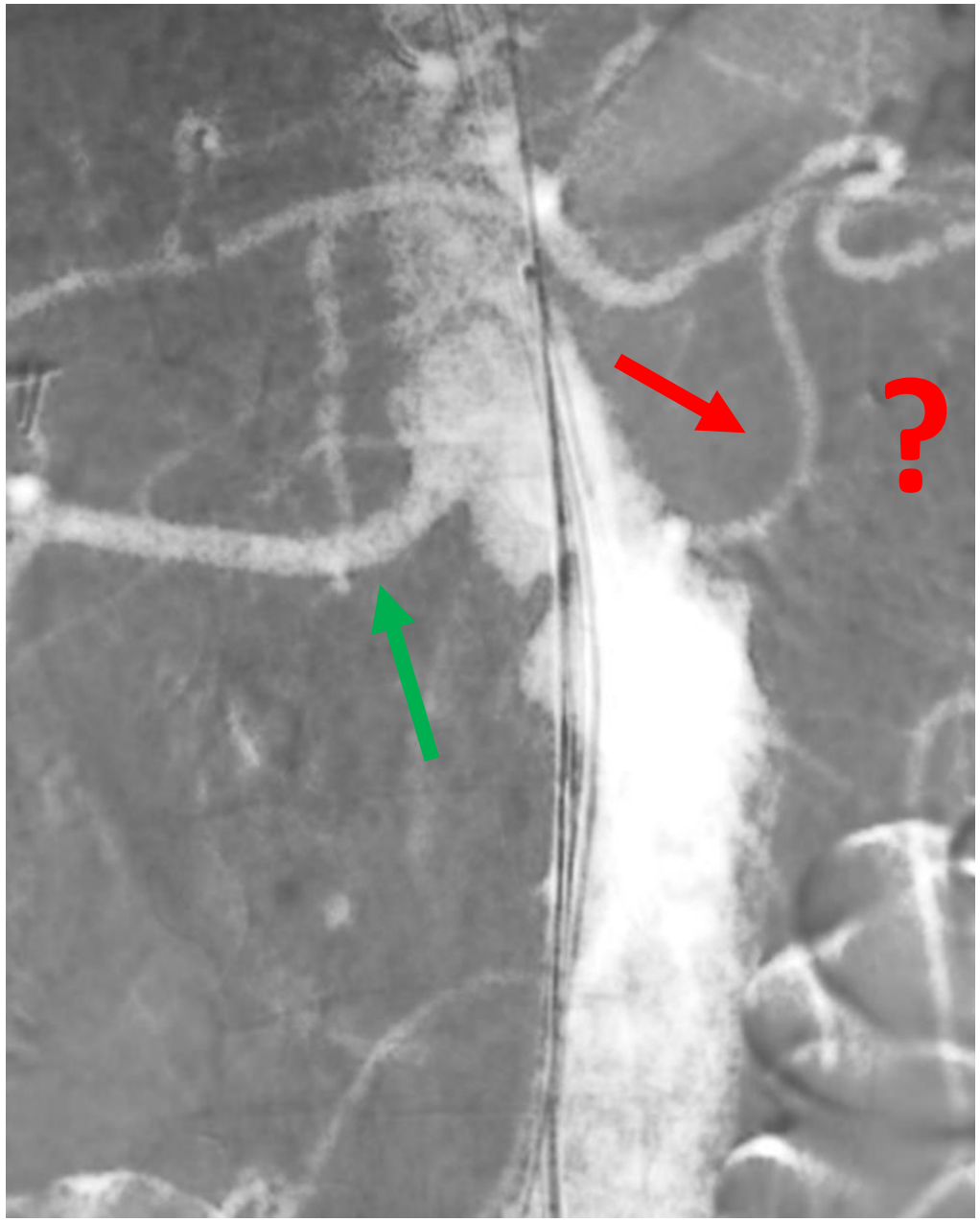


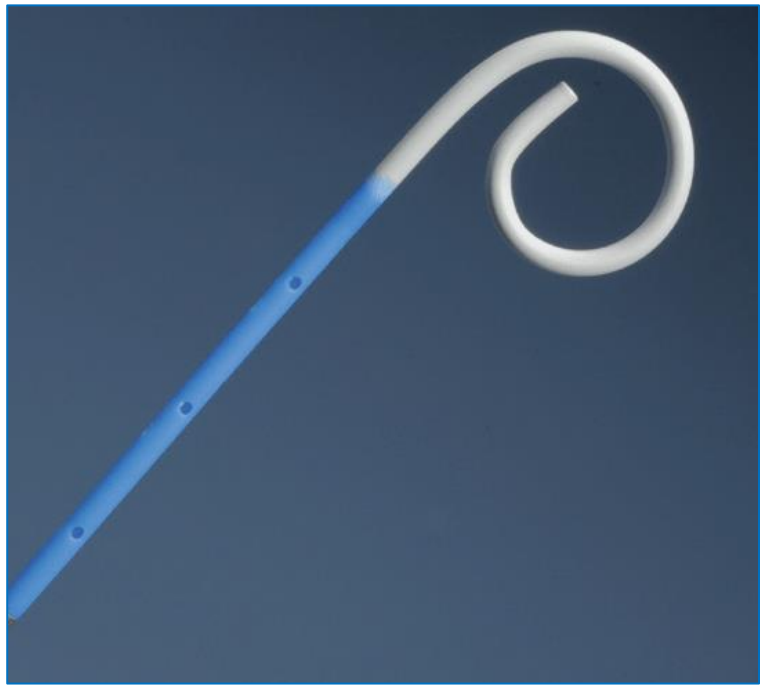
Anterior

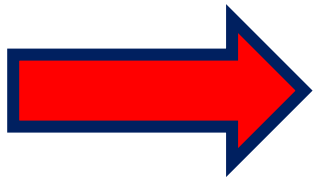


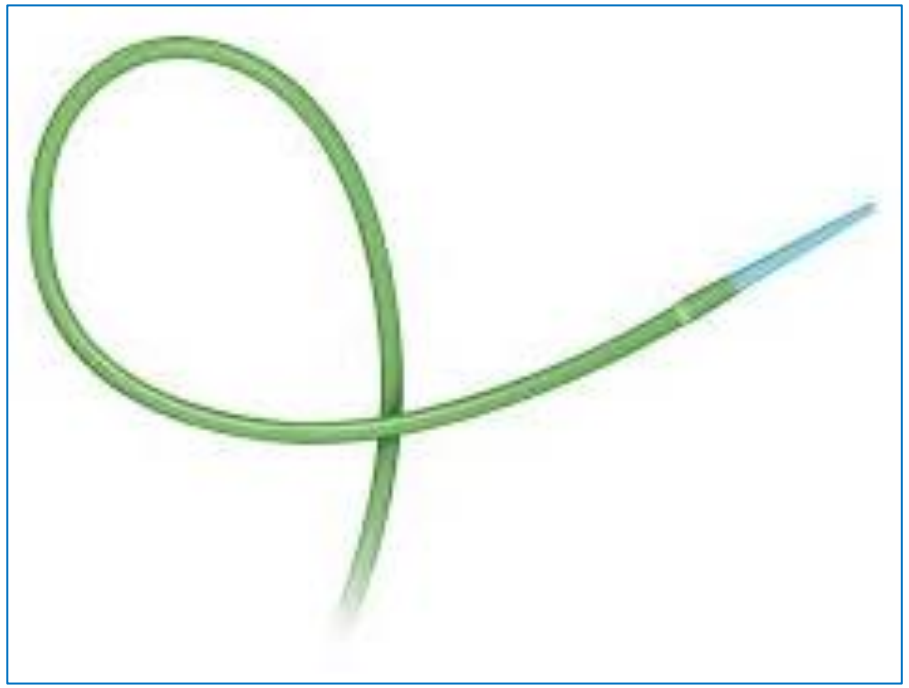
Posterior



Renal arteries detection





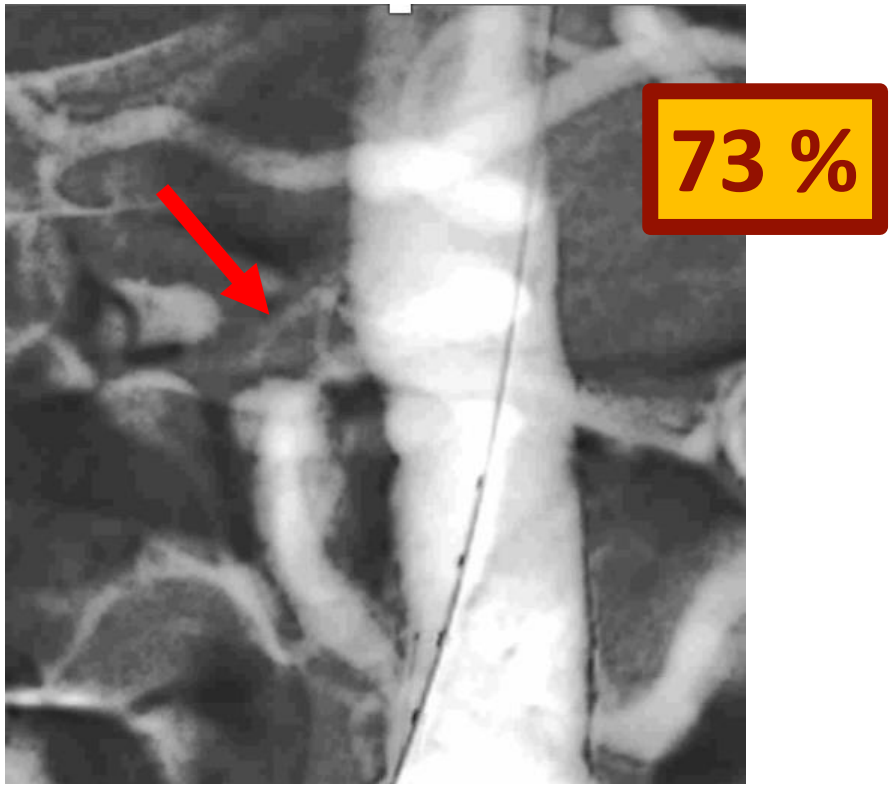


Multi Holes Pigtail catheter
5F, 65 cm

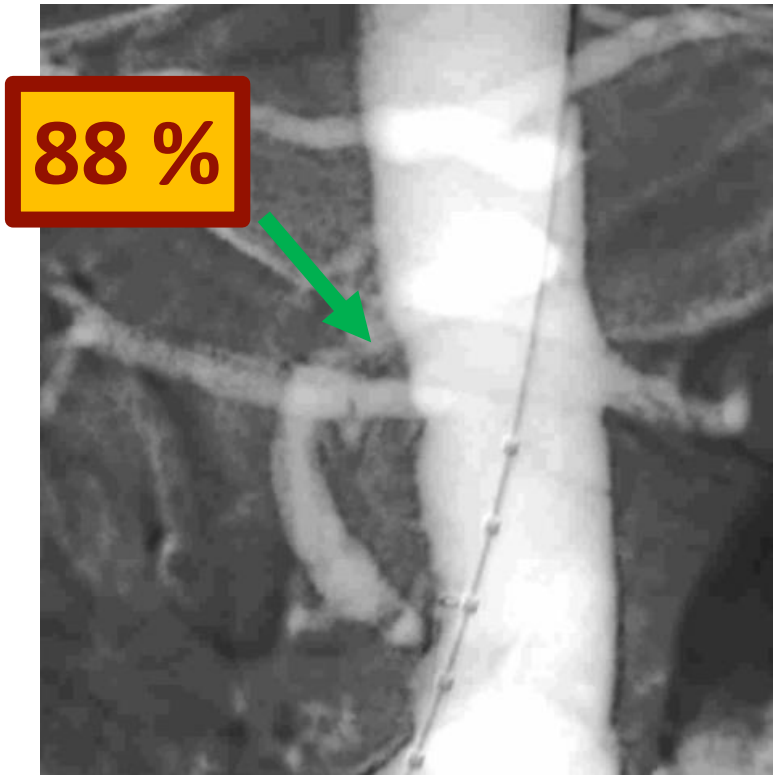
Single Hole Introducer
5F, 45 - 55 cm

Renal arteries detection

