Reducing neurological complications during TEVAR – the latest thinking

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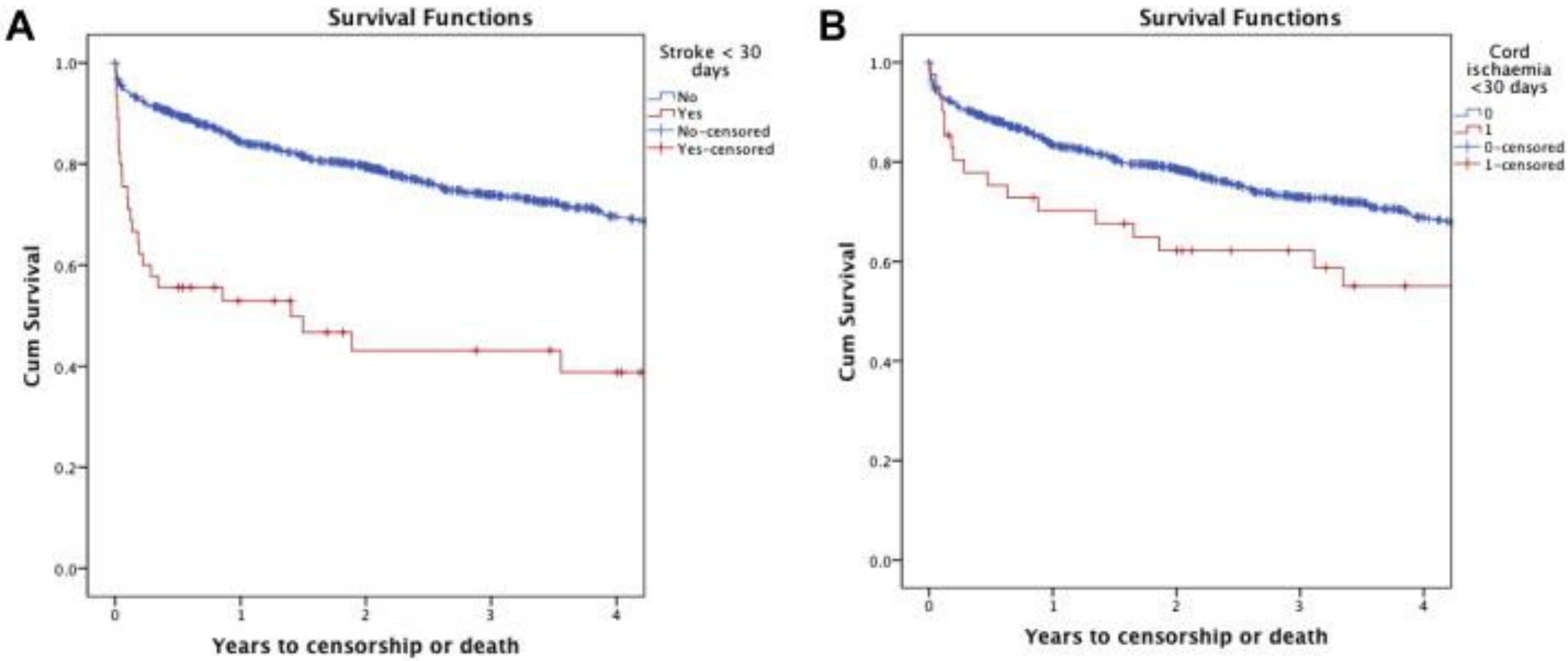
Disclosures

- Educational & Research funding from Gore Medical

Neurological Complications



		0	1	2	3	4
No Stroke	No. at risk	962	693	555	396	274
	Deaths	141	39	34	19	34
Stroke < 30d	No. at risk	48	19	12	11	9
	Deaths	21	3	0	1	0

		0	1	2	3	4
No Stroke	No. at risk	968	685	544	389	270
	Deaths	150	39	34	18	32
Stroke < 30d	No. at risk	42	27	23	18	13
	Deaths	12	3	0	2	0

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Patterson *et al* JVS 2014

Imperial College London

Original article

Cerebral embolizati … d neurocognitive de … aortic repair

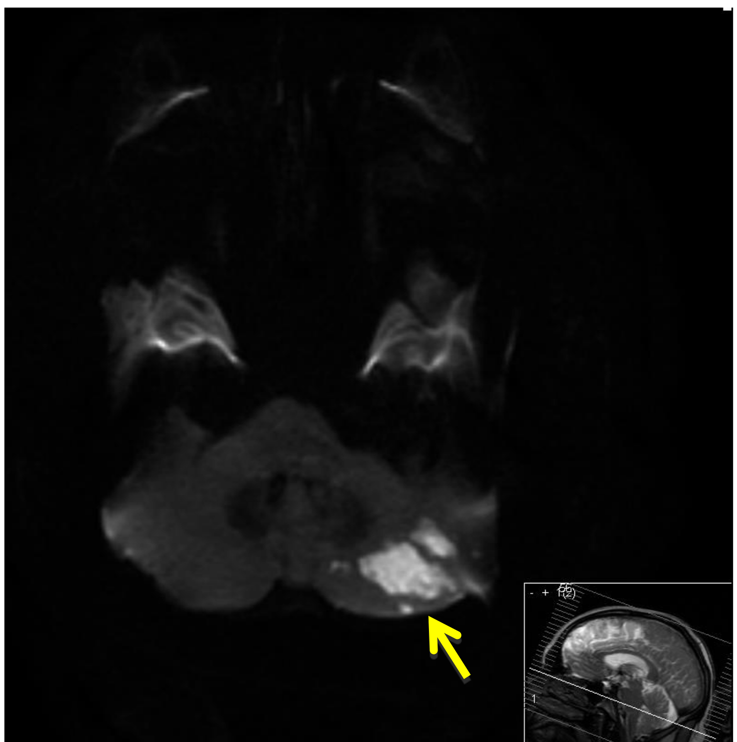
A. H. Perera[1], N. Rudar… . Kirmi[5], T. Athanasiou[7], M. Hamad…

