Update in Endovascular TAAA Procedures

S Haulon,J Sobocinski, R Clough,
R Spear, A Hertault, R Azzaoui

Aortic Center,
CHRU de Lille, France

Disclosures

- Research support, Consulting, IP
  - Cook Medical, GE Healthcare, Bentley

Treatment Options For TAAA

- Open surgery
- ~~Hybrid~~
- ~~CHEVAPS~~
- Fenestrated/branched procedures

Open vs Endo

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association®

Contemporary Analysis of Descending Thoracic and Thoracoabdominal Aneurysm Repair: A Comparison of Endovascular and Open Techniques

Roy K. Greenberg, Qingsheng Lu, Eric E. Roselli, Lars G. Svensson, Michael C. Moon, Adrian V. Hernandez, Joseph Dowdall, Marcelo Cury, Catherine Francis, Kathryn Pfaff, Daniel G. Clair, Kenneth Ouriel and Bruce W. Lytle

Circulation. 2008;118:808-817; originally published online August 4, 2008;
doi: 10.1161/CIRCULATIONAHA.108.769695
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2008 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7322. Online ISSN: 1524-4539

Table 3. Patient Characteristics for Open and Endovascular Repair Techniques

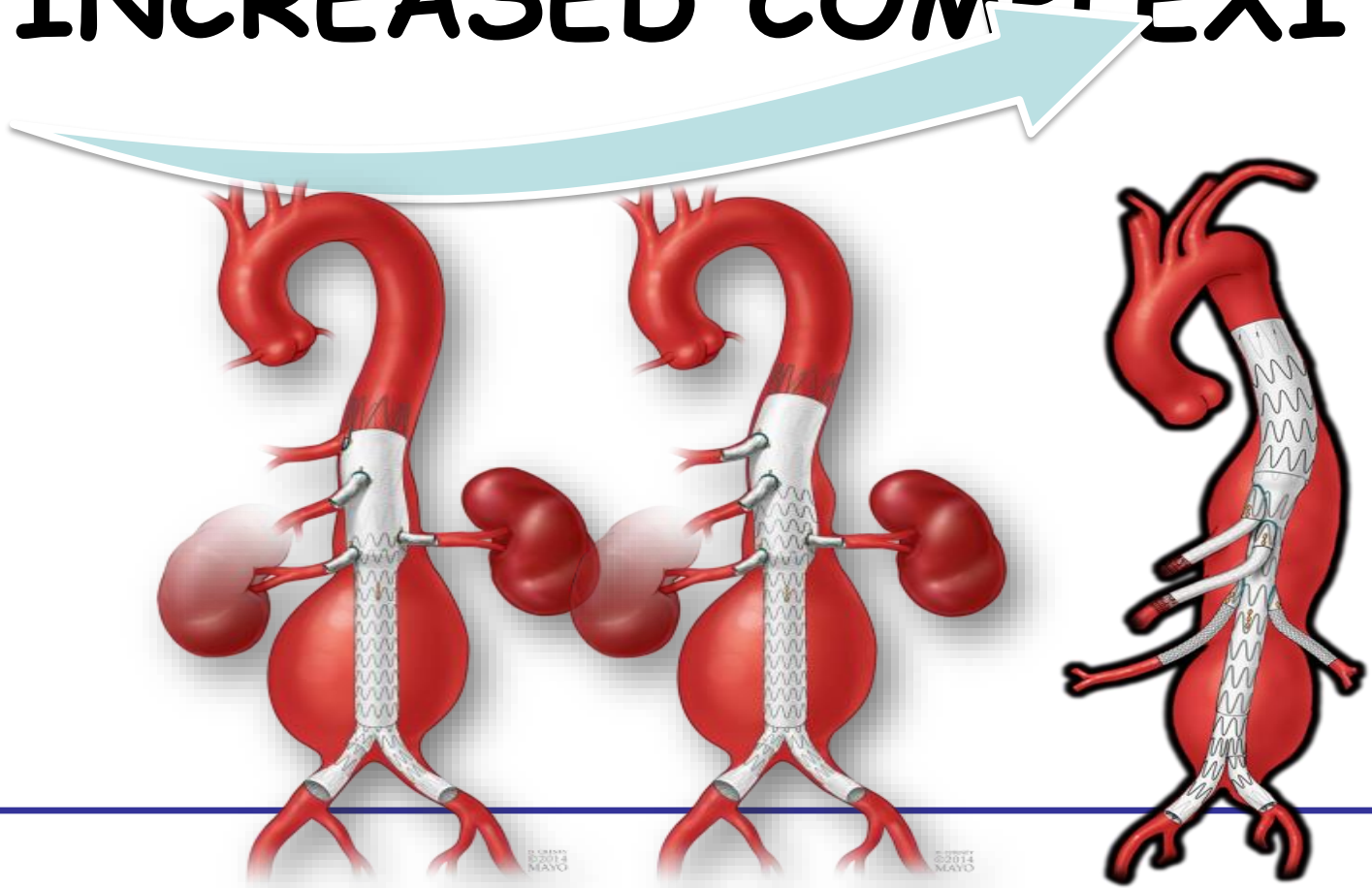
Patient Characteristics	SR (n=372)	ER (n=352)	*P*
Age, mean±SD	62.7±13	71.3±12	<0.001
Male gender, %	64	65	0.6
Black, %	10	7	0.1
Smoking, %	54	62	0.03
Diabetes mellitus, %	5	11	0.003
Cardiac			
History of CAD, %	33	50	<0.001
EF, mean±SD*	54.4±8.8	52.5±11.8	0.02
EF <0.30, %	3	6	0.03
Pulmonary			
History of COPD, %	17	30	<0.001
FEV1*	2.2±0.8	1.7±0.8	<0.001
FEV1 <1 L, %*	3	20	<0.001
FEF 25% to 75%*	1.7±0.9	0.9±0.7	<0.001
FEF 25% to 75% <30% of expected, %*	32	52	0.001
History of cancer, %	9	13	0.09
BMI, mean±SD*	27.5±10.2	26.8±5.1	0.4
Renal			
GFR, mean±SD†	77.7±30	66.1±28.5	<0.001
<40, %	9	17	0.001
<60, %	28	40	0.001
Aortic diameter, cm, mean±SD	6.2±1.3	6.3±1.3	0.9
Extent of aneurysm repair, %			
0	36	46	<0.0001
I	14	23	
II	16	5	
III	17	6	
IV	17	20	
Chronic dissections, %	30	13	<0.001
History of surgery for proximal aorta, %	31	18	<0.001
History of surgery for distal aorta, %	16	28	<0.001

	Repair	n	Mortality at 30 days			Mortality at 1 year			SCI	
			n	%*	Rate**	n	%*	Rate**	n	%
0	ER	163	8	5	0.62	20	12	0.14	1	1
	SR	136	8	4	0.73	15	11	0.13	1	1
I	ER	82	6	7	0.94	15	19¶	0.25	8	10
	SR	51	1	2	0.24	2	4	0.04	7	14
II	ER	16	1	6	0.80	5	36	0.45	3	19
	SR	59	10	17	2.36	13	22	0.30	13	22
III	ER	22	2	9	1.16	7	34	0.52	1	5
	SR	62	8	12	1.68	13	21	0.27	6	10
IV	ER	69	3	4	0.55	8	12	0.18	2	3
	SR	64	4	6	0.80	16	22	0.30	1	2
All	ER	352	20	6	0.72	55	16	0.21	15	4
	SR	372	31	7	1.07	59	15	0.19	28	8

Greenberg et al, Circulation 2008

Centre Hospitalier Régional Universitaire de Lille

INCREASED COMPLEXITY



Centre Hospitalier Régional Universitaire de Lille

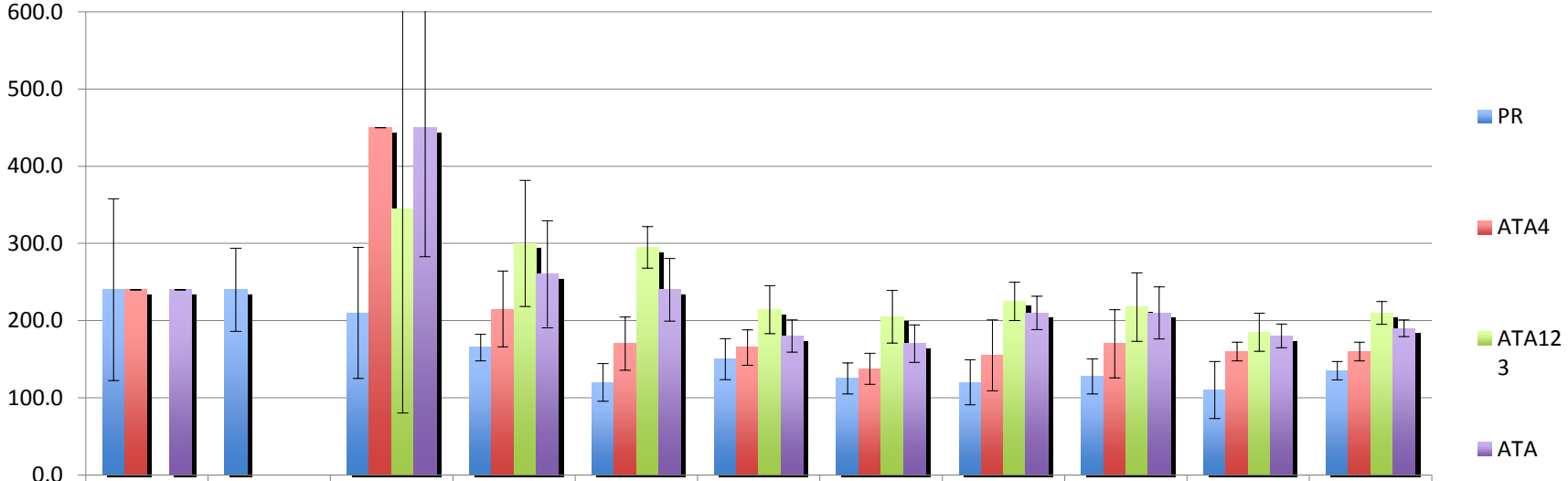
ENDOVASCULAR REPAIR: ISSUES?

- Challenging procedures
- Radiation exposure
- Durability
- Availability
- Learning curve / Volume
- Unsuitable anatomies

ISSUES?

- Challenging procedures
- Radiation exposure
- Durability
- Availability
- Learning curve / Volume
- Unsuitable anatomies

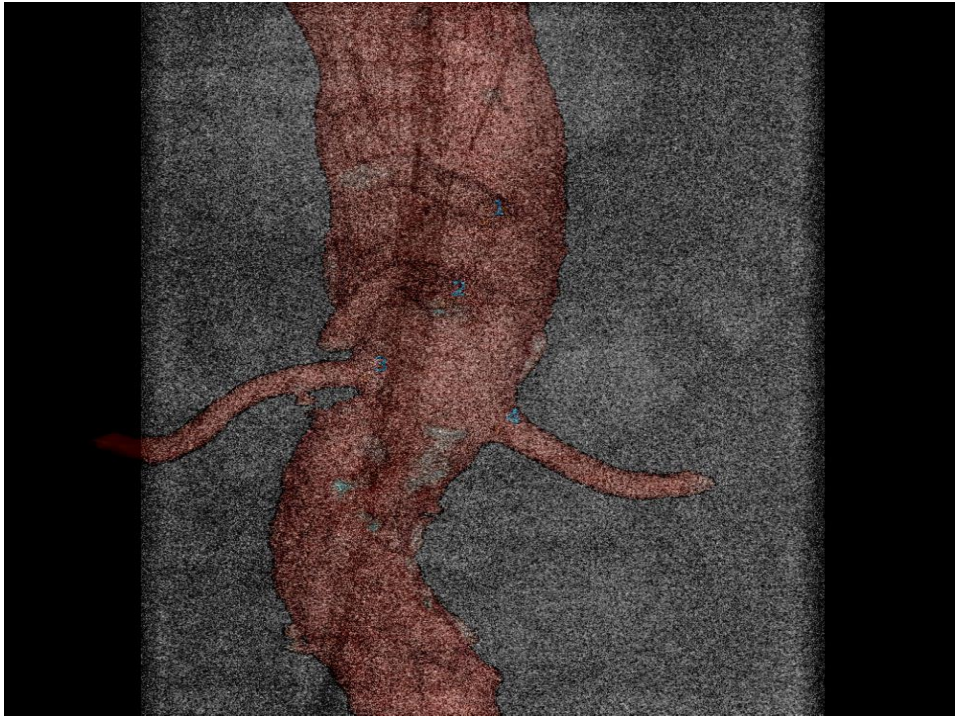
Median Procedure Time (min)



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	tot
PR	240.0	240.0	210.0	165.0	120.0	150.0	125.0	120.0	127.5	110.0	135.0
ATA4	240.0	0.0	450.0	215.0	170.0	165.0	137.5	155.0	170.0	160.0	160.0
ATA123	0.0	0.0	345.0	300.0	295.0	214.0	205.0	225.0	217.5	185.0	210.0
ATA	240.0	0.0	450.0	260.0	240.0	180.0	170.0	210.0	210.0	180.0	190.0