ClinicalTrials.gov ID: NCT05304026

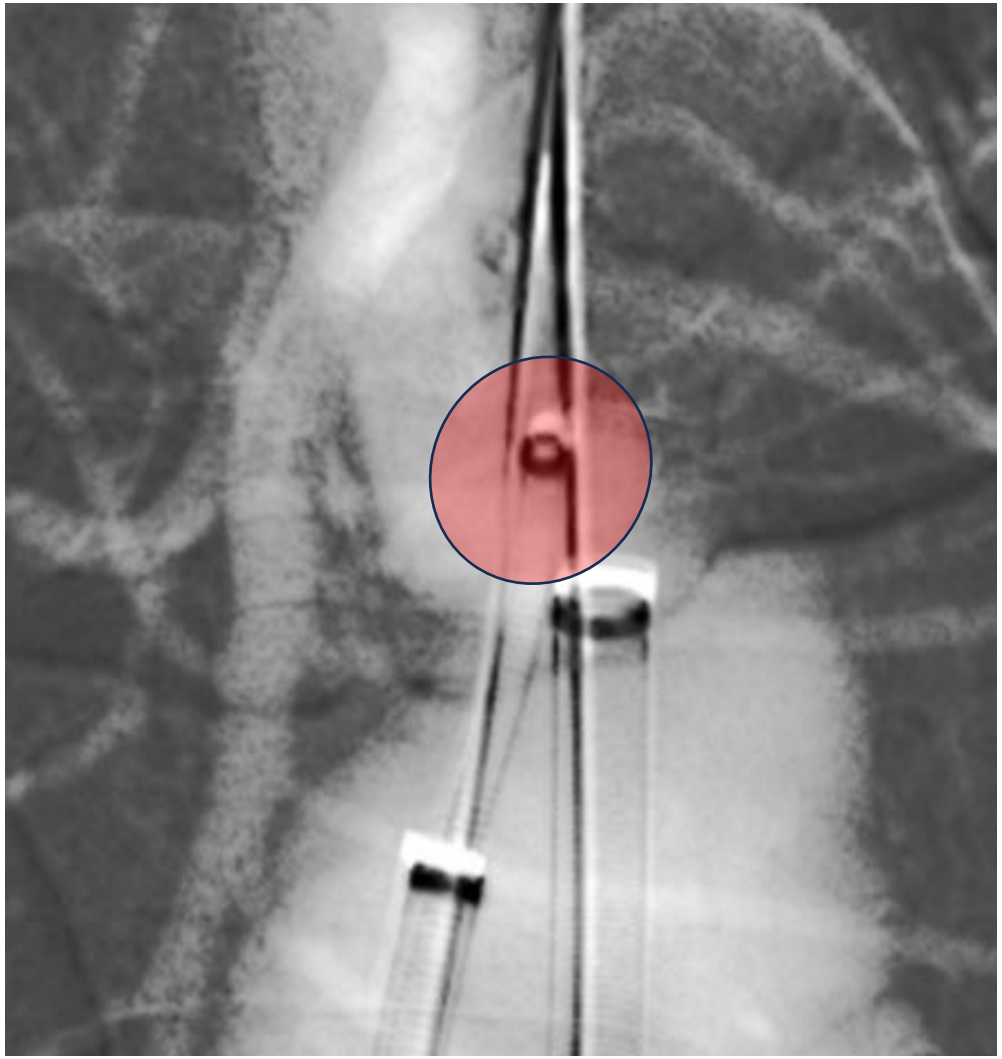


Multi Holes Pigtail catheter
5F, 65 cm



Single Hole Introducer
5F, 45 - 55 cm

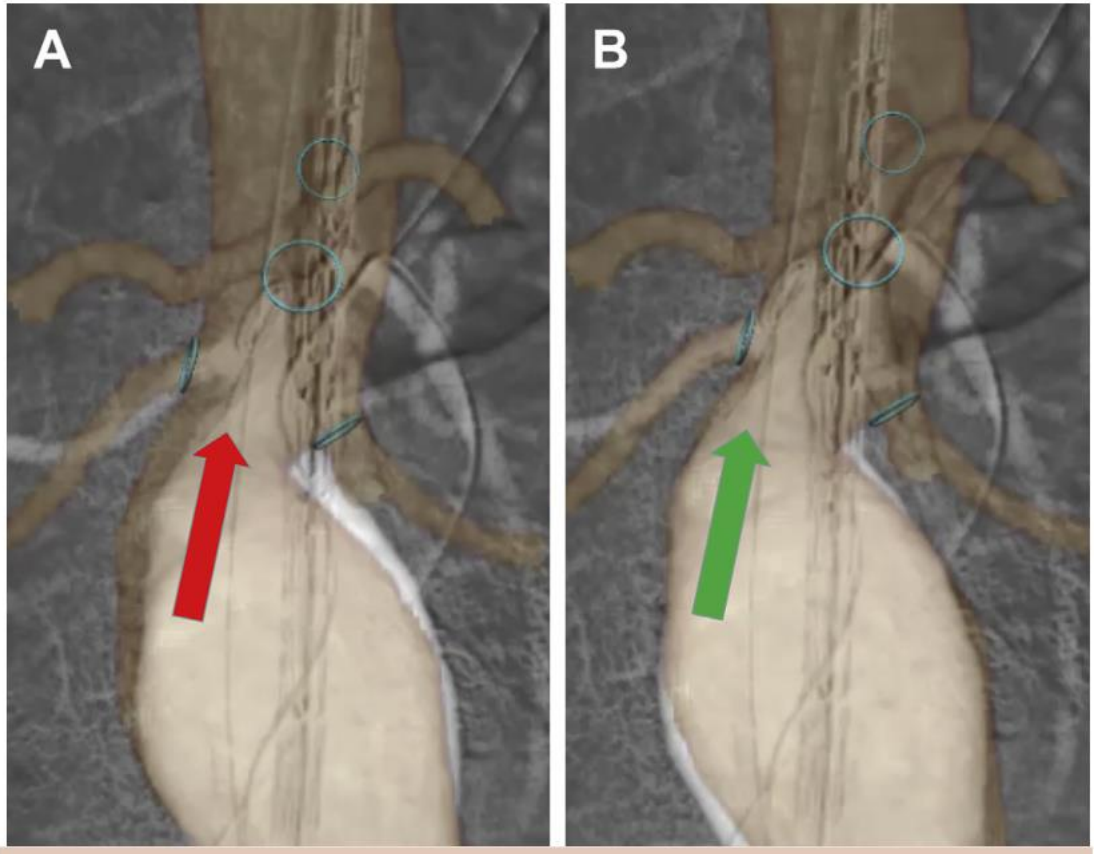
Renal arteries detection - 5 F, 45cm introducer



The benefit of combined carbon dioxide automated angiography and fusion imaging in preserving perioperative renal function in fenestrated endografting