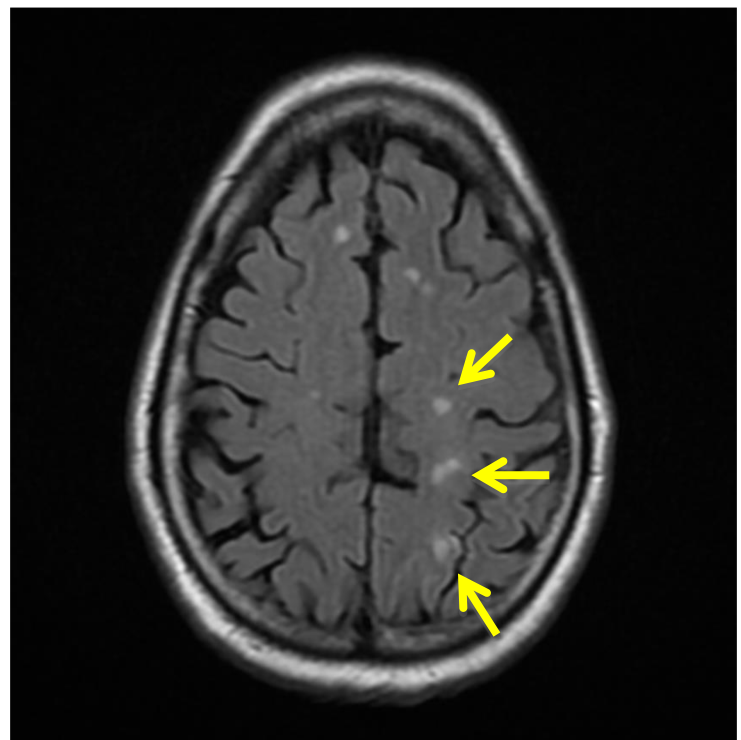
[1]Imperial Vascular Unit, Department of S… …ment of Vascular Surgery, Royal Free Hospital, [3]Department of Inter… …Department of Vascular Surgery, King's College London, British Hea… …th Research Biomedical Research Centre at King's Health Partners, St T… …Radiology, Imperial Healthcare NHS Trust, and [7]Department of Surgery, Imperial…

BJS 2018; **105**: 366–378

13% Stroke Rate
68% SCI Rate

81% Cerebral Infarction





Editorial

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SAGE

The Importance of Definitions and Reporting Standards for Cerebrovascular Events After Thoracic Endovascular Aortic Repair

Konstantinos Spanos, MSc, MD[1,2]
Barbara Rantner, MD[2], Ramin Bana
and Nikolaos Tsilimparis, MD, PhD

'Universal and unambiguous definitions of stroke and neurovascular events become of paramount importance to understanding the etiology of stroke in TEVAR procedures'

Procedural Stroke:

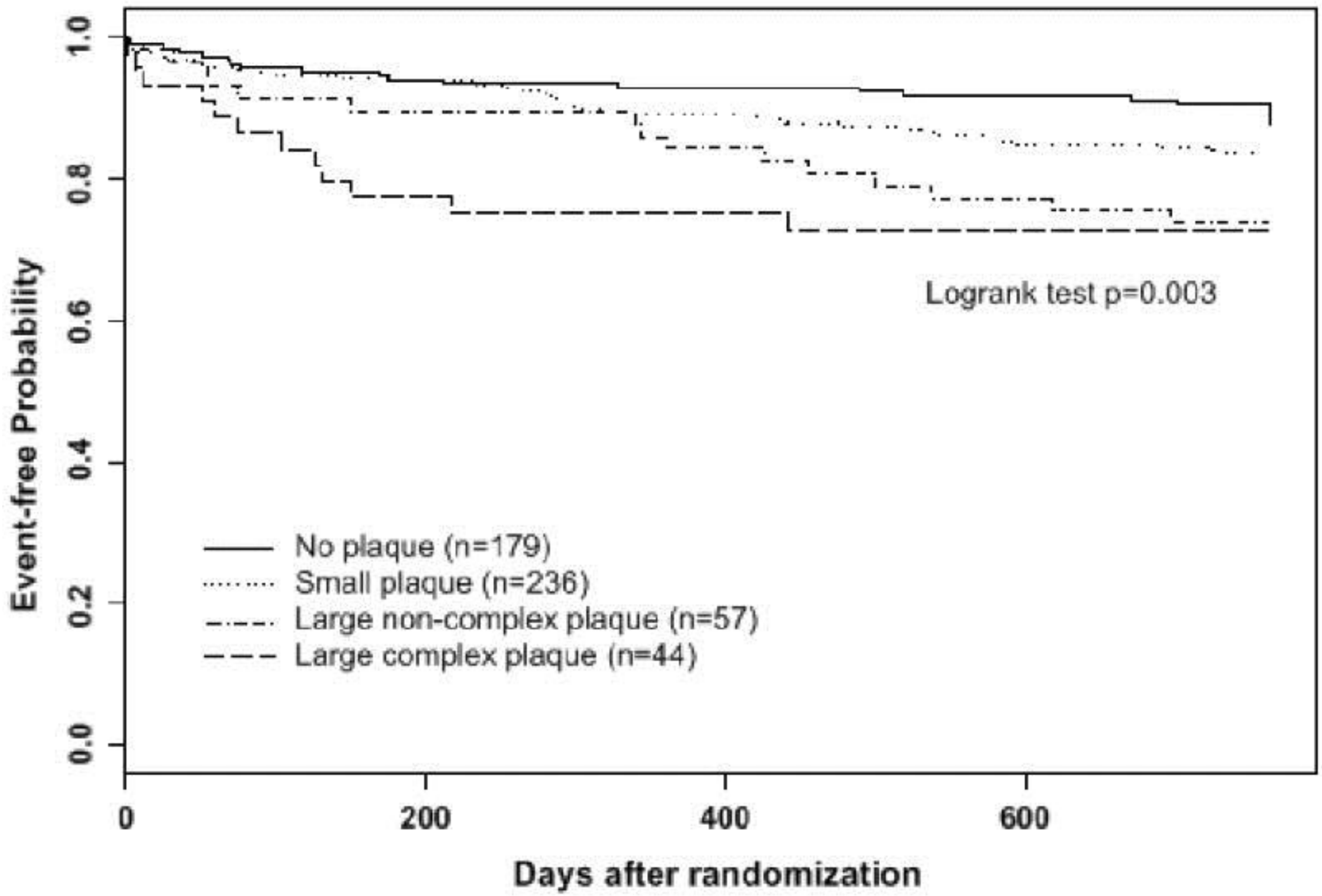
1. Overt CNS Injury
2. Covert CNS Injury
3. Neurological dysfunction without CNS injury