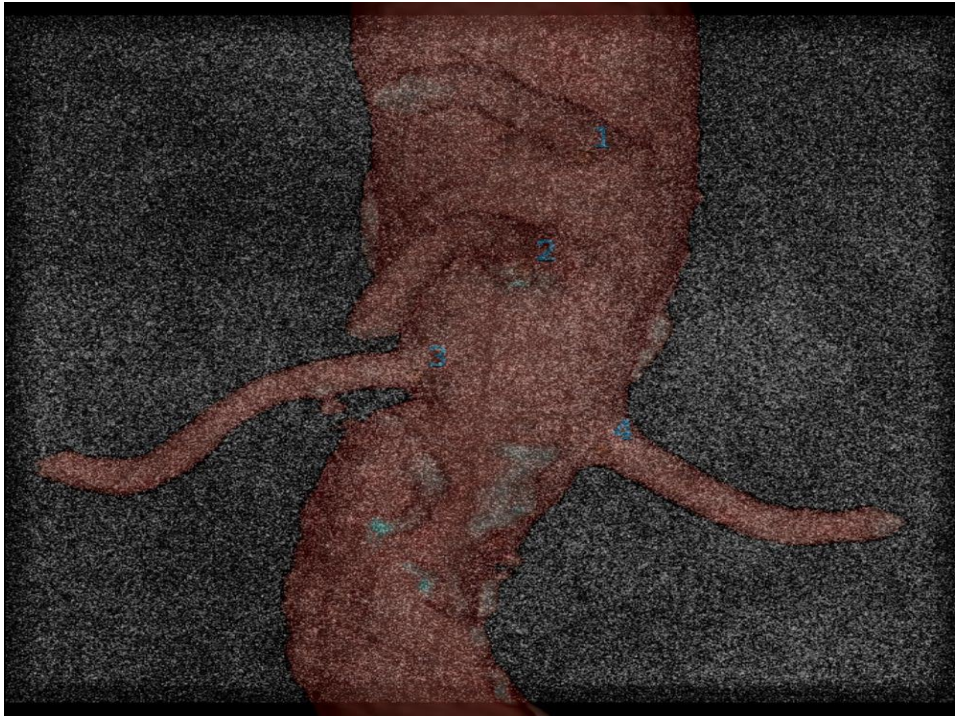
GE Discovery IGS 730

Centre Hospitalier Régional Universitaire de Lille



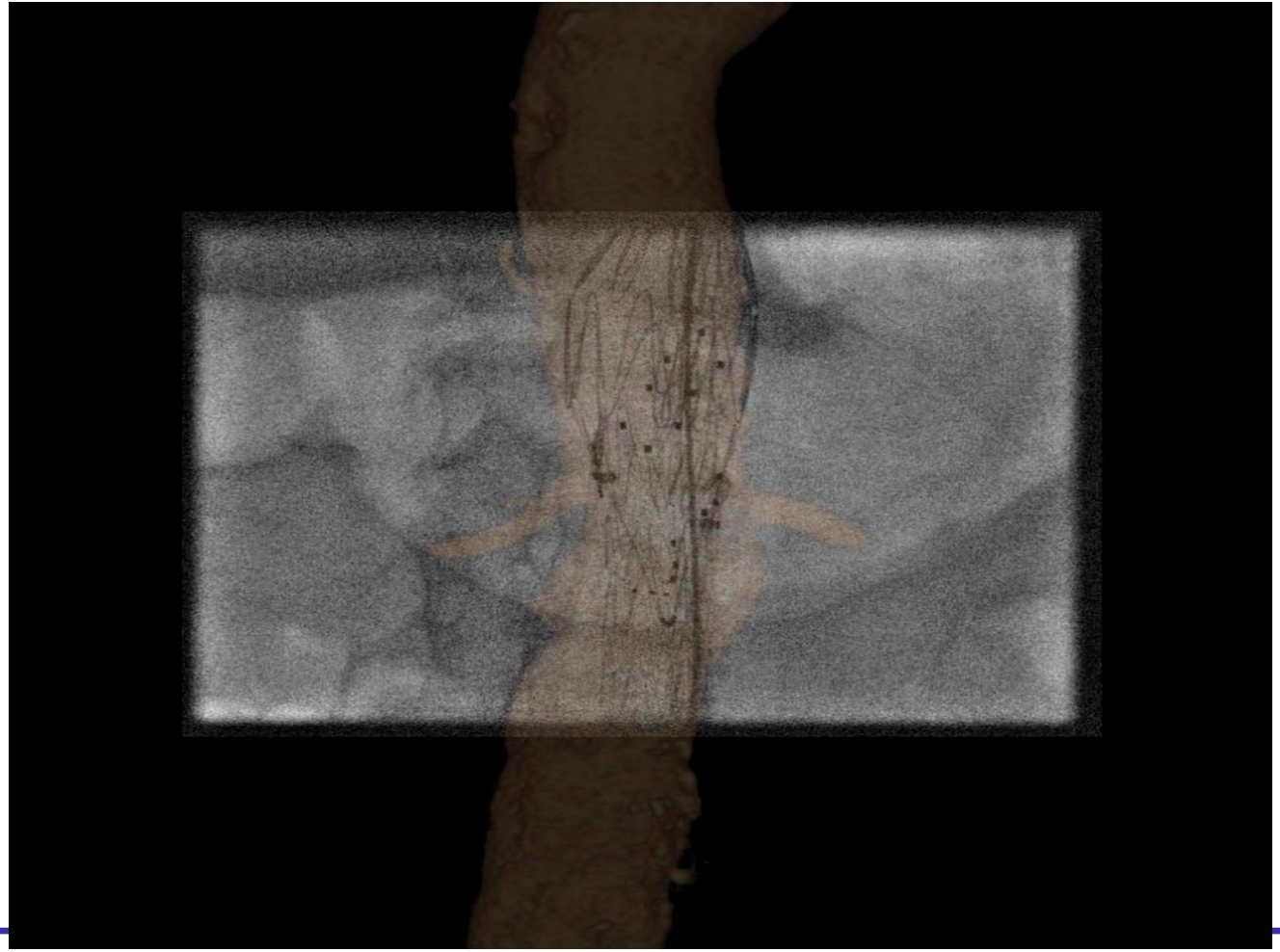
GE DISCOVERY IGS 730

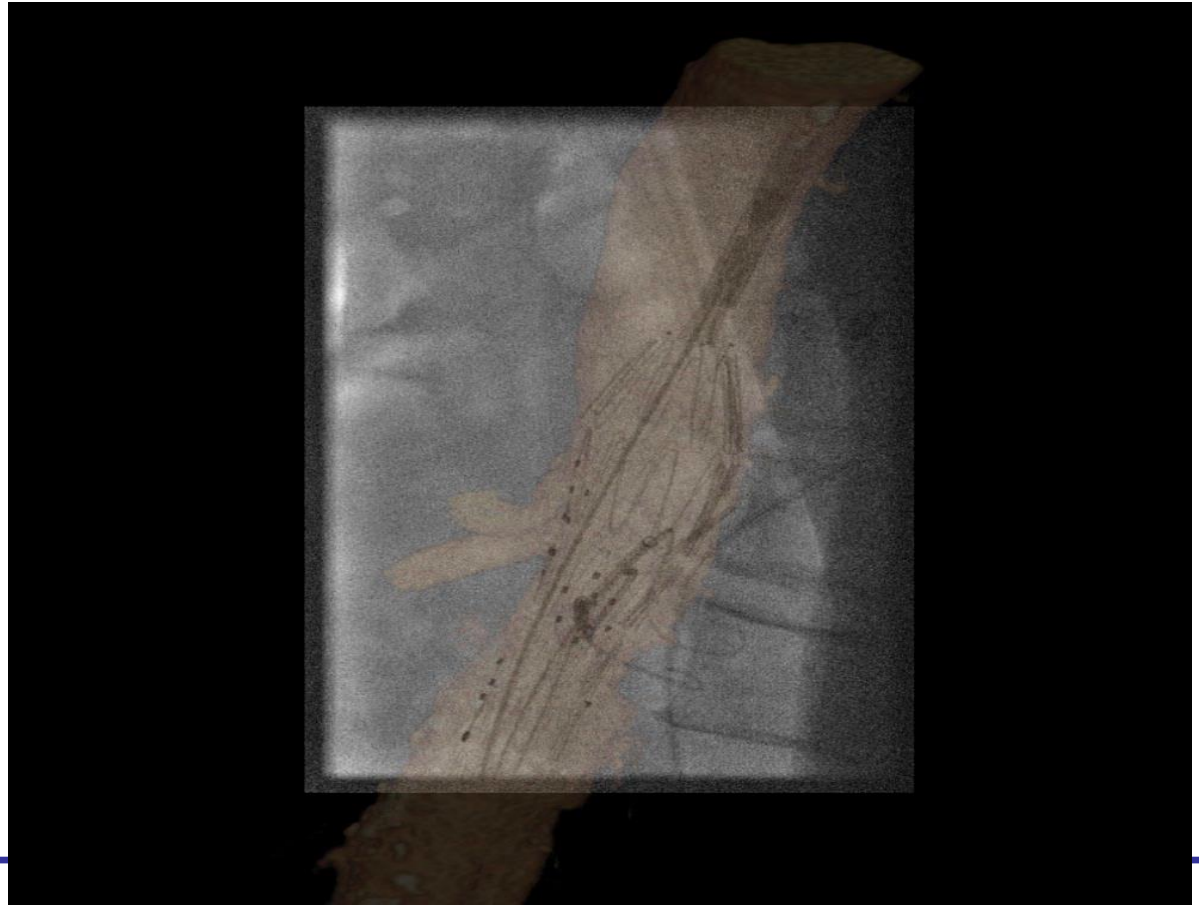
Centre Hospitalier Régional Universitaire de Lille



GE DISCOVERY IGS 730

Centre Hospitalier Régional Universitaire de Lille





ISSUES?

- Challenging procedures
- Radiation exposure
- Durability
- Availability
- Learning curve / Volume
- Unsuitable anatomies

Impact of Hybrid Rooms with Image Fusion on Radiation Exposure during Endovascular Aortic Repair

A. Hertault [a], B. Maurel [a], J. Sobocinski [a], T. Martin Gonzalez [a], M. Le Roux [a], R. Azzaoui [a], M. Midulla [b], S. Haulon [a,*]

[a] Vascular Surgery, Hôpital Cardiologique, CHRU de Lille, INSERM U1008, Université Lille Nord de France, 59037 Lille Cedex, France
[b] Radiology, Hôpital Cardiologique, CHRU Lille, INSERM U1008, Université Lille Nord de France, 59037 Lille Cedex, France

WHAT THIS PAPER ADDS

Experience has shown that the routine use of fusion during endovascular aneurysm repair has significantly reduced the exposure of patients and operators to X-rays and contrast volume injection during complex repairs, without jeopardising the overall procedure workflow.

Objective: To evaluate exposure to radiation during endovascular aneurysm repair (EVAR) performed with intraoperative guidance by preoperative computed tomographic angiogram fusion.
Methods: All consecutive patients who underwent standard bifurcated (BIF) or thoracic (THO), and complex fenestrated (FEN) or branched (BR) EVAR were prospectively enrolled. Indirect dose—area product (DAP), fluoroscopy time (FT), and contrast medium volume were recorded. These data were compared with a previously published prospective EVAR cohort of 301 patients and to other literature. Direct DAP and peak skin dose were measured with radiochromic films. Results are expressed as median (interquartile range).
Results: From December 2012 to July 2013, 102 patients underwent standard (56.8%) or complex (43.2%) EVAR. The indirect DAP (Gy.cm^2) was as follows: BIF 12.2 (8.7—19.9); THO 26.0 (11.9—34.9); FEN 43.7 (24.7—57.5); and BR 47.4 (37.2—108.2). The FT (min) was as follows: BIF 10.6 (9.1—14.7); THO 8.9 (6.0—10.5); FEN 30.7 (20.2—40.5); and BR 39.5 (34.8—51.6). The contrast medium volume (mL) was as follows: BIF 59.0 (50.0—75.0); THO 80.0 (50.0—100.0); FEN 105.0 (70.0—136.0); and BR 120.0 (100.0—170.0). When compared with a previous cohort, there was a significant reduction in DAP during BIF, FEN, and BR procedures, and a significant reduction of iodinated contrast volume during FEN and BR procedures. There was also a significant reduction in DAP during BIF procedures when compared with the literature ($p < .01$). DAP measurement on radiochromic films was strongly correlated with indirect DAP values ($r^2 = .93$).
Conclusion: The exposure of patients and operators to radiation is significantly reduced by routine use of image fusion during standard and complex EVAR.
© 2014 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.
Article history: Received 17 February 2014, Accepted 30 May 2014, Available online 17 July 2014
Keywords: Aorta, Endovascular procedures, Fusion imaging, Hybrid room, Radiation, Radiation protection

INTRODUCTION

The evolution of device technology has allowed physicians to perform more and more complex minimally invasive aortic endovascular repairs. Imaging systems have also evolved to facilitate these challenging procedures. For example, fixed-room flat panel detectors have demonstrated strong imaging superiority over standard fluoroscopic two-dimensional (2D) fluoroscopy imaging systems (mobile C-arms), which are limited by overheating and image degradation, particularly when performing complex endovascular aneurysm repair (EVAR).[1] Hybrid rooms, combining an optimal open surgical environment and advanced imaging capabilities are currently replacing mobile C-arms in the operating room.