Enrico Gallitto, MD, PhD, Gianluca Faggioli, MD, Andrea Vacirca, MD, Rodolfo Pini, MD, PhD, Chiara Mascoli, MD, Cecilia Fenelli, MD, Antonino Logiacco, MD, Mohammad Abualhin, MD, *and* Mauro Gargiulo, MD, *Bologna, Italy*

JVS, 2020



F/B-EVAR combining

Vessel Navigator + CO_2 angiography

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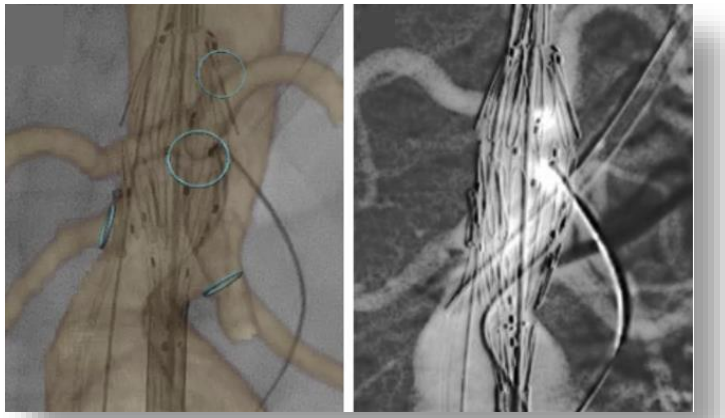
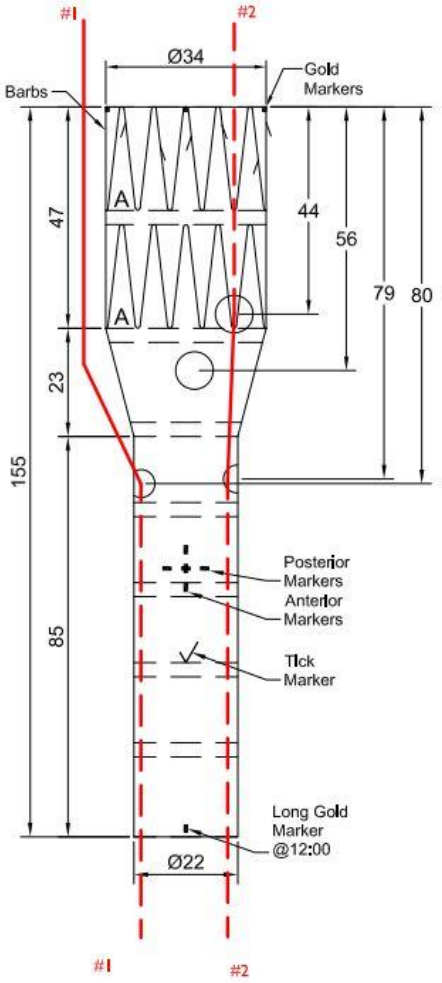
JVS, 2020