Neurologic Academic Research Consortium 2017

Stroke

Aortic Arch Plaques and Risk of Recurrent Stroke and Death

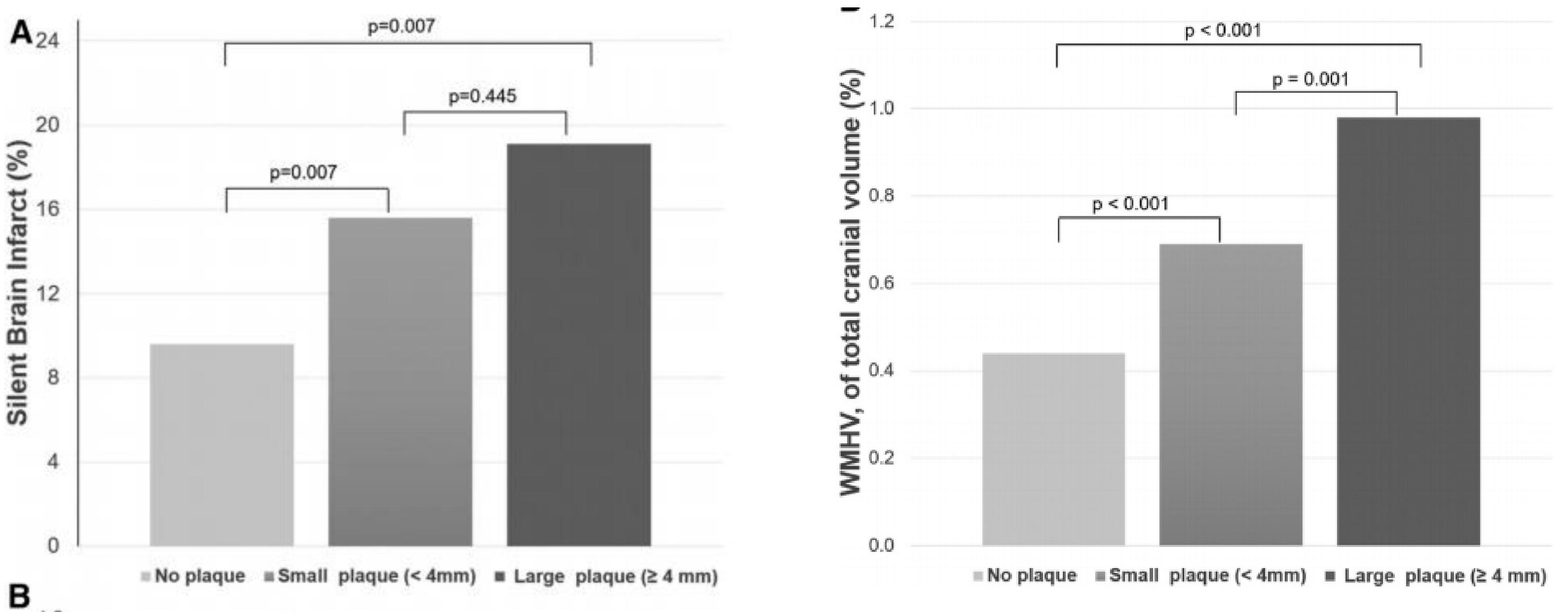
Marco R. Di Tullio, MD; Cesare Russo, MD; Zhezhen Jin, PhD; Ralph L. Sacco, MD, MS;
J.P. Mohr, MD; Shunichi Homma, MD;



Circulation. 2009 May 5; 119(17): 2376–2382.

Atherosclerotic Plaques in the Aortic Arch and Subclinical Cerebrovascular Disease

Aylin Tugcu, MD; Zhezhen Jin, PhD; Shunichi Homma, MD; Mitchell S.V. Elkind, MD, MS;
Tatjana Rundek, MD, PhD; Mitsuhiro Yoshita, MD, PhD; Charles DeCarli, MD;
Koki Nakanishi, MD; Sofia Shames, MD; Clinton B. Wright, MD, MS;
Ralph L. Sacco, MD, MS; Marco R. Di Tullio, MD



Stroke. 2016;47:2813-2819. DOI: 10.1161/
STROKEAHA.116.015002

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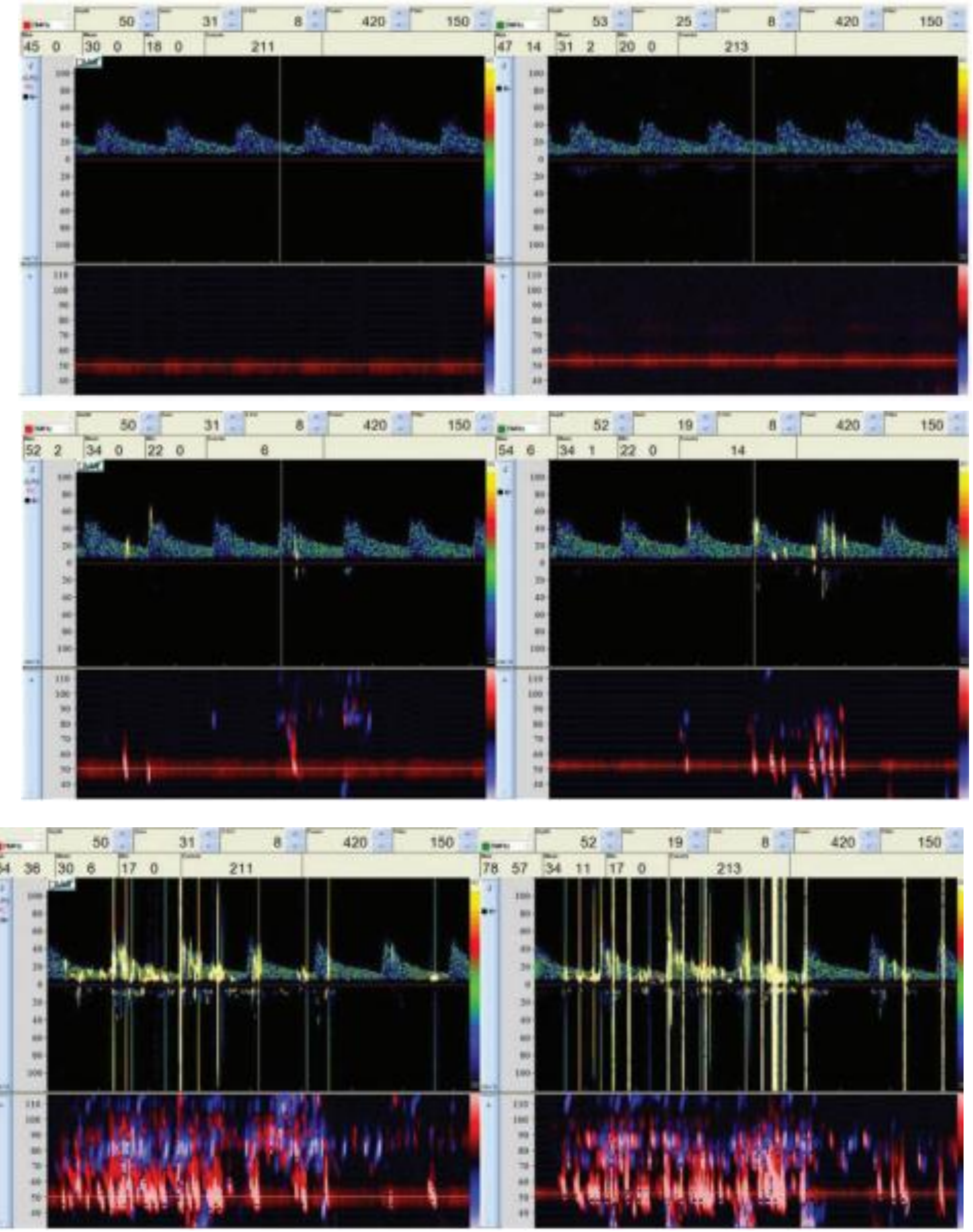
TCD HITS