The latest hybrid rooms have advanced imaging applications, such as contrast-enhanced cone beam computed tomography (CBCT; three-dimensional [3D] images acquired through a C-arm rotation around the patient), and preoperative computed tomography angiography (CTA) image fusion with live fluoroscopy to provide a "3D roadmap". The latter facilitates endovascular navigation and increases the accuracy of endograft implantation.[2,3] Despite the current widespread use of these new imaging applications, little has been published on their impact on exposure to ionising radiation.[4–6]

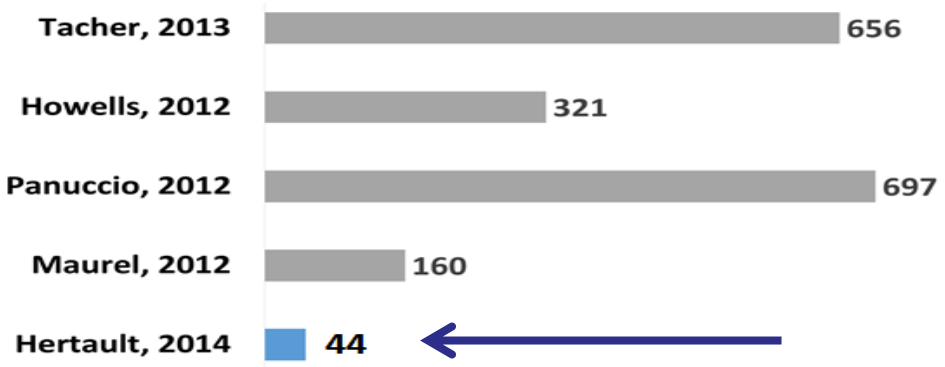
Published evidence suggests that repeated injections of contrast medium contribute to the development of lifelong nephropathy.[7] The effects of radiation are cumulative and put patients at deterministic risk of radiation injuries after exposure.[8] Also, clinical staff regularly exposed to radiation during everyday fluoroscopy-directed procedures are

* Corresponding author.
E-mail address: stephan.haulon@chru-lille.fr (S. Haulon).
1078-5884/$ — see front matter © 2014 European Society for Vascular Surgery. Published by Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ejvs.2014.05.026

Centre Hospitalier Régional Universitaire de Lille

Literature overview
Where do we stand?

Median DAP (Gy.cm²) values reported in the Literature for complex EVAR procedures



Dose saving

Imaging parameters

Auto kV, mA settings (Acq. protocol)
& Normal/Low dose setting (table side control)

IQ Standard
Normal
100% dose

Receptor Dose Limited +
Low
34 %

Fluoro Frame rate

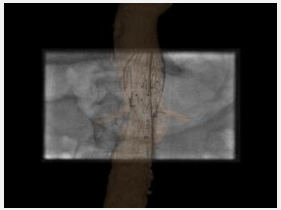
15 fps
7.5 fps
23 %

FOV & Collimation

16 cm
30 cm
Collimation to 16 cm to limit exposure to the area of interest
11 % dose

Imaging modes

- **Use of CTA Fusion**
  - No need of intra-op. 3D
  - Center anatomy and optimize C-arm angulation without x-ray as 3D fusion mask follows the table and gantry movements
- **Minimization of DSA runs**



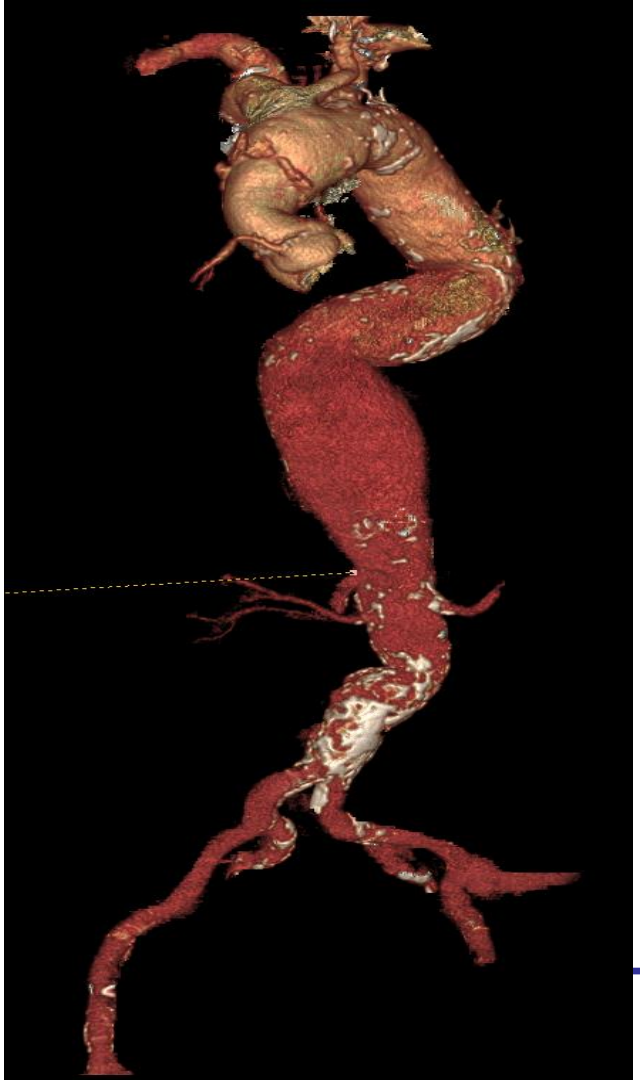
ISSUES?

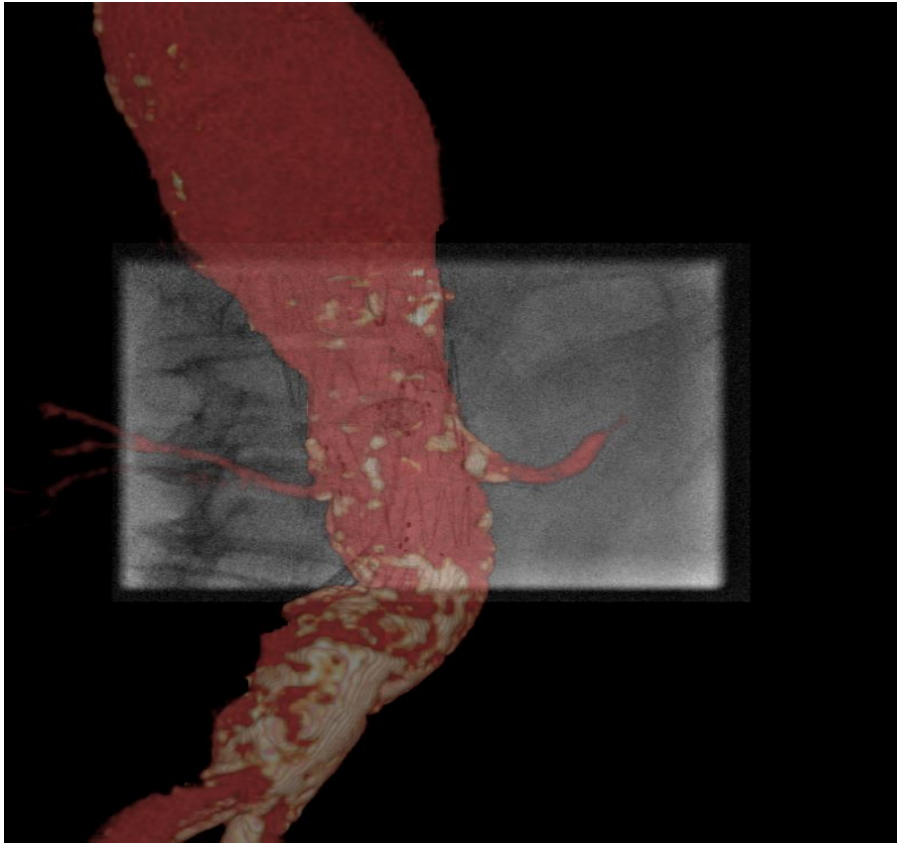
- Challenging procedures
- Radiation exposure
- Durability
- Availability
- Learning curve / Volume
- Unsuitable anatomies

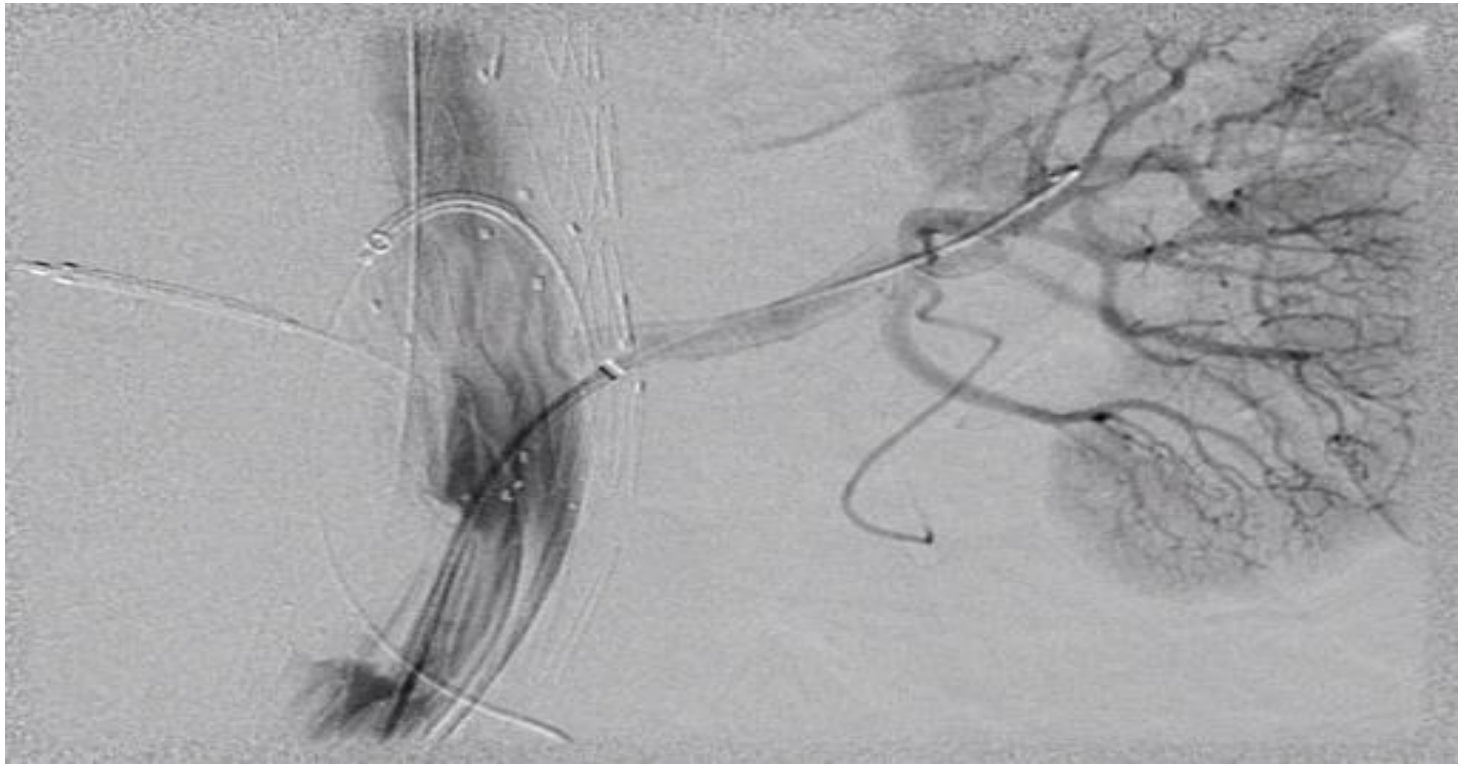
Durability of branches in branched and fenestrated endografts