	CO_2 + FI, median (IQR)	ICM + FI, median (IQR)	*P*
Procedure time, minutes	290 (135)	348 (111)	.07
Fluoroscopy time, minutes	60 (33)	75 (17)	.25
Total DAP, mGy·cm^2	1,201,117 (571,310)	892,108 (834,558)	.27
ICM, mL	41 (26)	139 (88)	.001

	CO_2 + FI, median (IQR)	**ICM + FI, median (IQR)**	***P***
Creatinine increase (mg/dL)	0.09 (0.03)	0.3 (0.4)	.049
Hospitalization (days)	5 (1)	7.5 (4)	.002

FEVARs with no Contrast ?



Catheter Pathway

REINFORCED LARGE FENESTRATION #1
Preloaded Catheter access from above (#2)
Strut Free
DIAMETER: 8mm
DIST FROM PROX EDGE: 44mm
CLOCK: 1:30
IVD: 27mm

REINFORCED LARGE FENESTRATION #2
Strut Free
DIAMETER: 8mm
DIST FROM PROX EDGE: 56mm
CLOCK: 12:15
IVD: 27mm

REINFORCED SMALL FENESTRATION #1
Preloaded Catheter access from below (#2)
DIAMETER: 6mm
DIST FROM PROX EDGE: 79mm
CLOCK: 3:15
IVD: 21mm

REINFORCED SMALL FENESTRATION #2
Preloaded Catheter access from below (#1)
DIAMETER: 6mm
DIST FROM PROX EDGE: 80mm
CLOCK: 10:00
IVD: 21mm

- SINGLE DIAMETER REDUCING TIES
- LOW PROFILE FABRIC

****MODIFIED PRELOADED DELIVERY SYSTEM*****
(Biport handle and preloaded catheters)

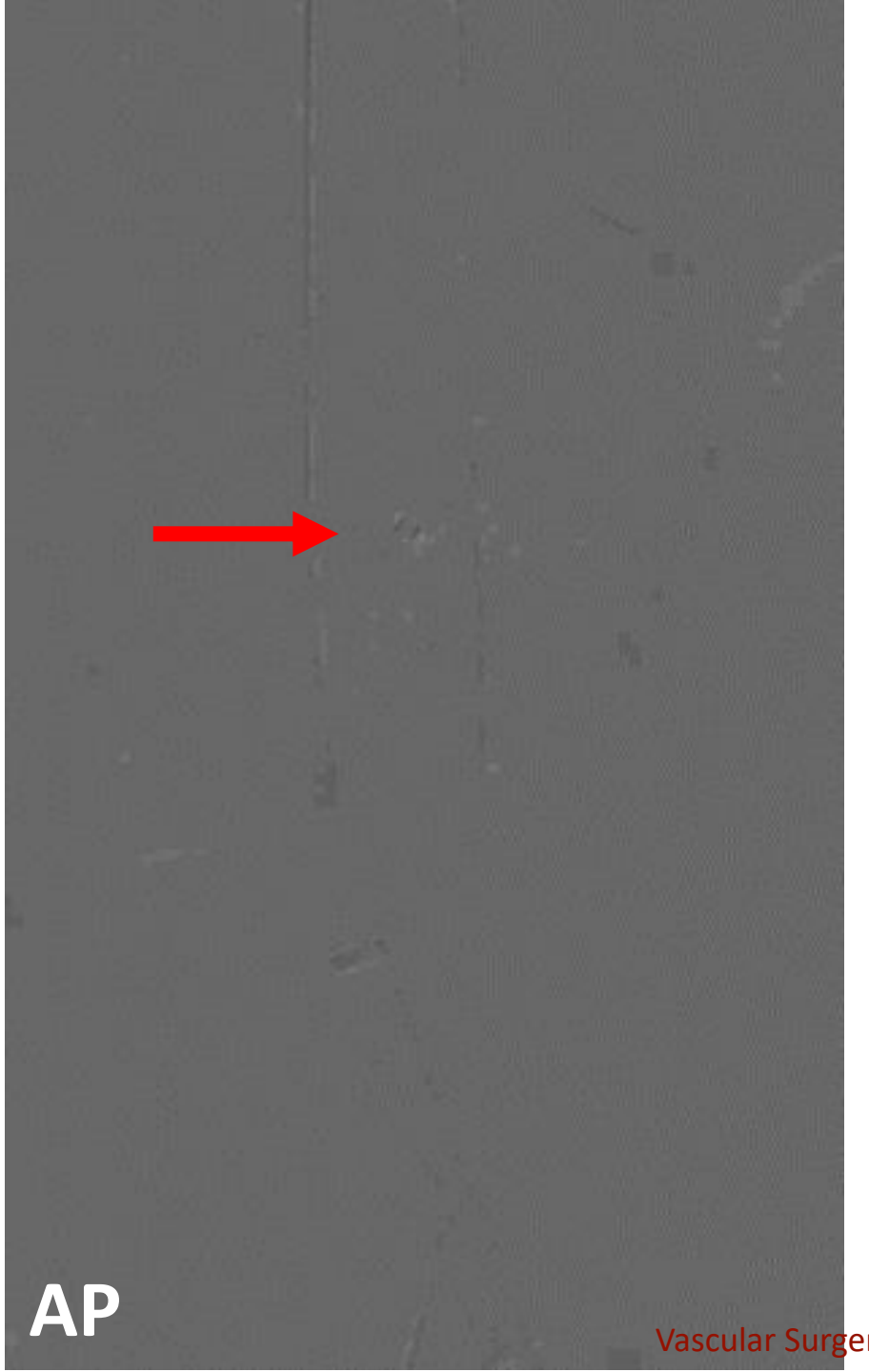
Plus:

G32595 - AAA-BIFURCATED-GRAFT
(As per ZFEN-D-12-45-76)