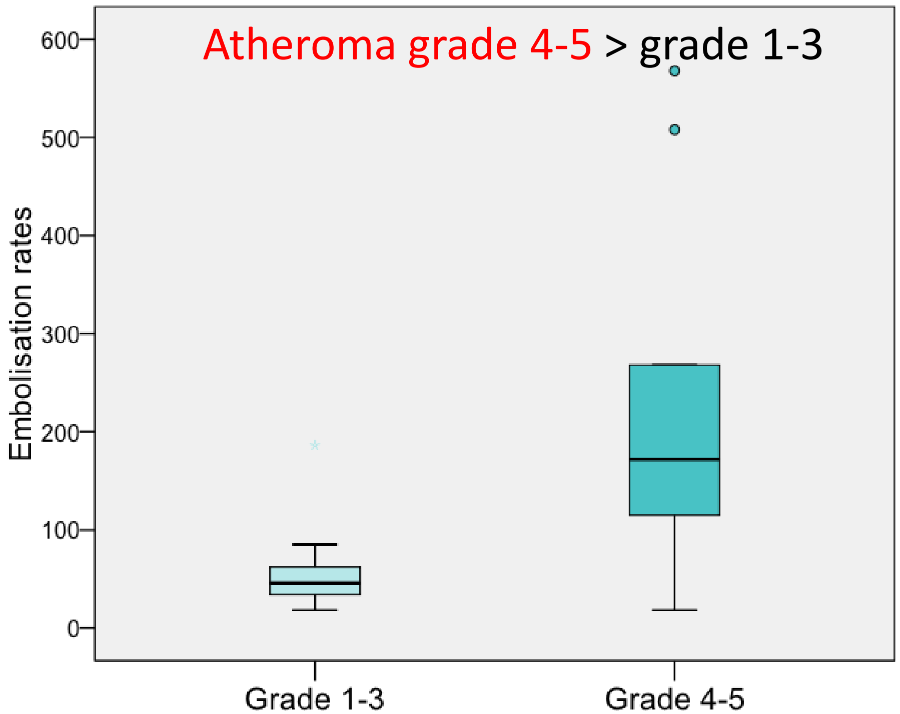


Pre-operative

Wire/catheter exchange

Stent graft deployment

TCD HITS Relate To Aortic Atheroma Severity

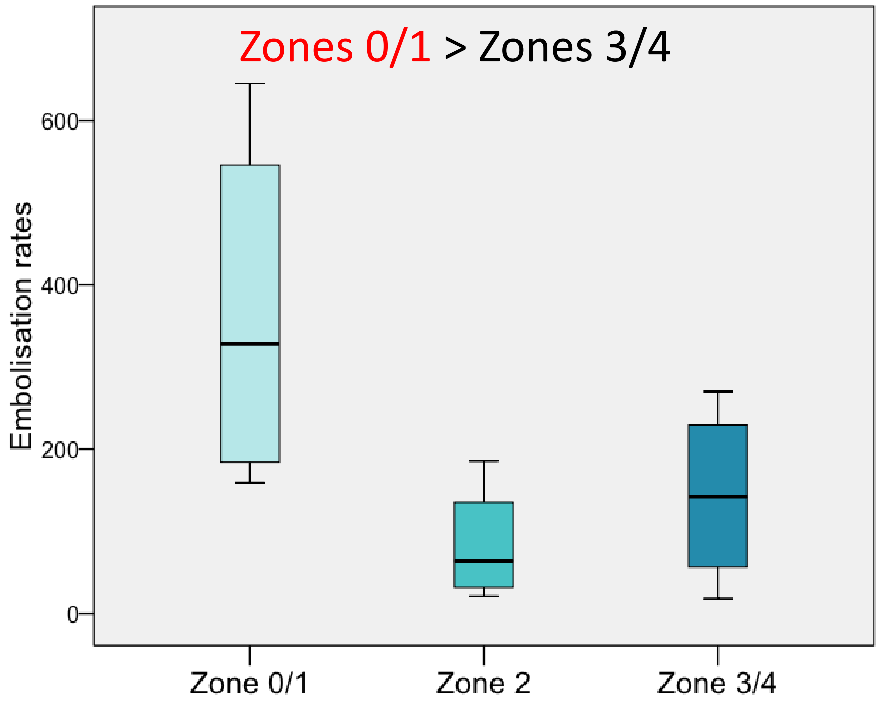


100

207

p=0.042

TCD HITS Relate To Landing Zone



450 207 72

p=0.001

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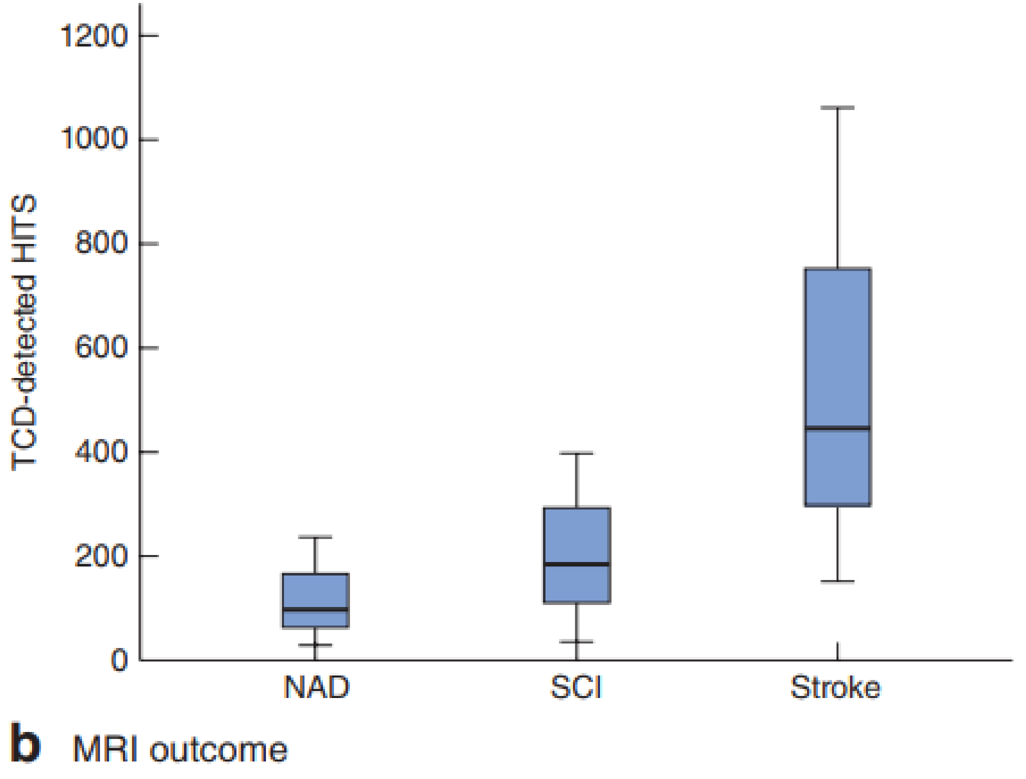
TCD HITS Relate To Cerebral Outcomes