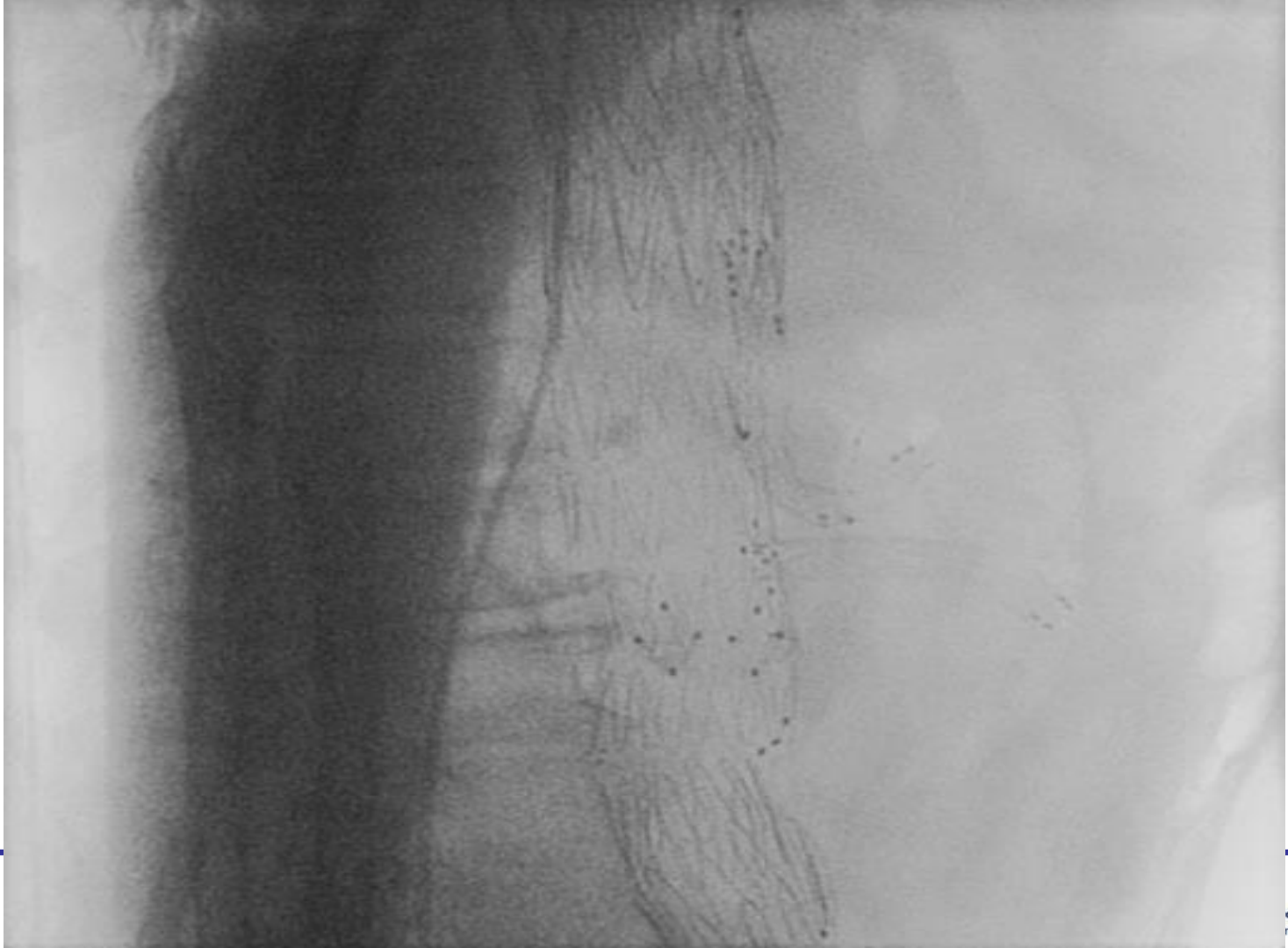
Tara M. Mastracci, MD, Roy K. Greenberg, MD, Matthew J. Eagleton, MD, and **Adrian V. Hernandez, PhD,**
Cleveland, Ohio

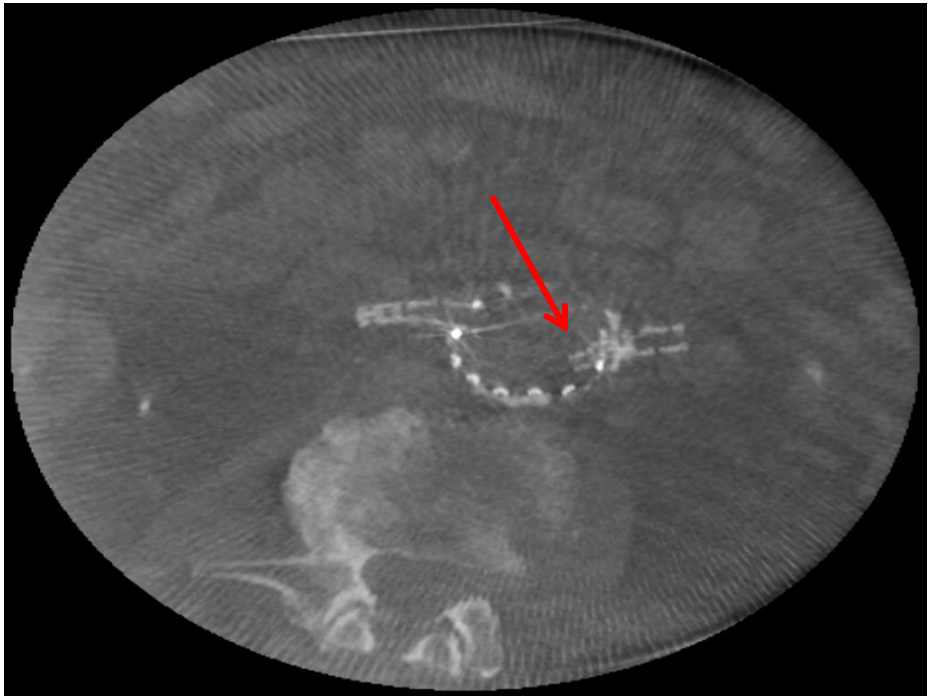
Objective: Branched and fenestrated repair has been shown to be effective for treatment of complex aortic aneurysms. However, the long-term durability of branches is not well reported.
Methods: Prospective data collected for all patients enrolled in a physician-sponsored investigational device exemption trial for branched and fenestrated endografts were analyzed. Retrospective review of imaging studies and electronic records was used to supplement the dataset. Incidences of branch stent secondary intervention, stent fracture, migration, branch-related rupture, and death were calculated. A time-to-event analysis was performed for secondary intervention for any branch. Univariable and multivariable analyses were performed to identify related variables. Branch instability, a composite outcome of any branch event, was reported as a function of exponential decay to capture the loss of freedom from complications over time.
Results: Between the years 2001 and 2010, 650 patients underwent endovascular aortic repair with branched or fenestrated devices. Over 9 years of follow-up (mean [standard deviation], 3 [2.3] years), secondary procedures were performed for 0.6% of celiac, 4% of superior mesenteric artery (SMA), 6% of right renal artery, and 5% of left renal artery stents. Mean time to reintervention was 237 (354) days. The 30-day, 1-year, and 5-year freedom from branch intervention was 98% (95% confidence interval [CI], 96%-99%), 94% (95% CI, 92%-96%), and 84% (95% CI, 78%-90%), respectively. Death from branch stent complications occurred in three patients, two related to SMA thrombosis and one due to an unstented SMA scallop. Multivariable analysis revealed no factors as independent predictors of need for branch reintervention.
Conclusions: Branches, after branched or fenestrated aortic repair, appear to be durable and are rarely the cause of patient death. The absence of long-term data on branch patency in open repair precludes comparison, yet the lower morbidity and mortality risk coupled with longer-term durability data will further alter the balance of repair options. (J Vasc Surg 2013;57:926-33.)

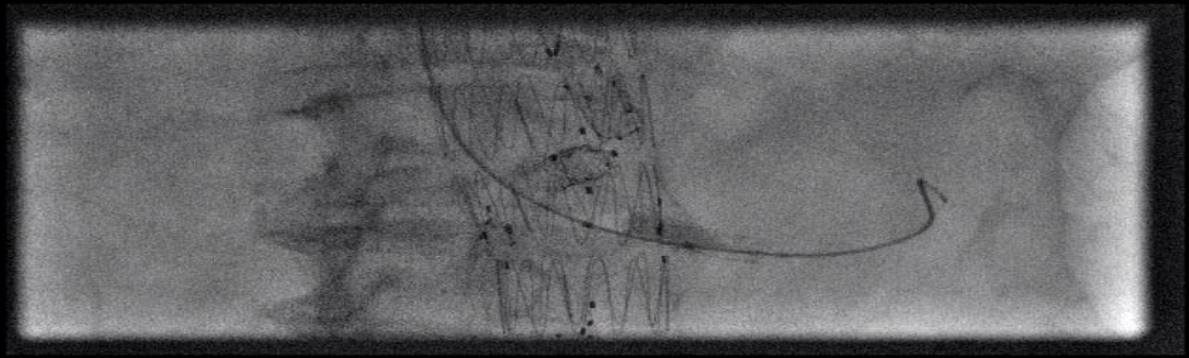




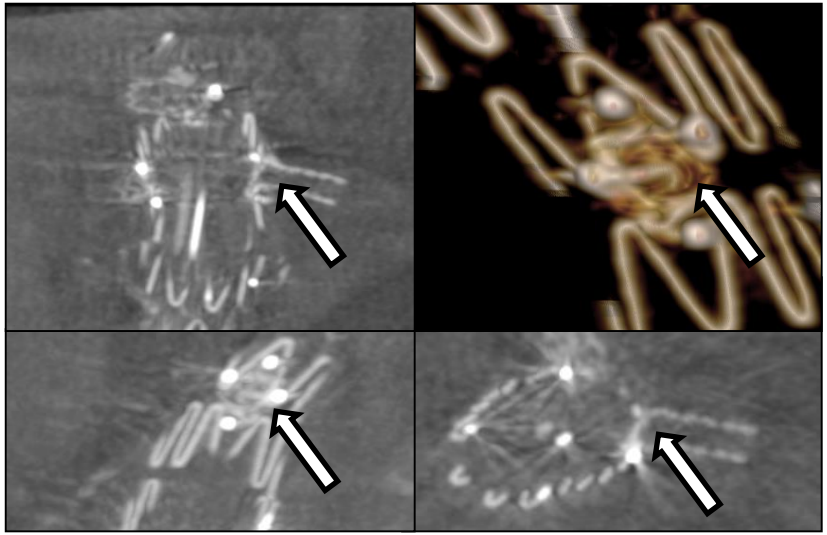


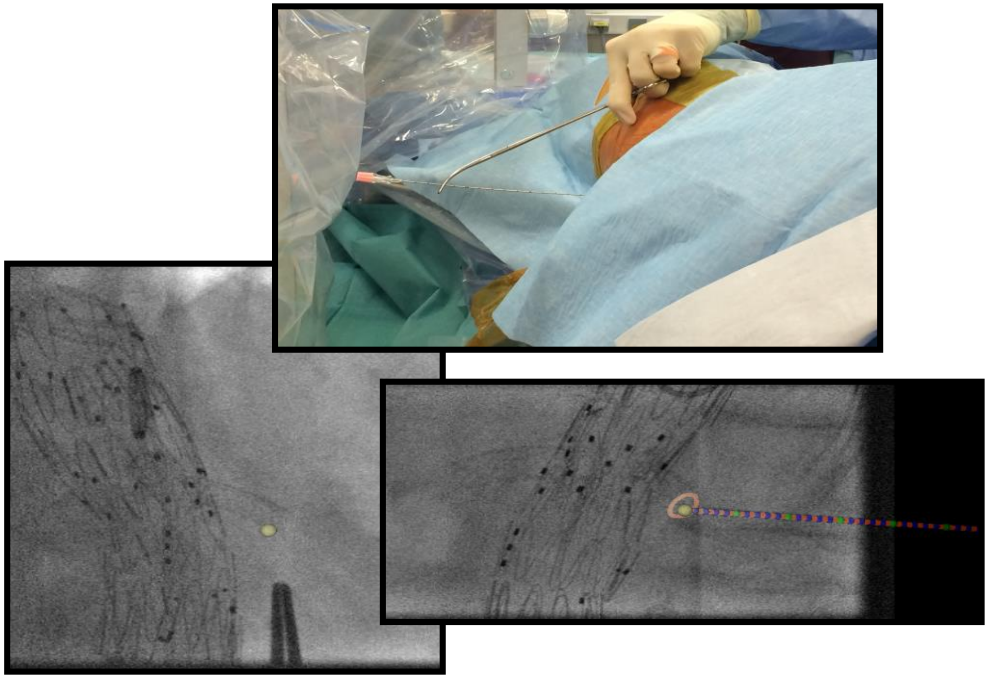




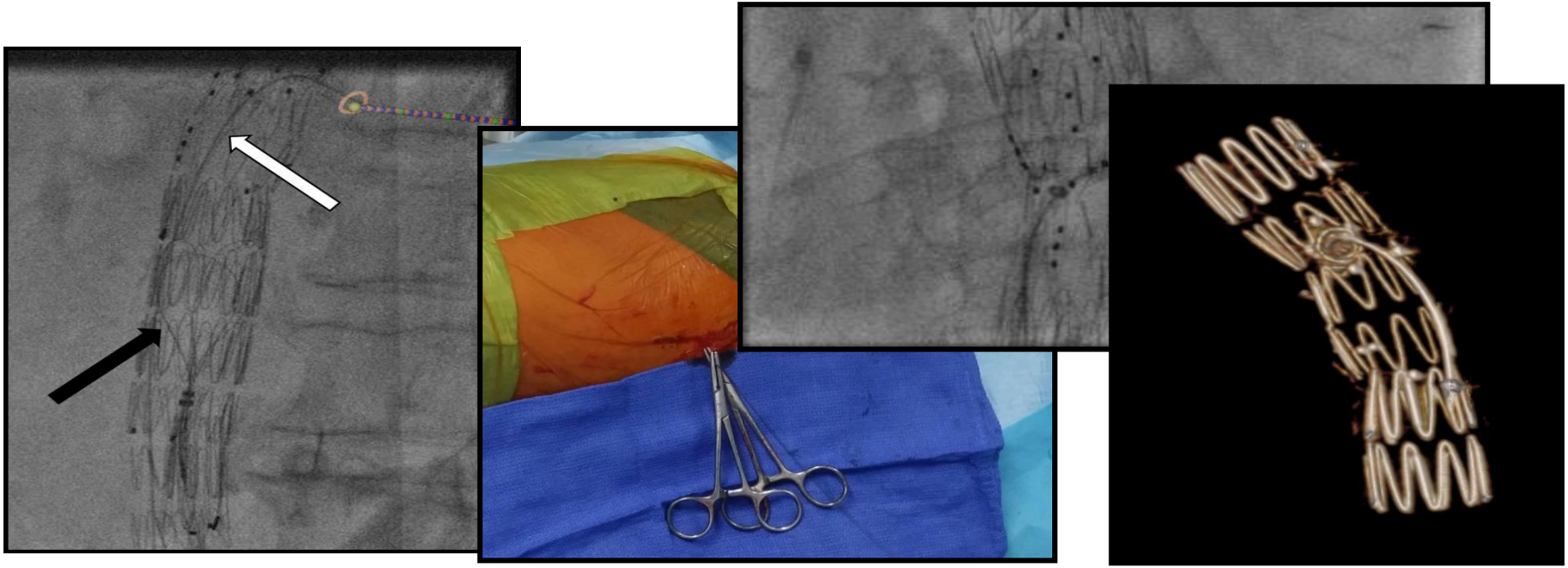


TrackVision Needle Guidance





TrackVision Needle Guidance



Eur J Vasc Endovasc Surg (2015) 49, 541—548

Benefits of Completion 3D Angiography Associated with Contrast Enhanced Ultrasound to Assess Technical Success after EVAR