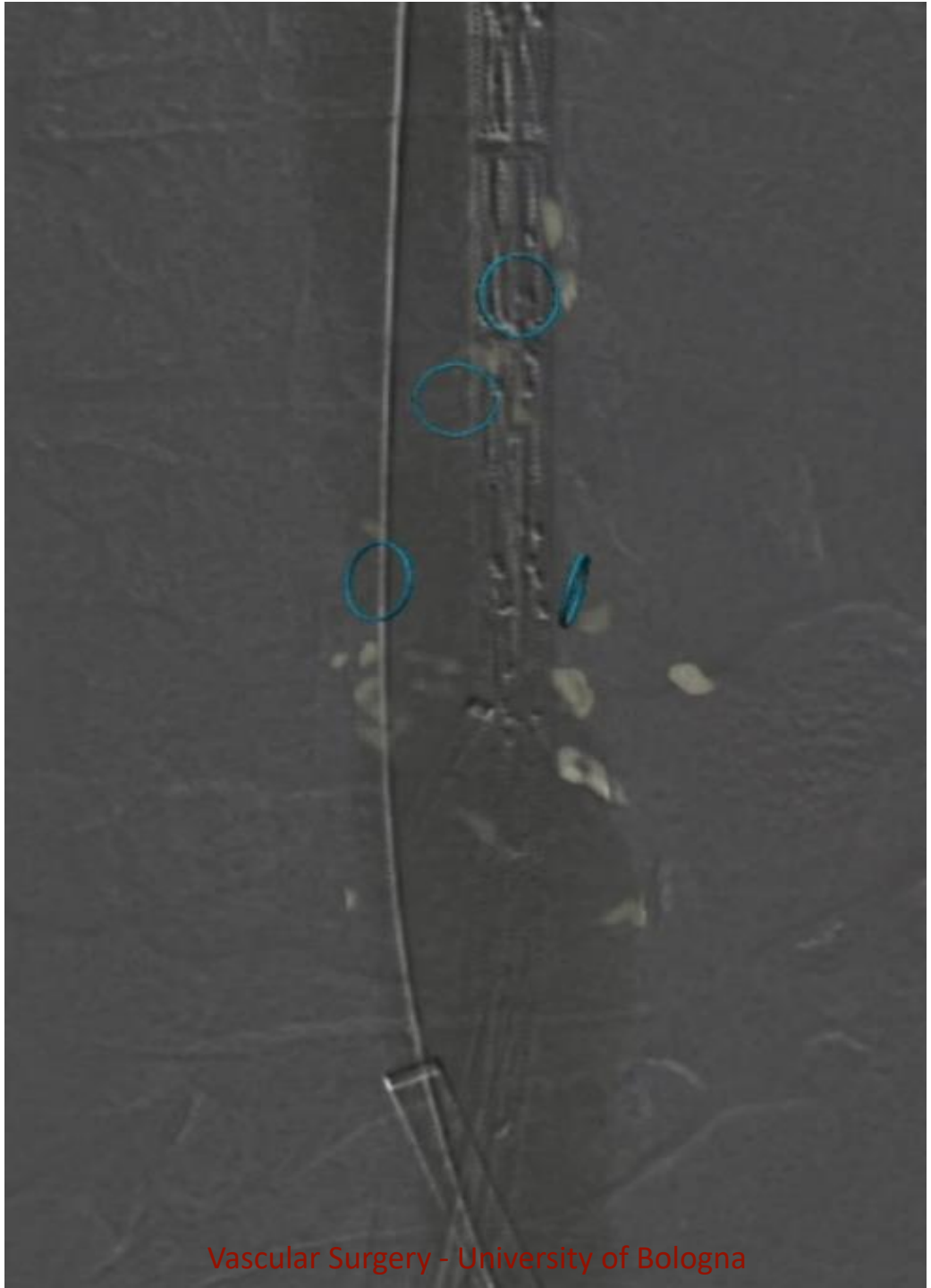
Ipsilateral Leg Extension
ZISL-16-93

Contralateral Leg Extension
ZBIS-12-61-41

Bridging limb
ZISL-16-59



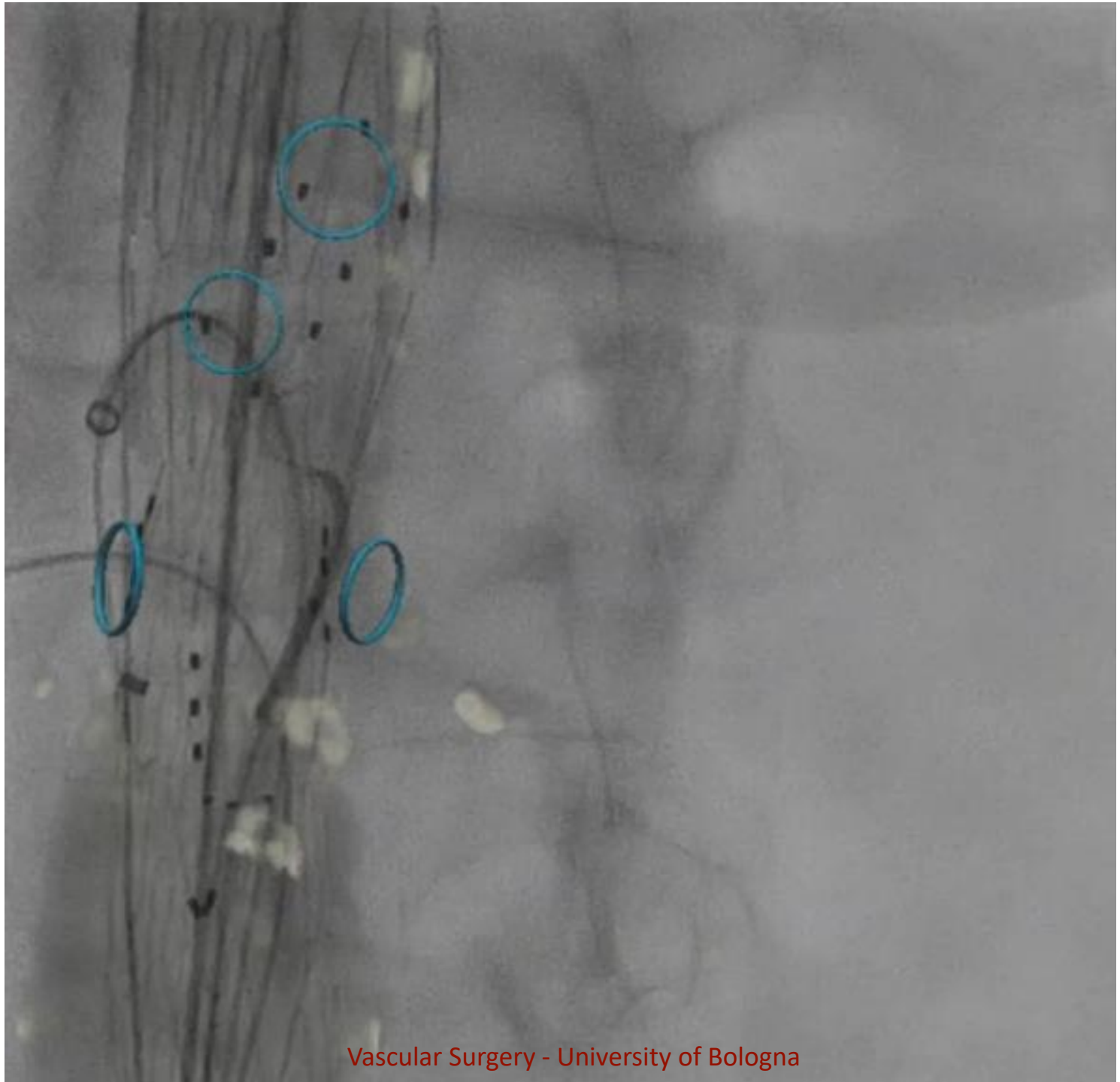
- ✓ 6Fr, 55cm Flexor
  Juxta-renal aorta
- ✓ Volume 100 mL
- ✓ Pressure 650 mmHg
- ✓ DSA 6 - 3 fps