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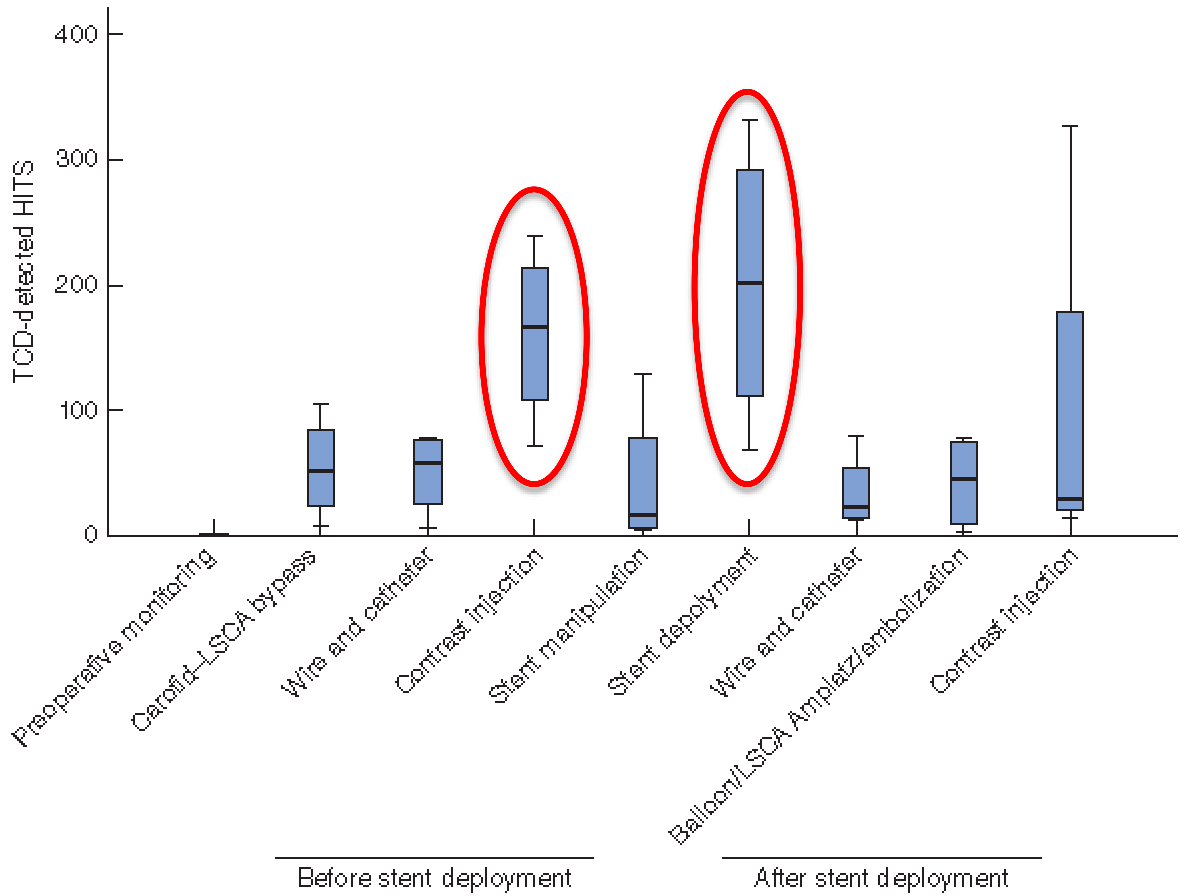
TCD HITS Relate To Procedural Phases Of TEVAR



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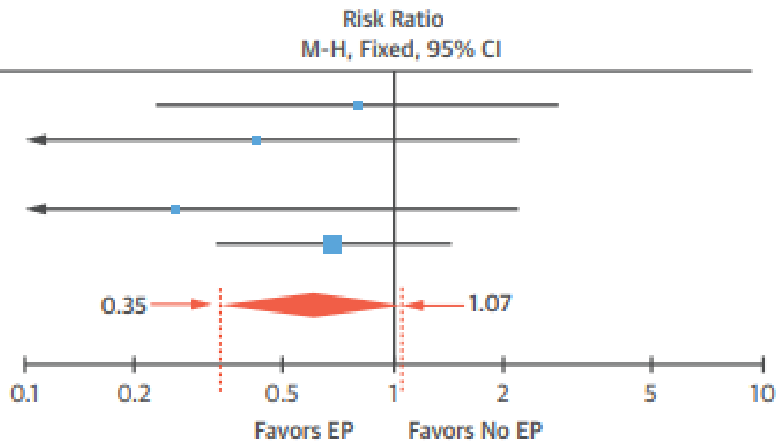
Can we reduce particulate embolisation during TEVAR?

Study or Subgroup	Embolic Protection Events	Embolic Protection Total	No Embolic Protection Events	No Embolic Protection Total	Weight	Risk Ratio M-H, Fixed, 95% CI
CLEAN-TAVI	4	50	5	50	17.7%	0.80 [0.23, 2.81]
DEFLECT-III	2	46	4	39	15.4%	0.42 [0.08, 2.19]
EMBOL-X	0	14	0	16		Not estimable
MISTRAL-C	1	32	4	33	14.0%	0.26 [0.03, 2.18]
SENTINEL	16	234	11	111	52.9%	0.69 [0.33, 1.44]
Total (95% CI)		**376**		**249**	**100.0%**	**0.61 [0.35, 1.07]**
Total events	23		24			

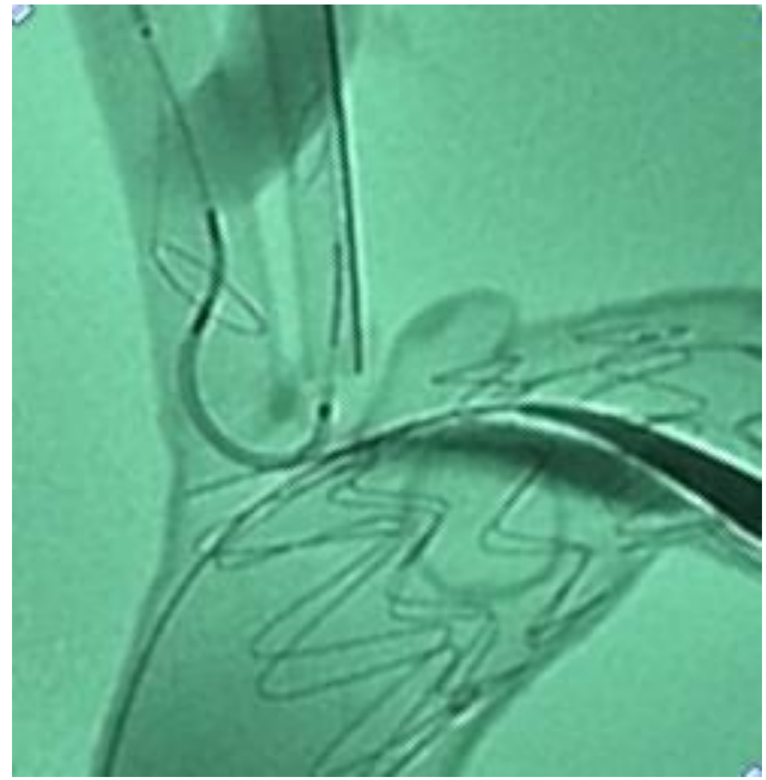
Heterogeneity: $Chi^2 = 1.10$, df = 3 (P = 0.78); $I^2 = 0\%$