A. Hertault [a], B. Maurel [a], F. Pontana [b], T. Martin-Gonzalez [a], R. Spear [a], J. Sobocinski [a], I. Sediri [c], C. Gautier [c], R. Azzaoui [a], M. Rémy-Jardin [b], S. Haulon [a,*]

[a] Service de Chirurgie Vasculaire, Hôpital cardiologique, CHRU Lille, France
[b] Service d'Imagerie Cardio-Vasculaire et Thoracique, Hôpital Calmette, CHRU de Lille, France
[c] Service des Explorations Fonctionnelles Cardio-Vasculaires, Hôpital Cardiologique, CHRU de Lille, France

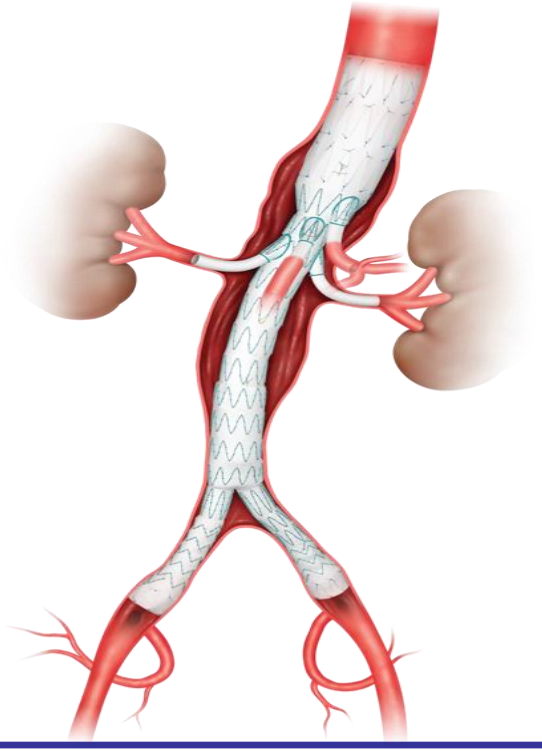
WHAT THIS PAPER ADDS

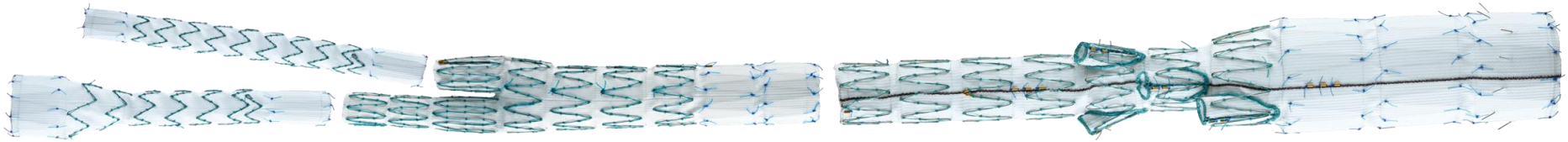
Use of a contrast enhanced CBCT based strategy to assess technical success after EVAR is feasible, and allows reduction of total in hospital radiation exposure and contrast medium volume injected.

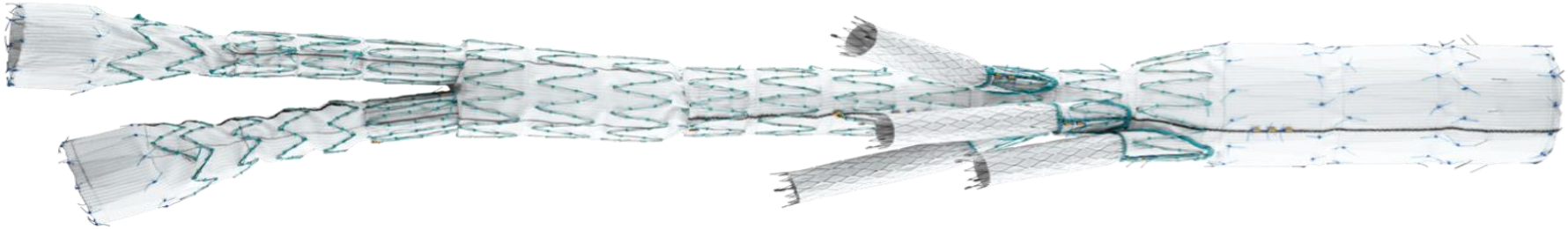
ISSUES?

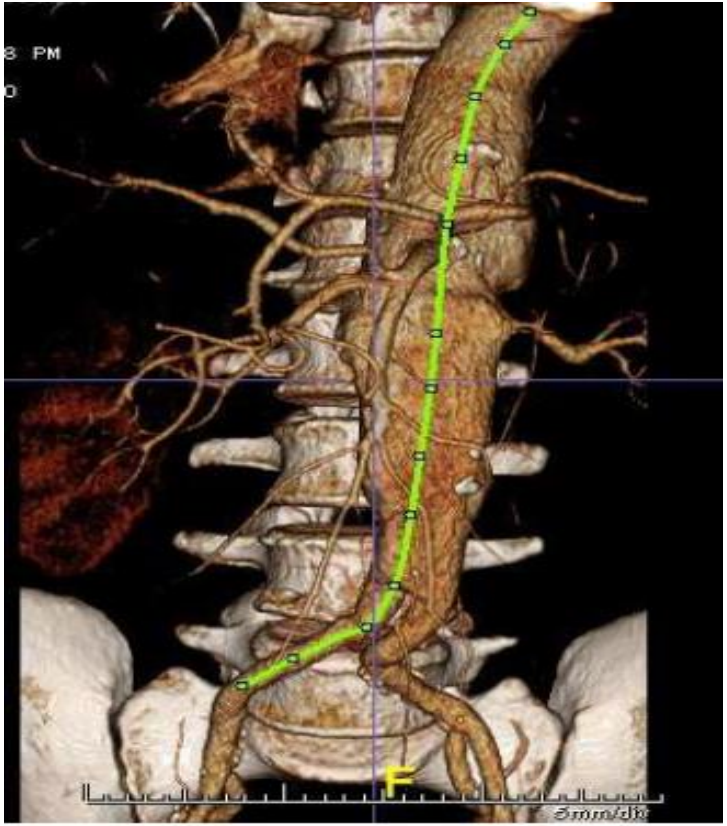
- Challenging procedures
- Radiation exposure
- Durability
- Availability
- Learning curve / Volume
- Unsuitable anatomies