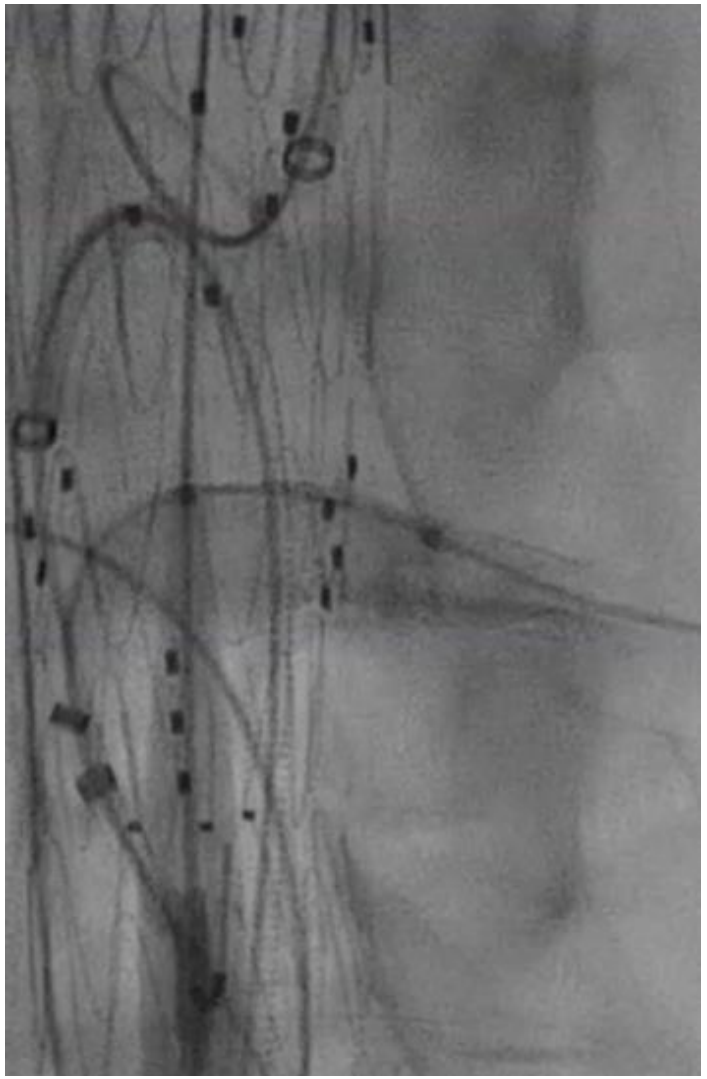
6Fr, 55cm Flexor

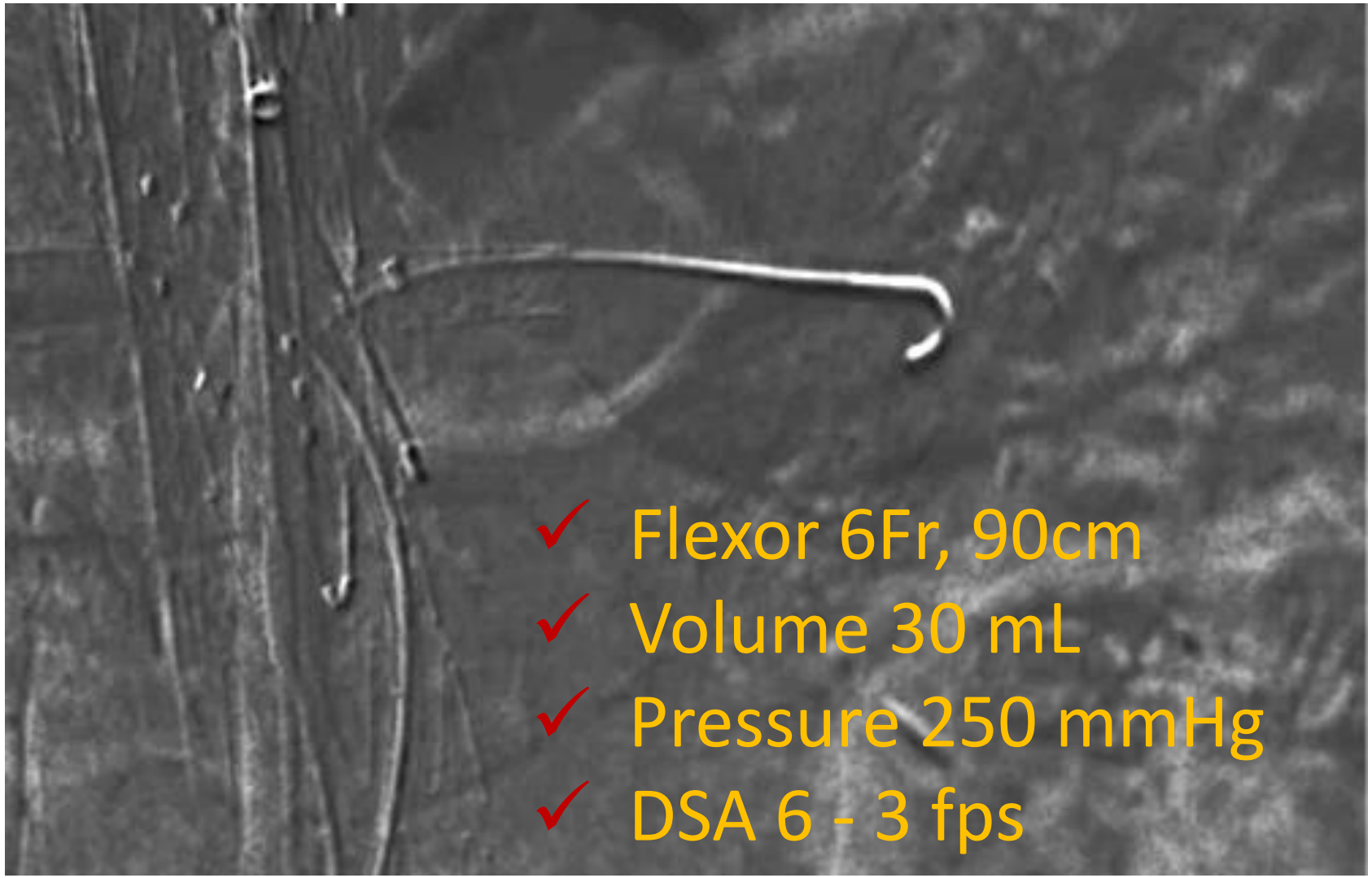
Juxta-renal aorta


6Fr, 55cm



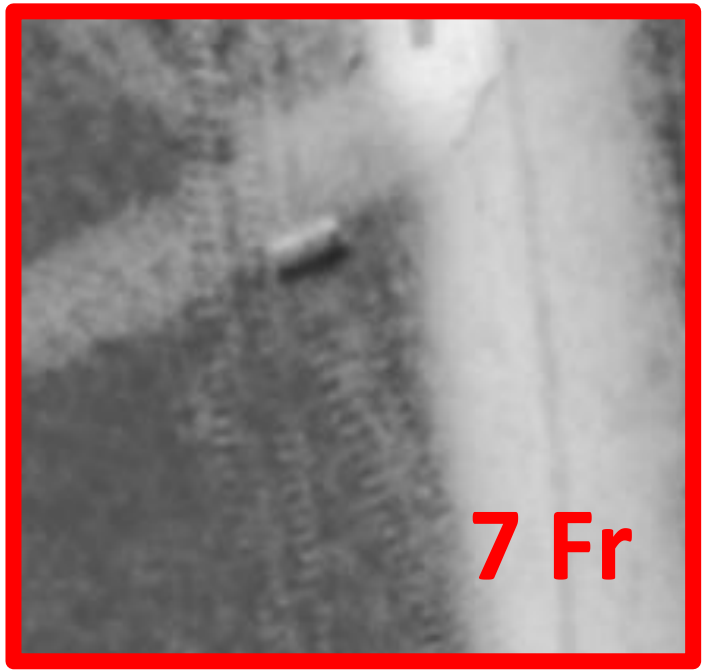
Selective Renal Artery angiography





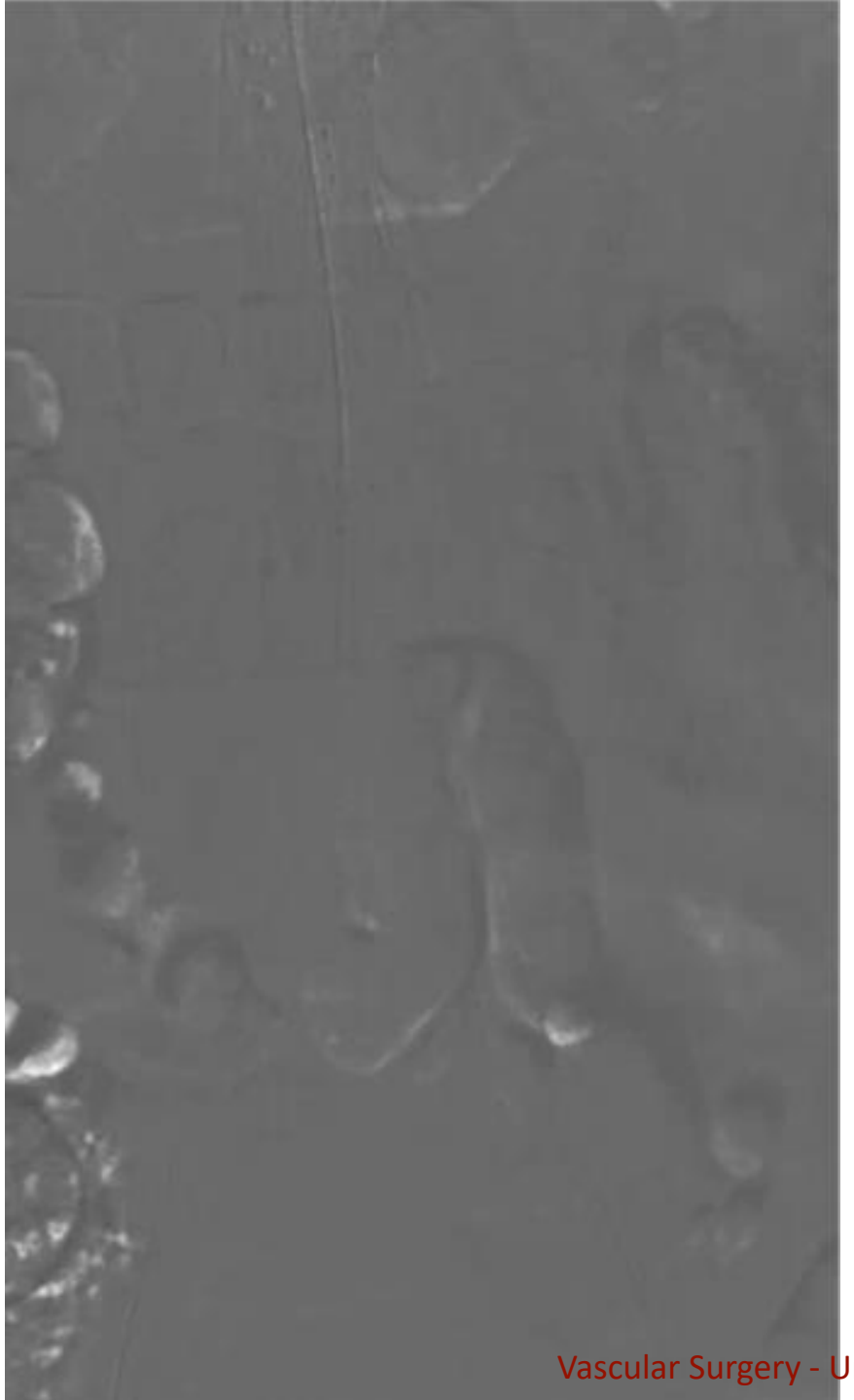
SMA angiography from the aorta

- ✓ Volume 100 mL
- ✓ Pressure 650 mmHg



Completion angiography

8 Fr from above



Completion angiography from femoral introducer

4 FEN + ZBIS	
Fluoroscopy time	46 min
DAP	869.730 mGy/cm^2
CO_2	2180 mL

No contrast FEVAR Prospective Study

ClinicalTrials.gov ID: NCT05304026

- ✓ FEVAR for j/p-AAAs
- ✓ November 2023 - December 2024
- ✓ Philips Hybrid Room
- ✓ Fusion Imaging
- ✓ Angiodroid CO_2 Injector