Test for overall effect: Z = 1.73 (P = 0.08)



Cerebral Embolic Protection During TAVR: A Clinical Event Meta-Analysis
JACC 69 (4) 463-70

Reducing cerebral injury during TEVAR



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Cerebral embolic protection in thoracic endovascular aortic repair

Gagandeep Grover, MRCS,[a] Anisha H. Perera, MRCS,[a] Mohamad Hamady, MD, FRCR,[b] Nung Rudarakanchana, PhD, FRCS,[a] Christen D. Barras, PhD, FRANZCR,[c] Abhinav Singh, FRCR,[d] Alun H. Davies, DSc, FRCS,[a] *and* Richard Gibbs, MD, FRCS,[a] *London, United Kingdom*

ABSTRACT

Background: Stroke occurs in 3% to 8% and silent cerebral infarction in >60% of patients undergoing thoracic endovascular aortic repair (TEVAR). We investigated the utility of a filter cerebral embolic protection device (CEPD) to reduce diffusion-weighted magnetic resonance imaging (DW-MRI) detected cerebral injury and gaseous and solid embolization during TEVAR.

Methods: Patients anatomically suitable underwent TEVAR with CEPD, together with intraoperative transcranial Doppler to detect gaseous and solid high-intensity transient signals (HITSs), pre- and postoperative DW-MRI, and clinical neurologic assessment ≤6 months after the procedure.

Results: Ten patients (mean age, 68 years) underwent TEVAR with a CEPD. No strokes or device-related complications developed. The CEPD added a median of 7 minutes (interquartile range [IQR], 5-16 minutes) to the procedure, increased the fluoroscopy time by 3.3 minutes (IQR, 2.4-3.9 minutes), and increased the total procedural radiation by 2.2%. The dose area product for CEPD was 1824 mGy·cm^2 (IQR, 1235-3392 mGy·cm^2). The average contrast volume used increased by 23 mL (IQR, 24-35 mL). New DW-MRI lesions, mostly in the hindbrain, were identified in seven of nine patients (78%). The median number was 1 (IQR, 1-3), with a median surface area of 6 mm^2 (IQR, 3-16 mm^2). A total of 2835 HITSs were detected in seven patients: 91% gaseous and 9% solid. The maximum number of HITSs were detected during CEPD manipulation: 142 (IQR, 59-146; 95% gaseous and 5% solid). The maximum number of HITSs during TEVAR occurred during stent deployment: 82 (IQR, 73-142; 81% gas and 11% solid). Solid HITSs were associated with an increase in surface area of new DW-MRI lesions (r_s = 0.928; P = .01). Increased gaseous HITSs were associated with new DW-MRI lesions (r_s = 0.912; P = .01), which were smaller (<3 mm; r = 0.88; P = .02). Embolic debris was captured in 95% of the filters. The median particle count was 937 (IQR, 146-1687), and the median surface area was 2.66 mm^2 (IQR, 0.08-9.18 mm^2).

Conclusions: The use of a CEPD with TEVAR appeared to be safe and feasible in this first pilot study and could serve as a useful adjunct to reduce cerebral injury. The significance of gaseous embolization and its role in cerebral injury in TEVAR warrants further investigation. (J Vasc Surg 2018;■:1-11.)

Keywords: CEPD; DW-MRI; Embolization; HITS; TEVAR

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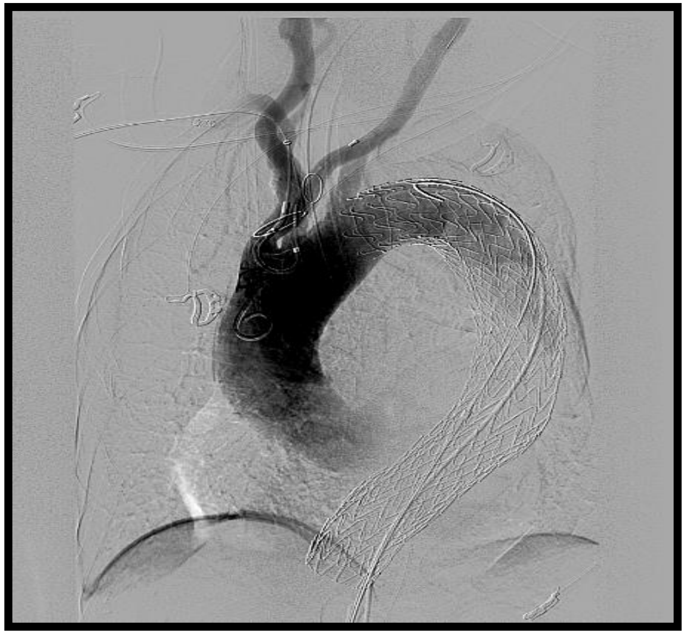
Sentinel Deployment



	Procedure Median (IQR)	CEPD Median (IQR)	Addition
Time (mins)	149 (125.5-191.5)	6.59 (4.6-16)	6.59 mins
Contrast (mls)	93 (76.3-108.8)	22.5 (20-32.5)	23mls
Radiation DAP (mGy.cm2)	58600 (41667-183303)	1824 (1235-3392)	2.2%
Fluoroscopy time (mins)	12.4 (10.4-14.9)	3.3 (2.4-3.9)	3.3mins

- 90% success rate
- No device associated complications or stroke

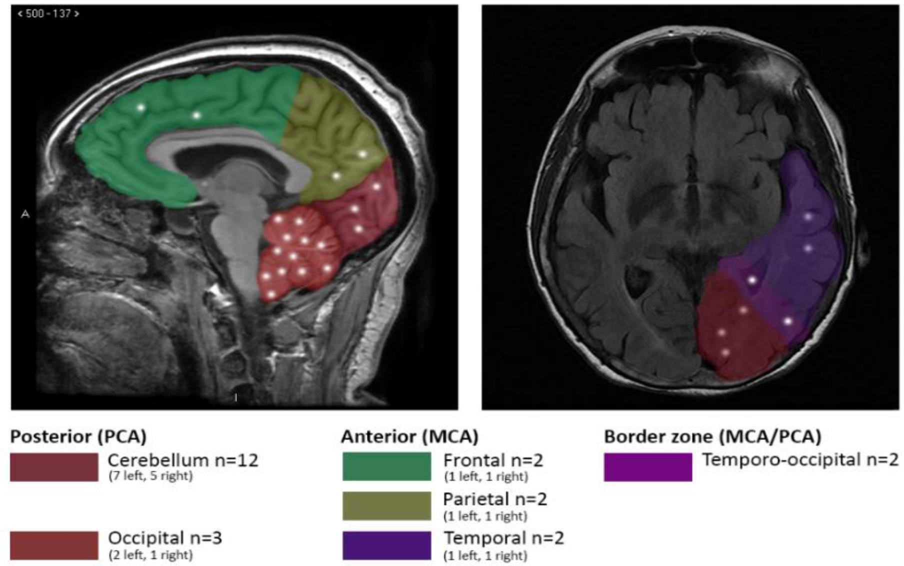
DW MRI Post-TEVAR Infarction

Protected

7/9 (78%) **23** new lesions

Total SA=**379mm2**

Median SA= **6mm2** (3-16)