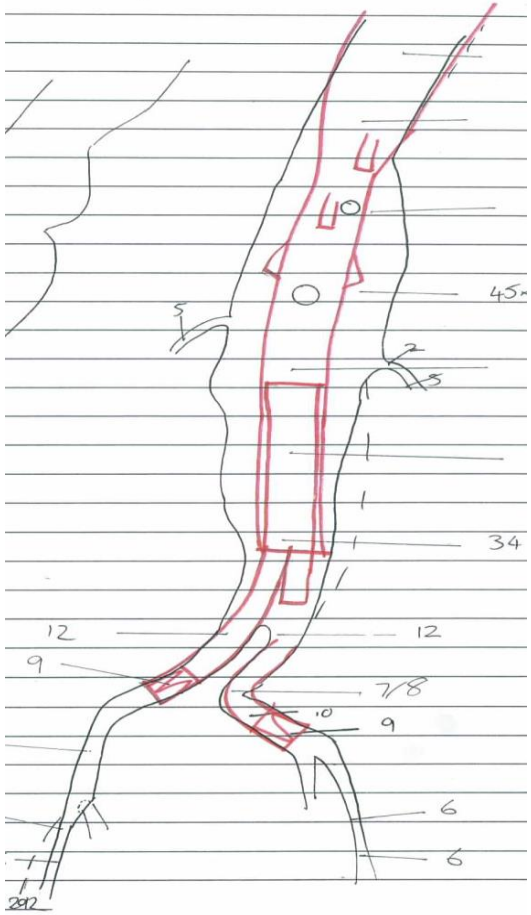
Off the Shelf 4-Branch Device

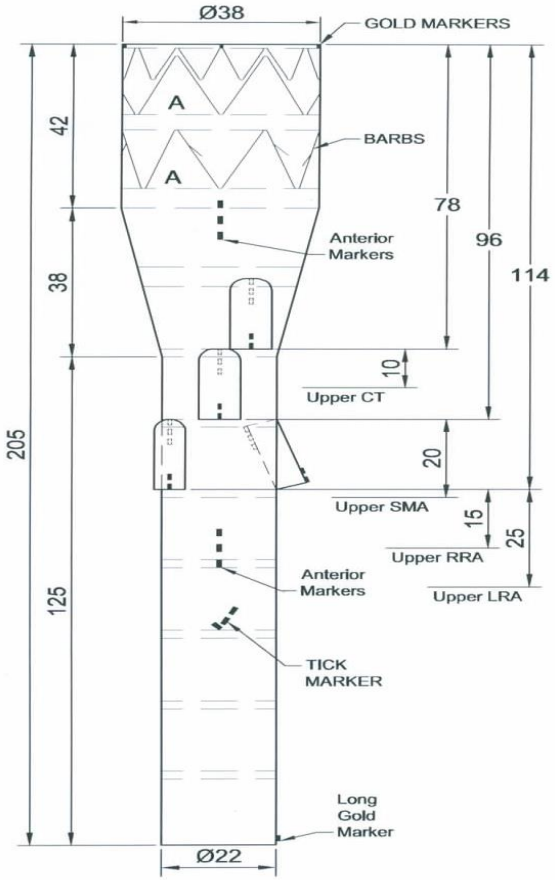


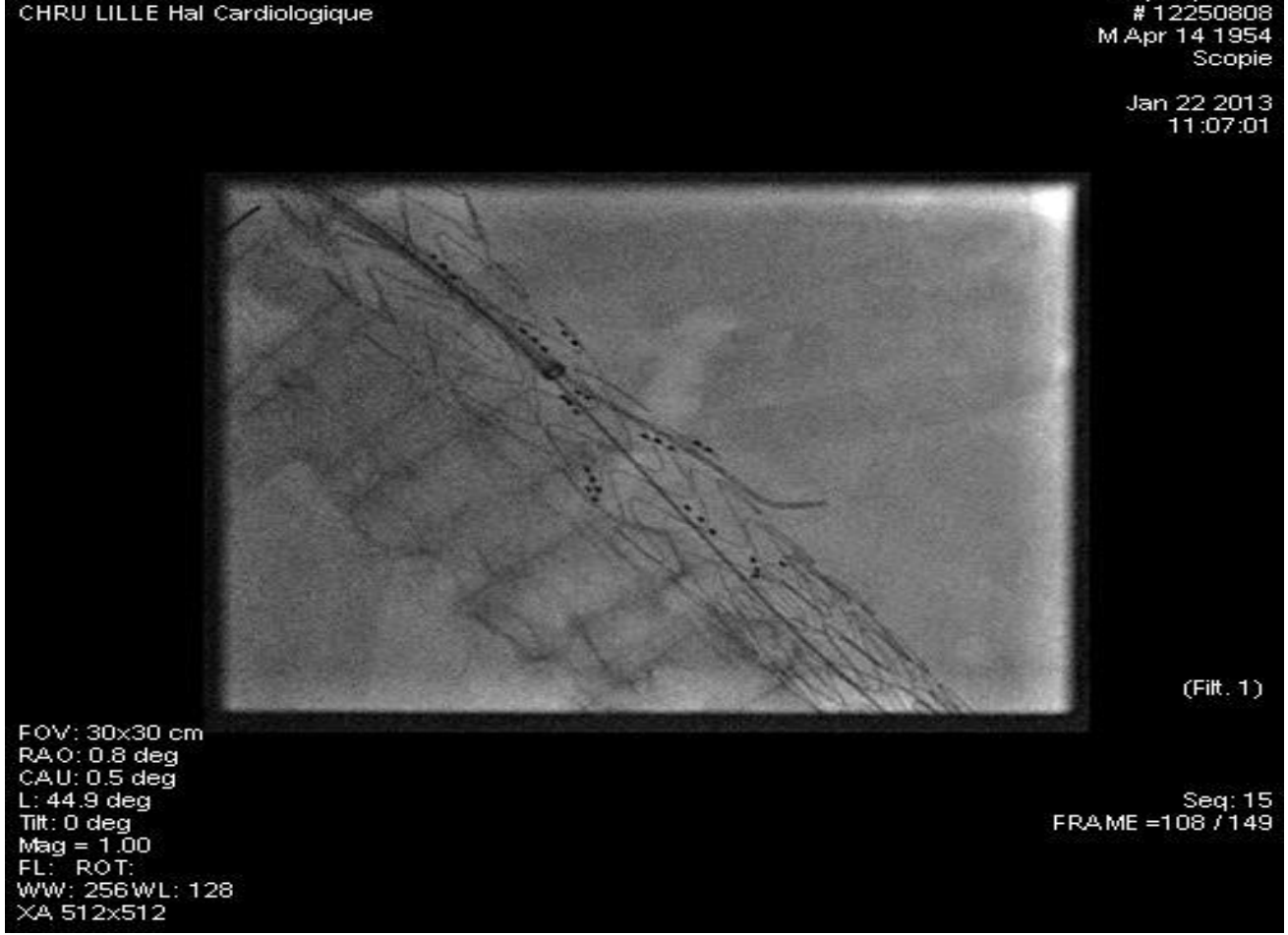


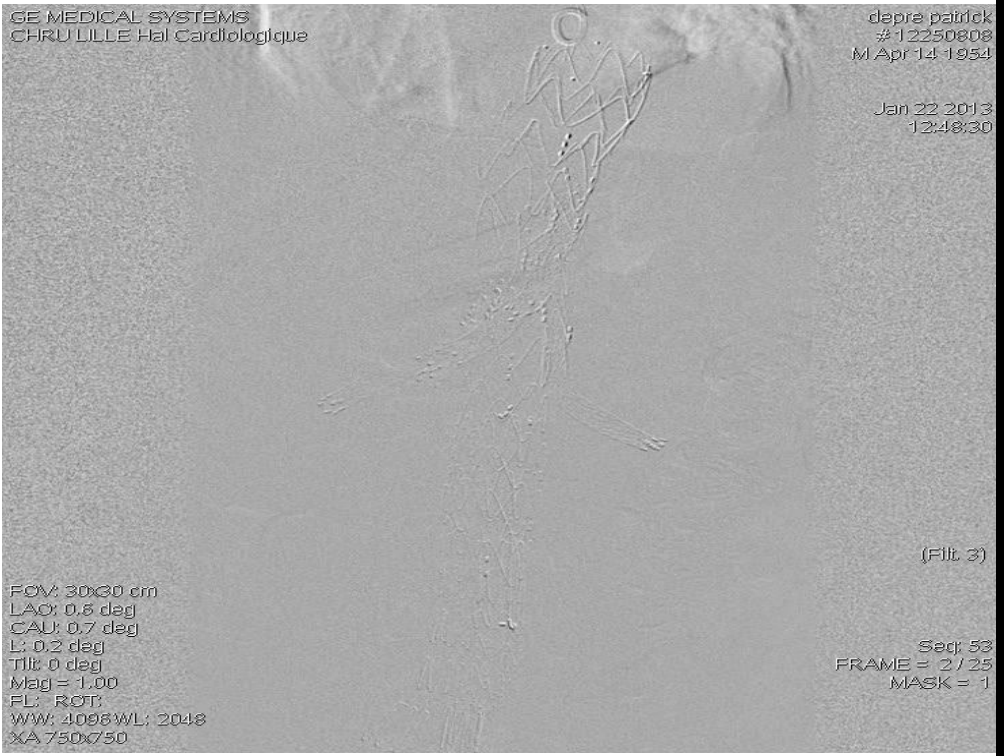


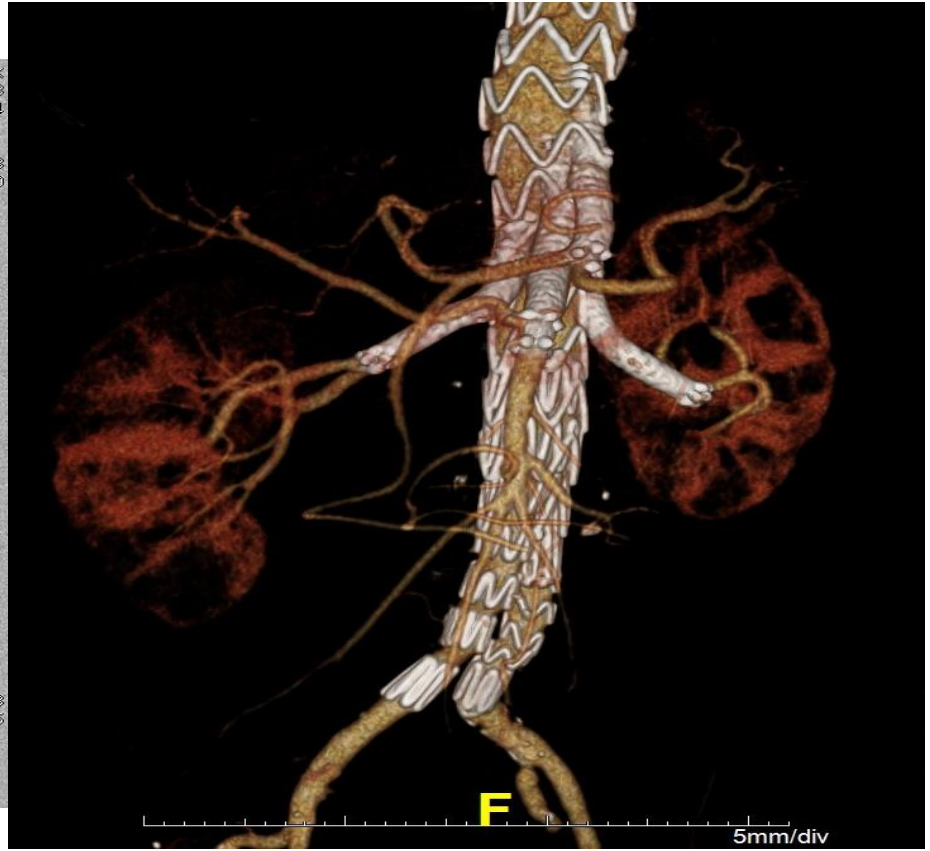

PM
F
5mm/dk


45
34
12
12
9
7/8
9
6
6


Ø38
GOLD MARKERS
A
A
BARBS
42
38
205
125
78
96
114
Anterior Markers
10
Upper CT
20
Upper SMA
15
25
Upper RRA
Upper LRA
Anterior Markers
TICK MARKER
Long Gold Marker
Ø22


CHRU LILLE Hal Cardiologique
12250808
M Apr 14 1954
Scopie
Jan 22 2013
11:07:01
(Filt. 1)
FOV: 30x30 cm
RAO: 0.8 deg
CAU: 0.5 deg
L: 44.9 deg
Tilt: 0 deg
Mag = 1.00
FL: ROT:
WW: 256 WL: 128
XA 512x512
Seq: 15
FRAME =108 / 149





Centre Hospitalier Régional
Universitaire de Lille

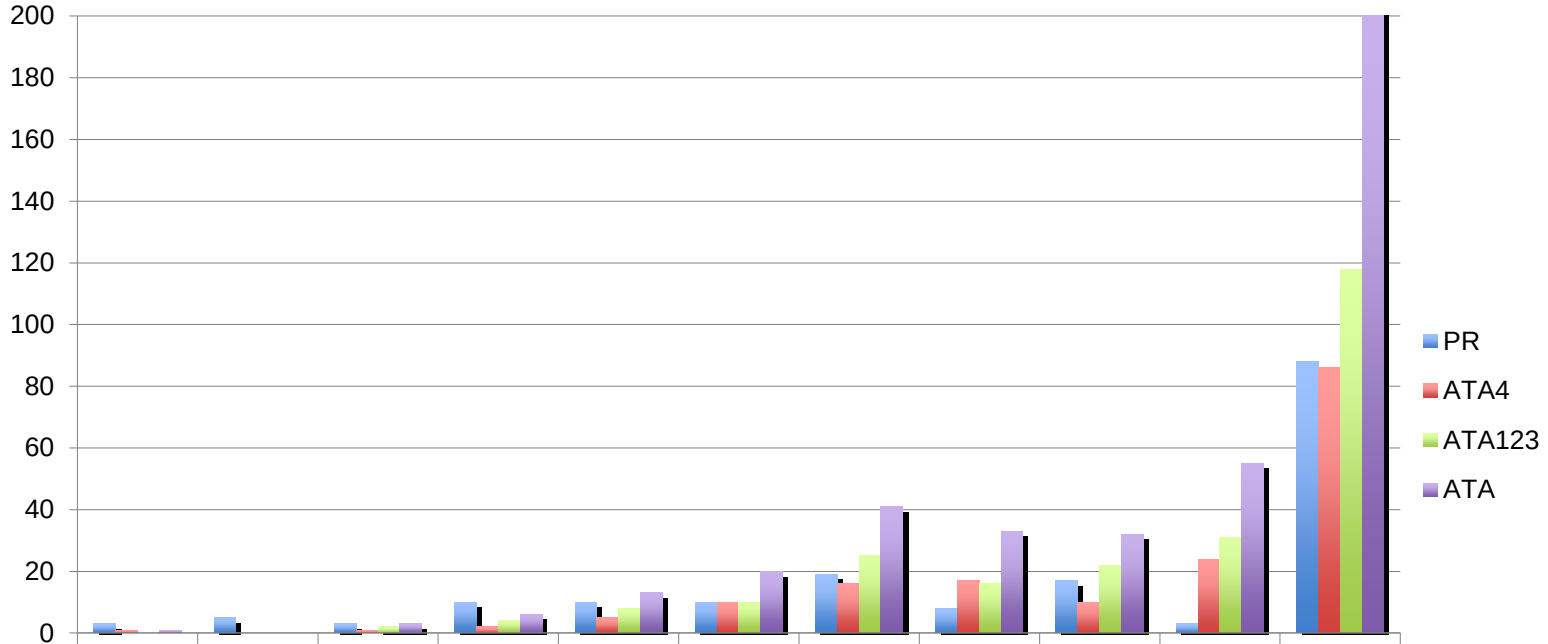
Off the Shelf for Everyone?

- Match long term results of CMD's
- Not adapted to all anatomies
- Restricted to emergencies

ISSUES?

- Challenging procedures
- Radiation exposure
- Durability
- Availability
- Learning curve / Volume
- Unsuitable anatomies

TAAA cases/year



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	tot
PR	3	5	3	10	10	10	19	8	17	3	88
ATA4	1	0	1	2	5	10	16	17	10	24	86
ATA123	0	0	2	4	8	10	25	16	22	31	118
ATA	1	0	3	6	13	20	41	33	32	55	204

Centre Hospitalier Régional Universitaire de Lille

Eur J Vasc Endovasc Surg (2015) 49, 248—254

Editor's Choice — The Impact of Early Pelvic and Lower Limb Reperfusion and Attentive Peri-operative Management on the Incidence of Spinal Cord Ischemia During Thoracoabdominal Aortic Aneurysm Endovascular Repair

B. Maurel [a], N. Delclaux [a], J. Sobocinski [a], A. Hertault [a], T. Martin-Gonzalez [a], M. Moussa [a], R. Spear [a], M. Le Roux [a], R. Azzaoui [a], M. Tyrrell [b], S. Haulon [a,*]

[a] Aortic Centre, Hôpital Cardiologique, CHRU de Lille, INSERM U1008, Université Lille Nord de France, 59037 Lille Cedex, France
[b] King's Health Partners, London, UK

WHAT THIS PAPER ADDS
This paper reports the impact of an optimized spinal cord protection strategy on spinal cord ischemia rates after endovascular thoracoabdominal aneurysm repair performed in a high volume center.