Aortography	100 mL, 650 mmHg
Selective TVVs angiography	30 mL, 250mmHg

- ✓ DSA 3 f / s

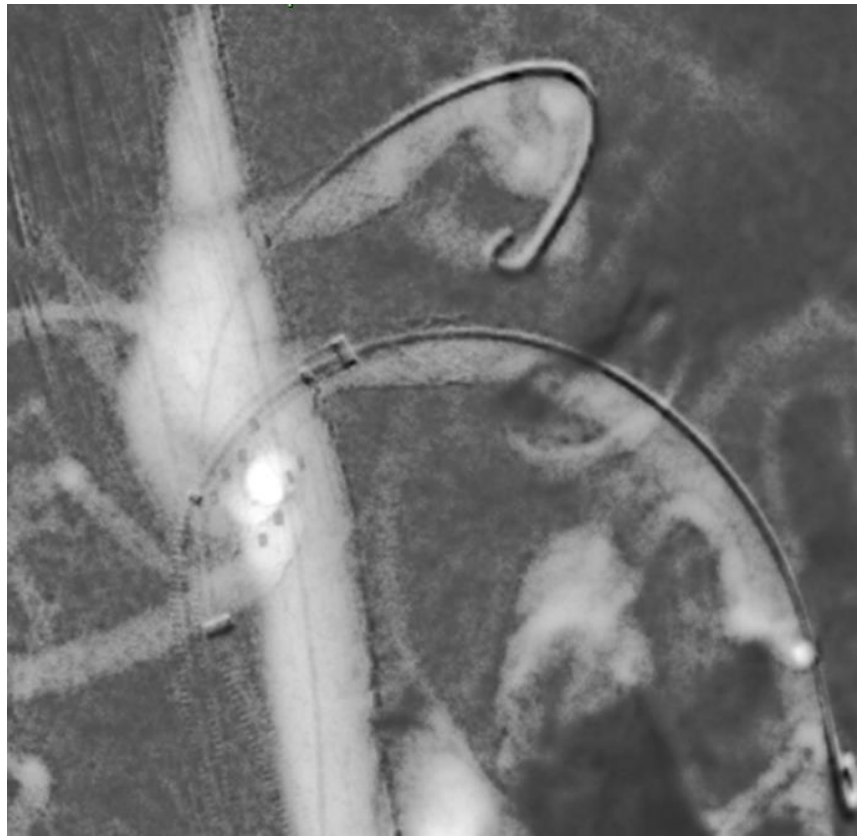
No contrast FEVAR Prospective Study

ClinicalTrials.gov ID: NCT05304026

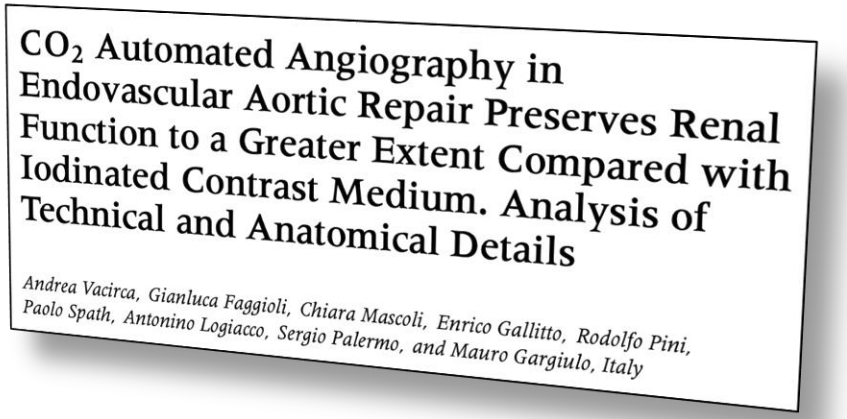
✓ Cases enrolled @ February 2024 17

	n	%
Technical Success	17	100
AKI	1	6
Reintervention @ 30-day	0	-

	median	IQR
Iodinated Contrast media (mL)	15	5 - 24



CO_2 reduces the postoperative renal impairment



CO_2 Automated Angiography in Endovascular Aortic Repair Preserves Renal Function to a Greater Extent Compared with Iodinated Contrast Medium. Analysis of Technical and Anatomical Details

Andrea Vacirca, Gianluca Faggioli, Chiara Mascoli, Enrico Gallitto, Rodolfo Pini, Paolo Spath, Antonino Logiacco, Sergio Palermo, and Mauro Gargiulo, Italy

AVS, 2022

	Tot $N = 321$ *N (percent) or mean ± SD*	CO_2-EVAR $= 72$ *N (percent) or mean ± SD*	ICM-EVAR $= 249$ *N (percent) or mean ± SD*	*P* value
Death	4 (1.2%)	0	4 (1.6%)	0.93
Postoperative creatinine (mg/dL)	1.16 ± 0.7	1.2 ± 0.9	1.15 ± 0.6	0.53
Postoperative eGFR (mL/min)	67.8 ± 7.1	69.2 ± 7.8	67.2 ± 6.7	0.47
Creatinine increase (mg/dL)	0.15 ± 0.08	0.08 ± 0.04	0.17 ± 0.09	0.01[a]
eGFR decrease (mL/min)	8.8 ± 4.9	2.3 ± 1.1	10.6 ± 5.3	<0.001[a]
Renal function worsening requiring hemodialysis	2 (0.6%)	0	2 (0.8%)	1
Post-OP hospital stay (days)	4.8 ± 3.1	4 ± 2.3	5 ± 3.5	0.27

CO_2 increases radiation exposure

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AVS, 2022

	Tot $N = 321$ *N (percent) or mean ± SD*	CO_2-EVAR $= 72$ *N (percent) or mean ± SD*	ICM-EVAR $= 249$ *N (percent) or mean ± SD*	*P* value
Urgent cases	25 (7.7%)	4 (5.5%)	21 (8.4%)	0.42
Suprarenal fixation graft	175 (54.5%)	41 (57%)	134 (53.8%)	0.9
ICM amount (mL)	80.9 ± 8.5	52.8 ± 6.1	88.1 ± 9.2	<0.001[a]
Fluoroscopy radiation dose DAP (mGy/cm^2)	150,159.2 ± 129,219.1	142,109.5 ± 113,534.4	156,439.2 ± 132,303.8	0.33
DSA radiation dose DAP (mGy/cm^2)	265,270.9 ± 247,845.7	366,901.1 ± 307,701.3	175,862.6 ± 126,061.3	<0.001[a]
Total radiation dose DAP (mGy/cm^2)	414,635.3 ± 320,944.8	500,550.8 ± 377,394.6	332,301.8 ± 230,139.3	0.001[a]
Anesthesia type:				0.48
General	135 (42.3%)	28 (38.9%)	107 (43.3%)	
Spinal	181 (56.7%)	44 (61.1%)	137 (55.5%)	
Local	3 (0.9%)	0	3 (1.2%)	

CO_2 increases radiation exposure

- Set up of Hybrid rooms (2 f/s)
- Procedural protocols optimization

CO_2 Automated Angiography in Endovascular Aortic Repair Preserves Renal Function to a Greater Extent Compared with Iodinated Contrast Medium. Analysis of Technical and Anatomical Details

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EVAR & F/B-EVAR with no contrast

1. AKI post EVAR & F/B-EVAR
   - occurs up to 20%
   - mL ICM
   - impacts on patient 'survival

2. CO_2 automated angiography
   - effective in EVAR & F/B-EVAR
   - reduces postoperative and 1-year renal impairment
   - may increase radiation exposure