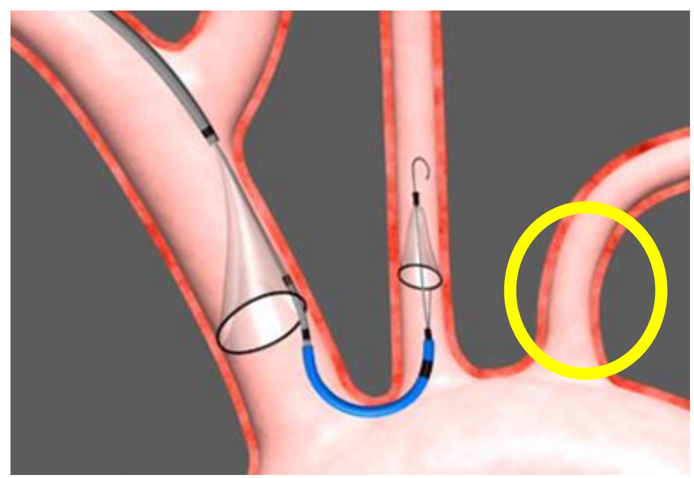


Unprotected

9/12 (75%) **55** new lesions

Total SA=**1534mm2**

Median SA=**16mm2** (3-103)

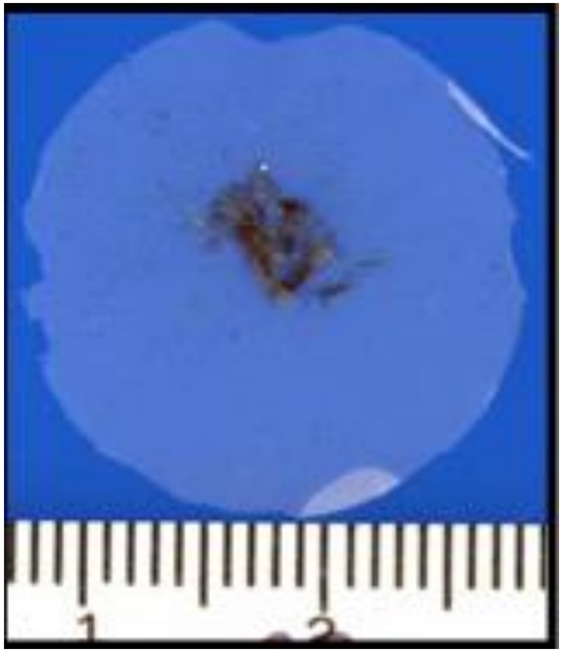


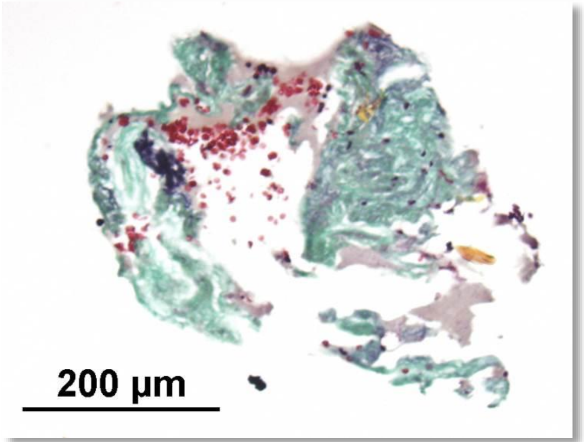
What Was Retrieved From The Filters?

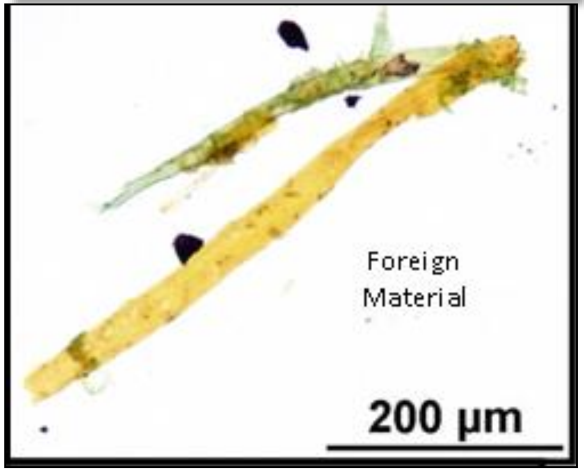
10 Proximal, 9 distal filters: **95%** contained debris

Median no particles: **937** (146-1687)

Median SA=2.66mm^2







acute thrombus (95%)
arterial wall (63%)
foreign material (32%).