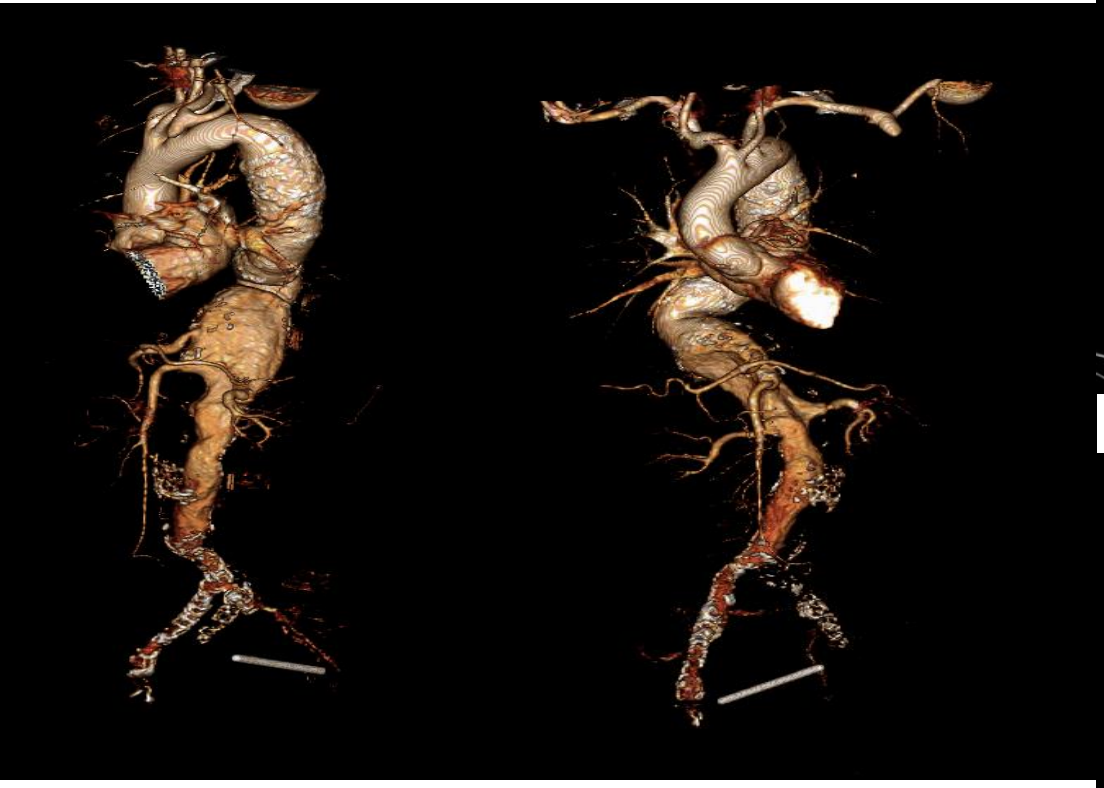
RESULTS

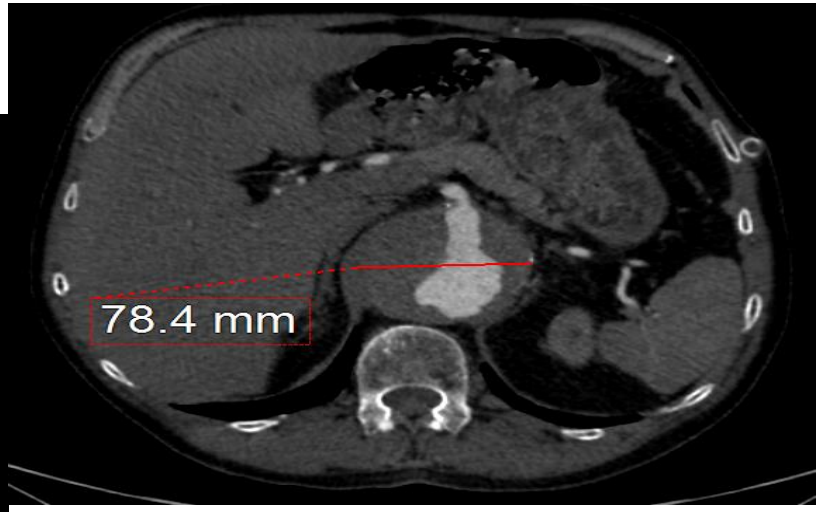
- In-hospital mortality: 11.6 % in group 1 vs 5.6 % in group 2 (RR = 0.481 [0.17-1.36]; p = 0.09)

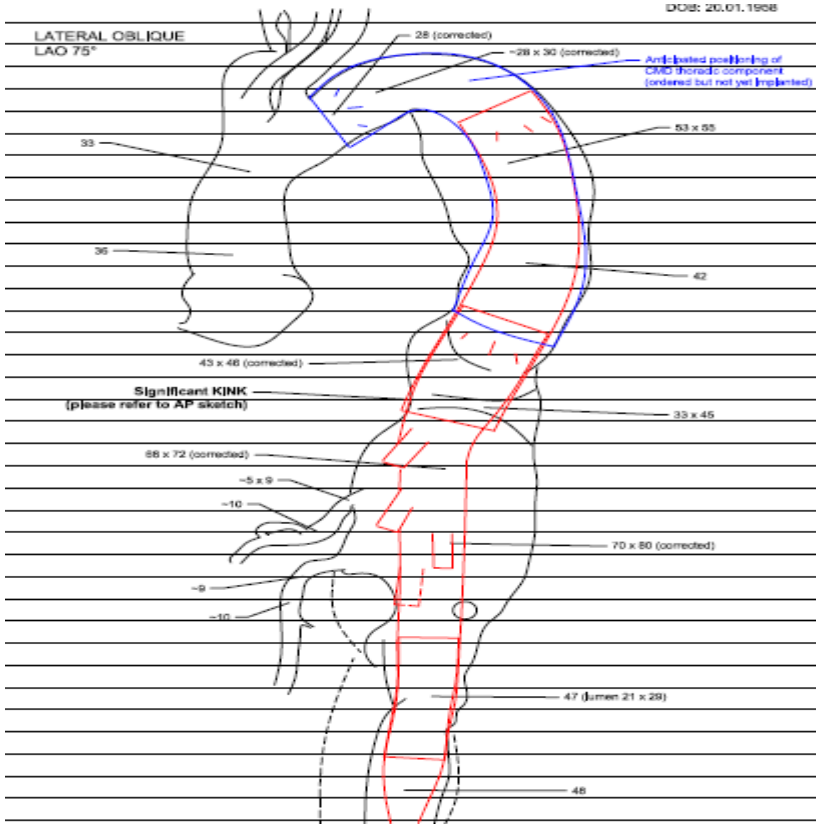
- Spinal Cord Ischemia: 14% vs 1.2% (RR = 1.148 [1.016-1.296]; p < 0.001)

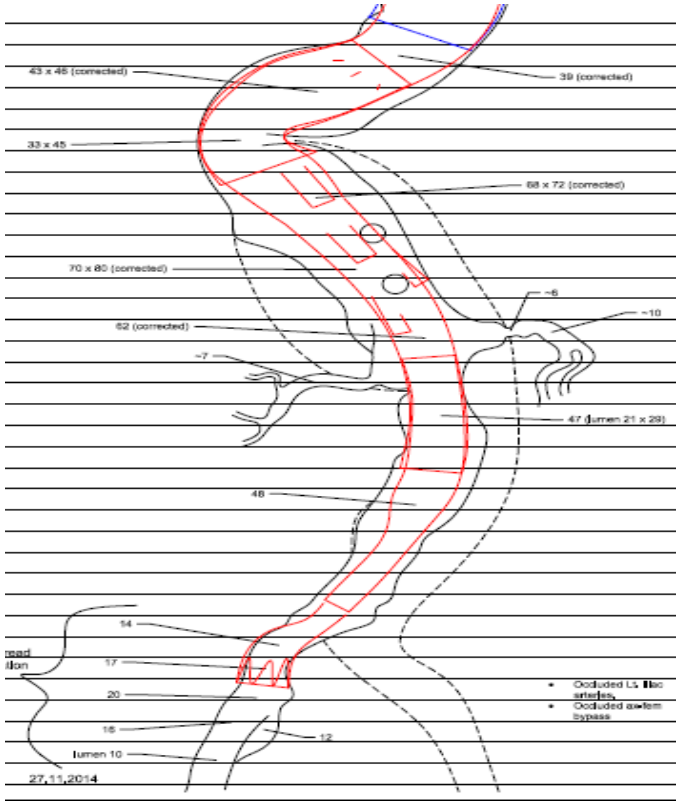
ISSUES?

- Challenging procedures
- Radiation exposure
- Durability
- Availability
- Learning curve / Volume
- Unsuitable anatomies

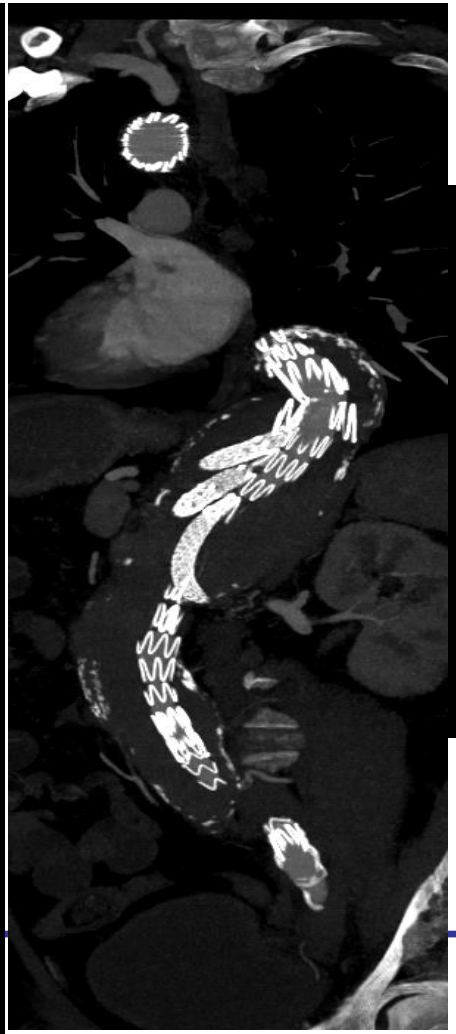



78.4 mm





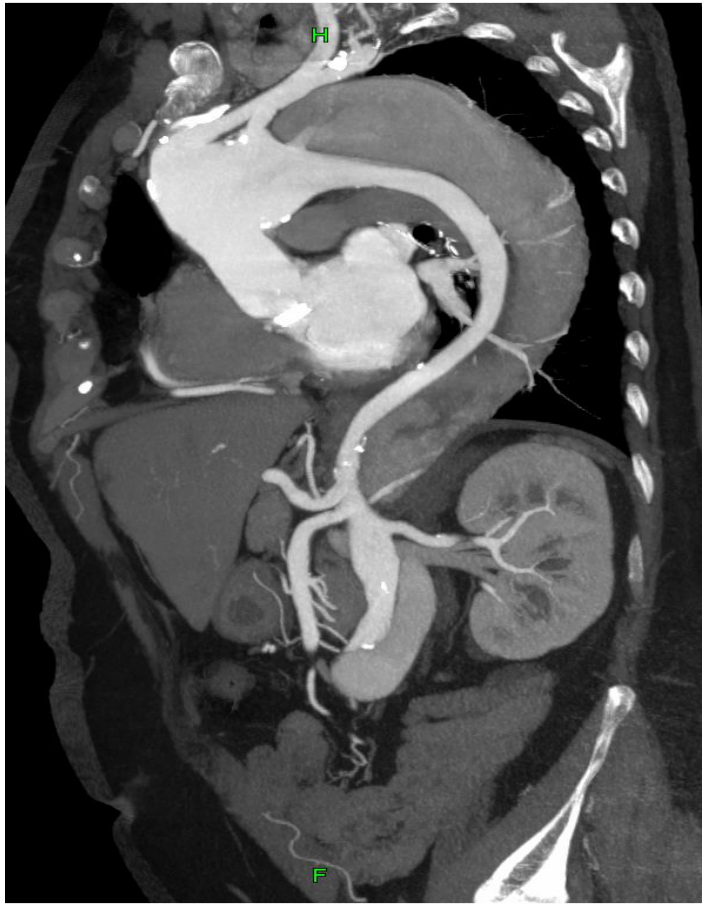
Centre Hospitalier Régional
Universitaire de Lille

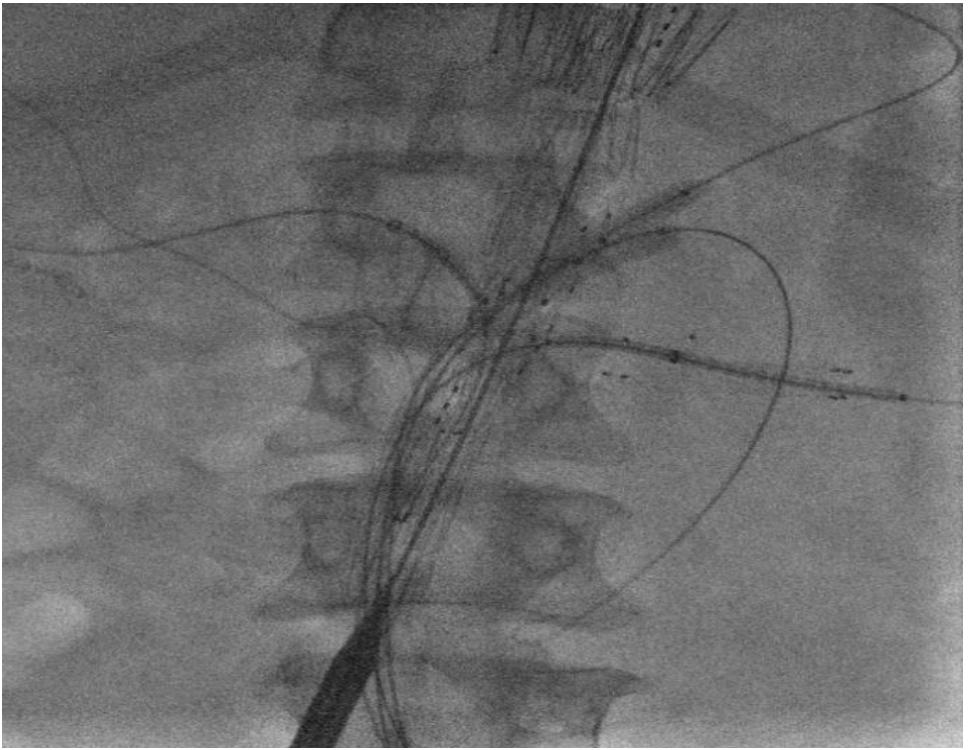


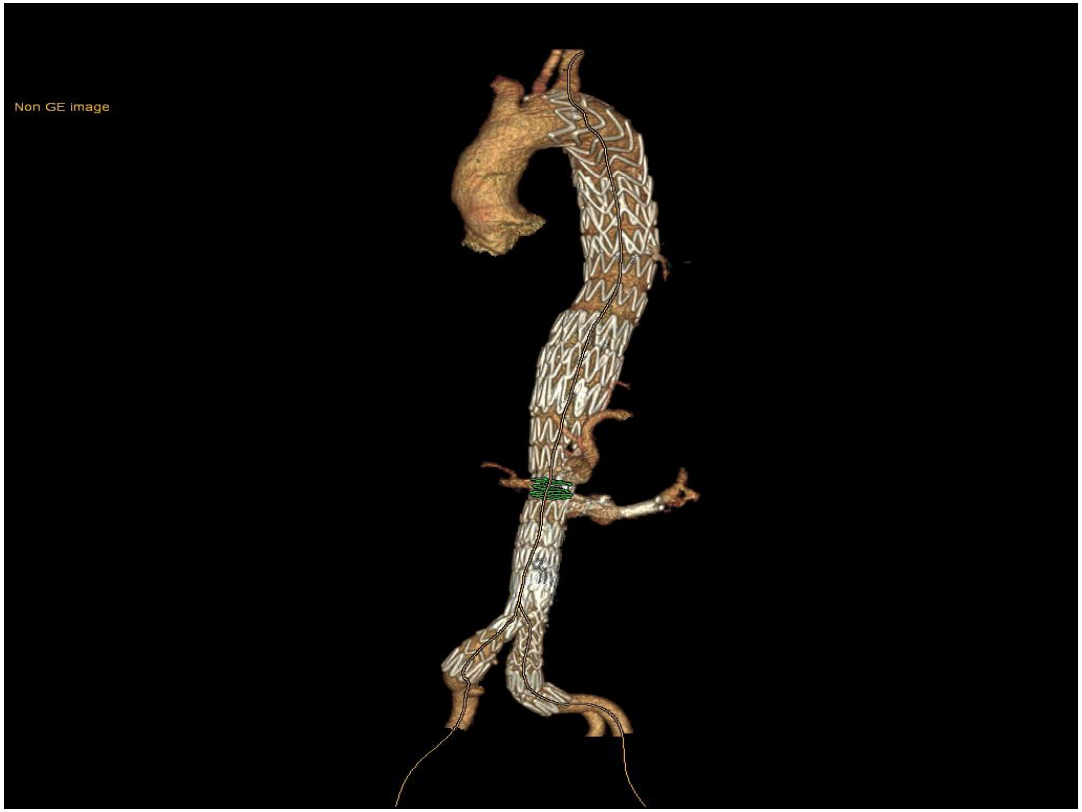
Centre Hospitalier Régional
Universitaire de Lille

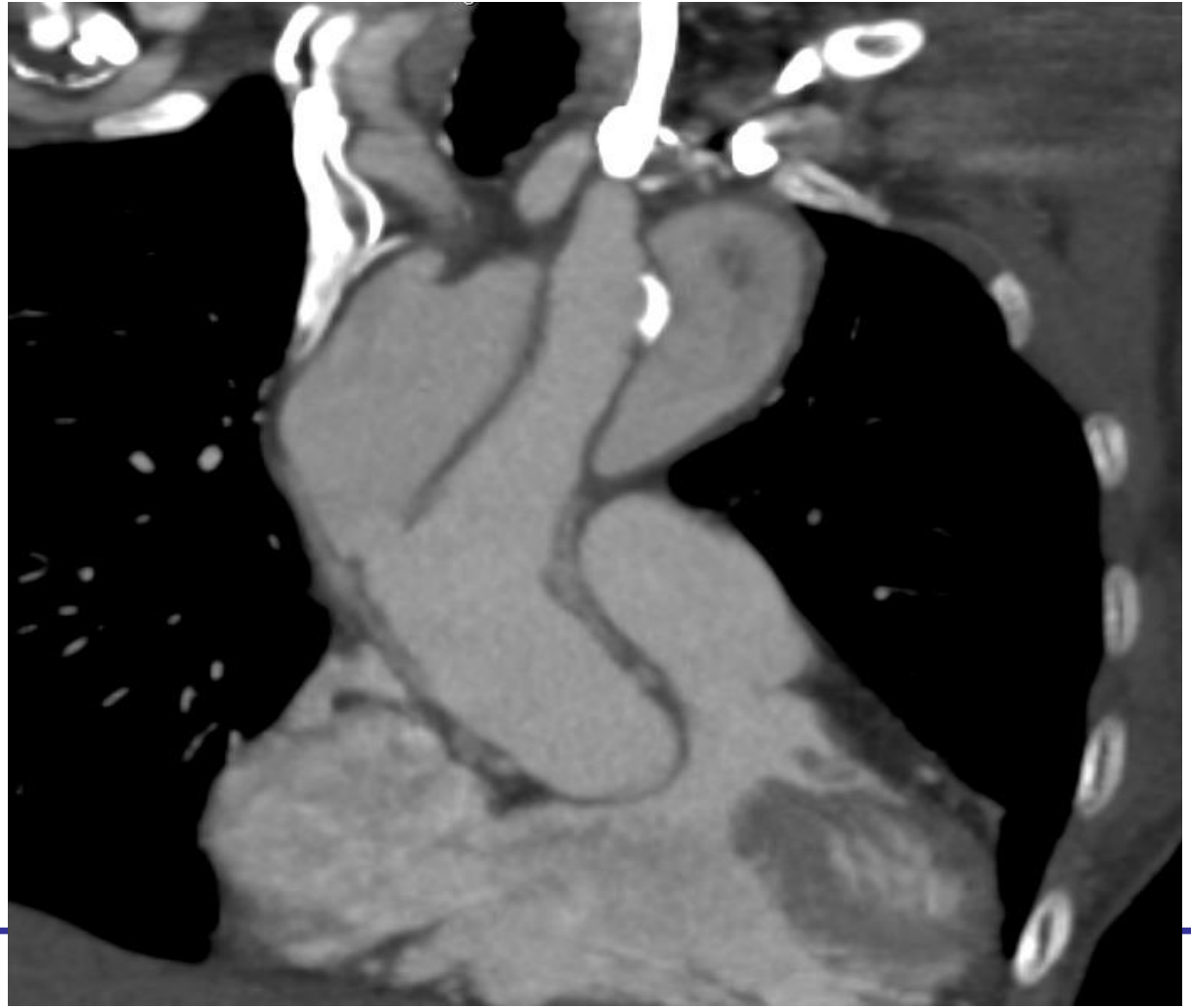
Challenging Anatomies

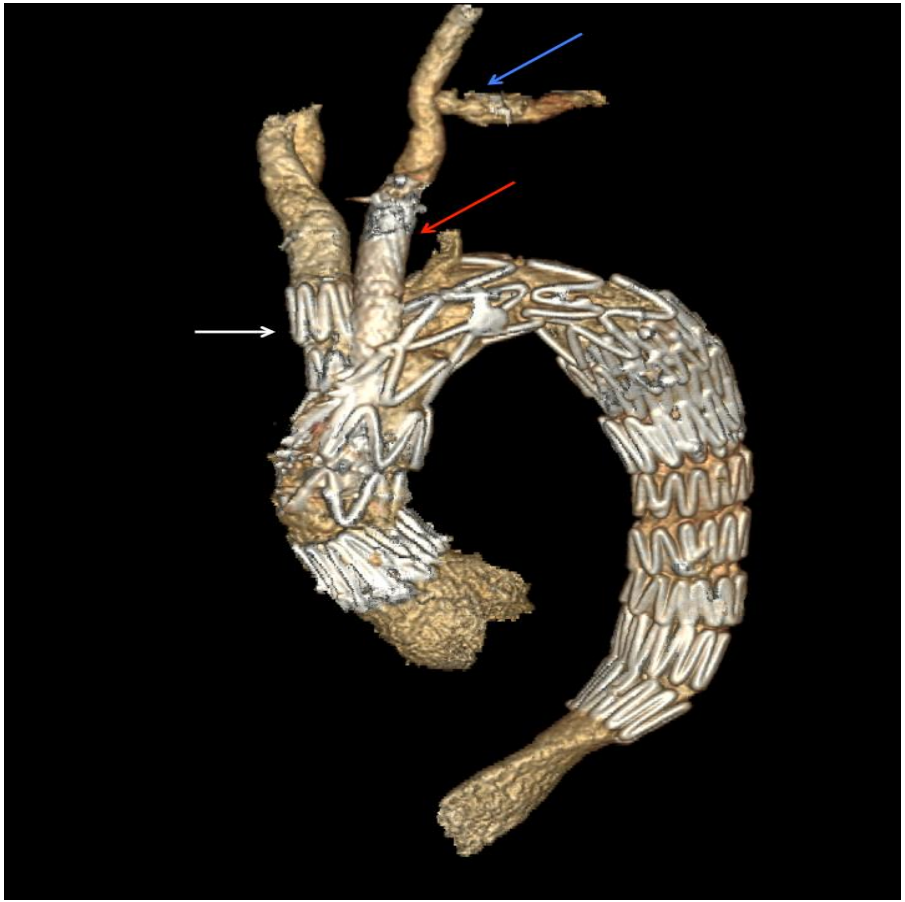
- Proximal and Distal Sealing
- Narrow true lumen
- Target vessels perfused by false lumen
- Limited experience

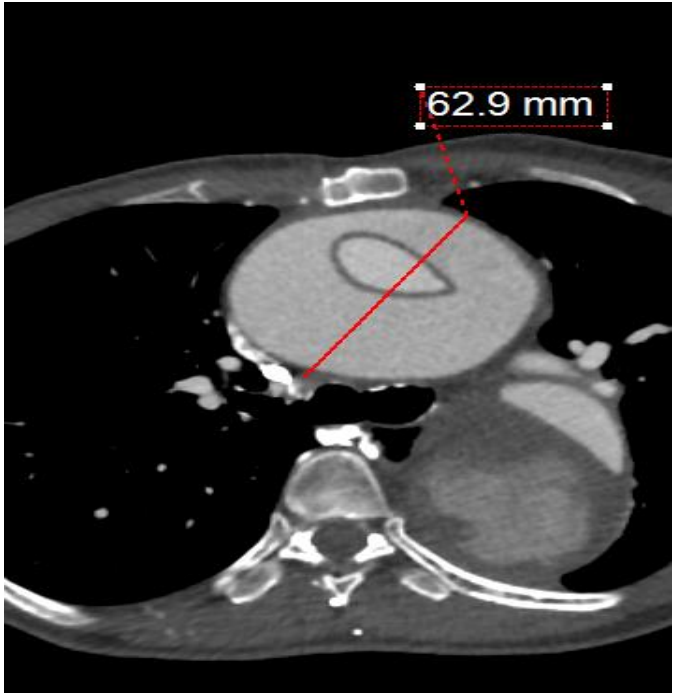




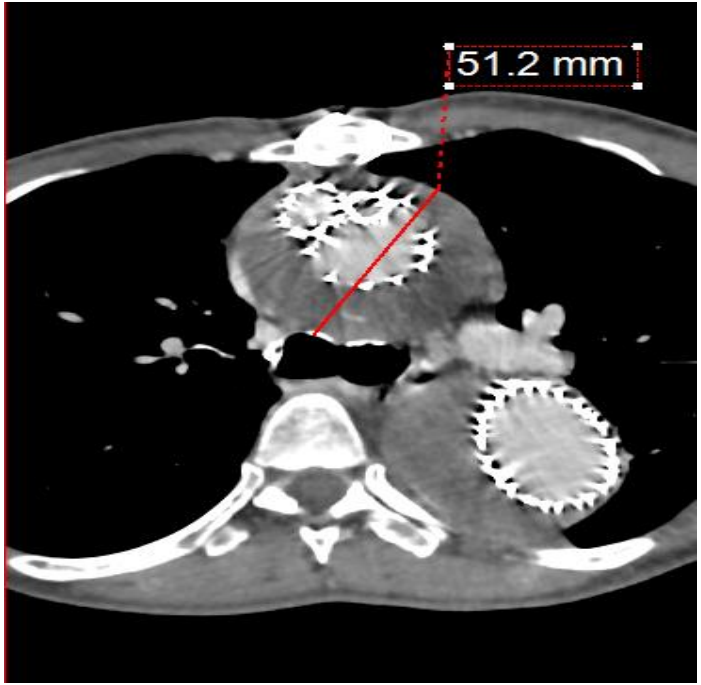

Non GE image







Pre-operative CT



2-year control

Pre-operative CT

2-year control

CONCLUSIONS

- Match mid term outcomes of OS
- Lesser surgical insult
- High volume centers performing both techniques