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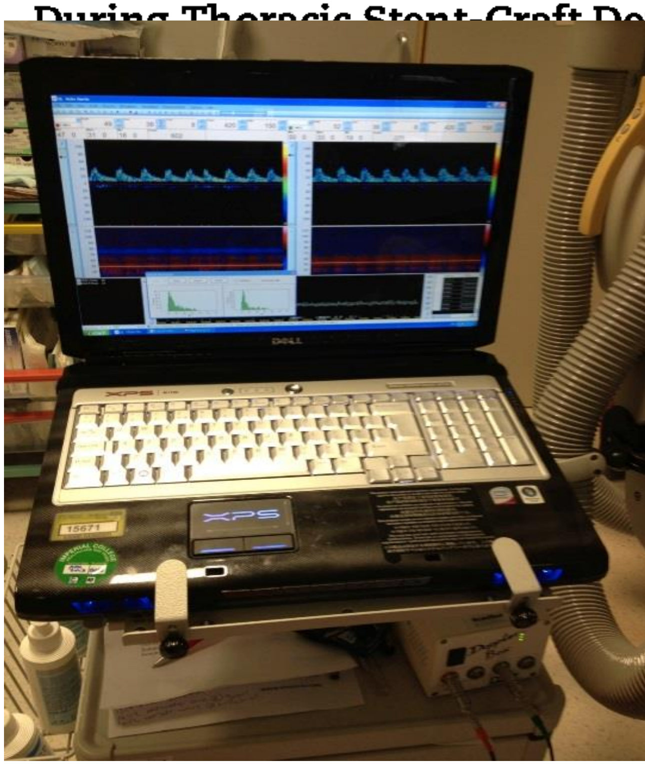
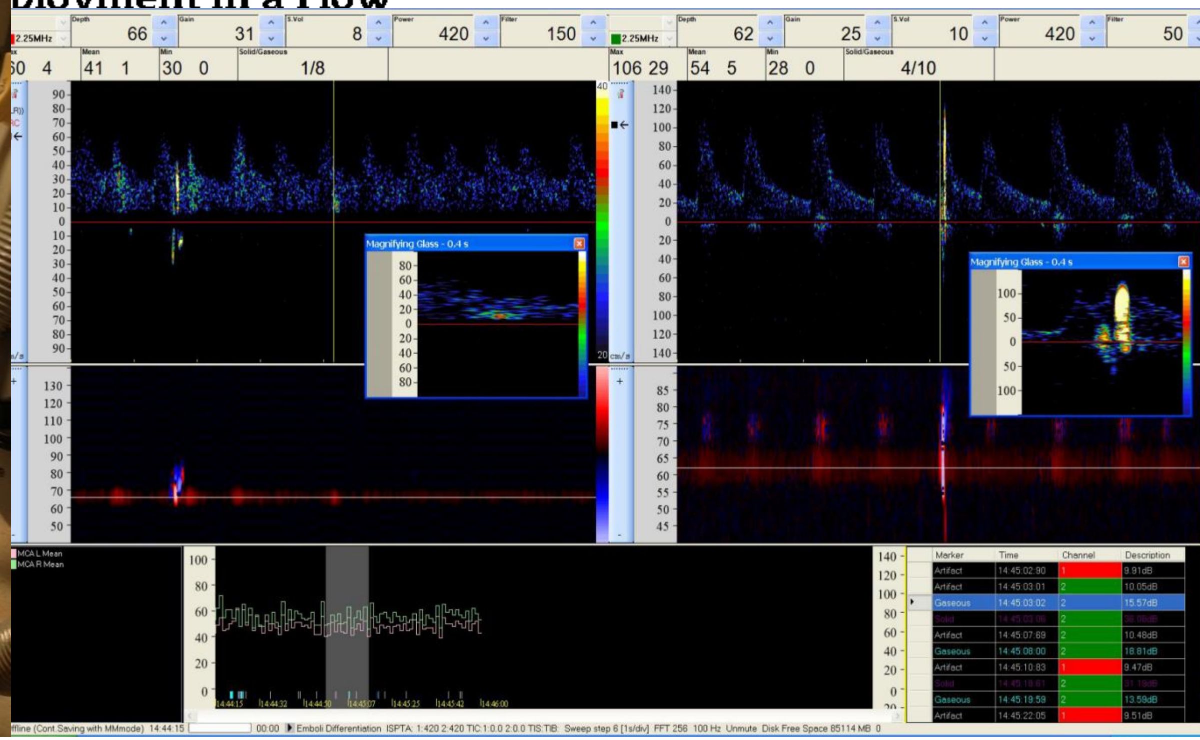
Bubble Counter for Measurement of Air Bubbles During Thoracic Stent-Graft Deployment in a Flow

Check for updates





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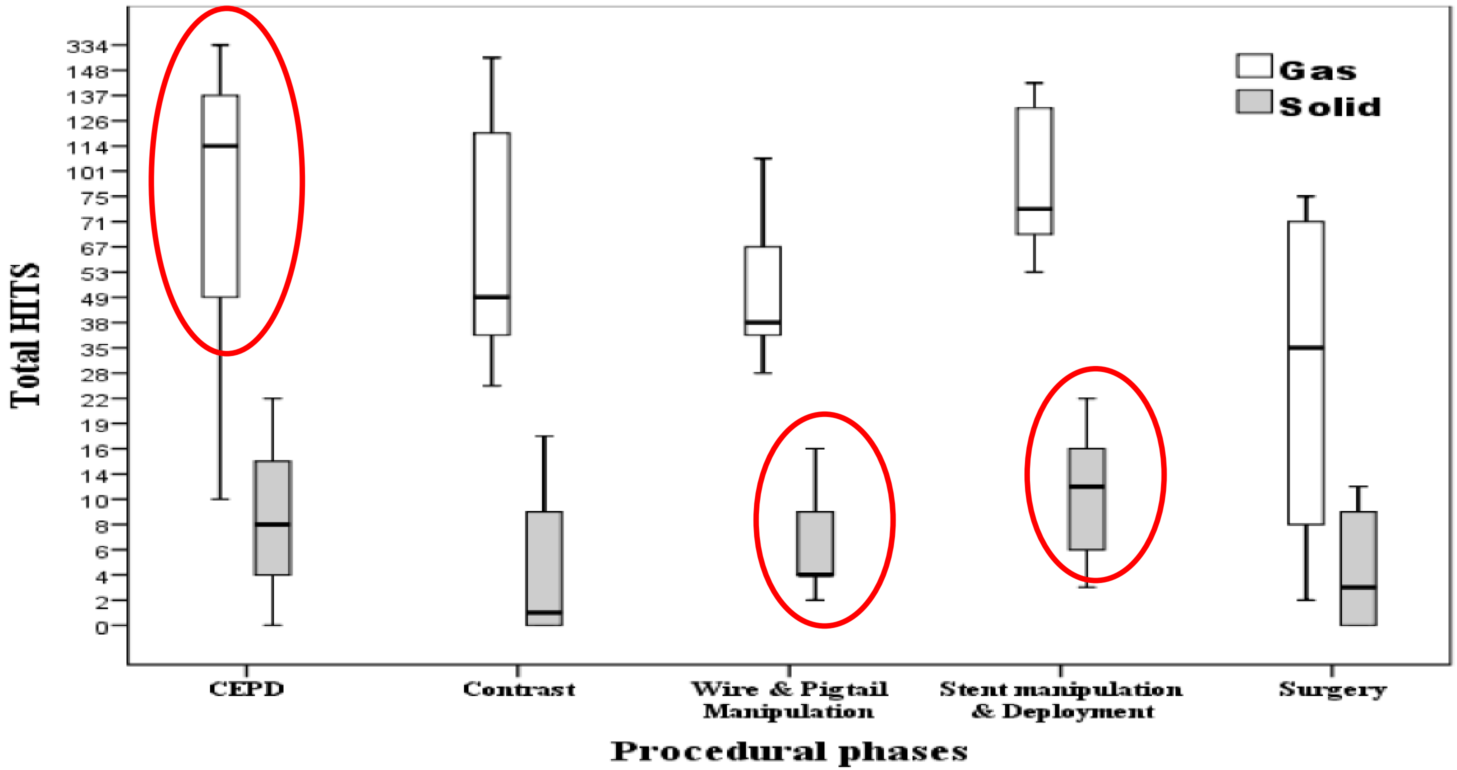
Procedural Embolization: Gas vs Solid

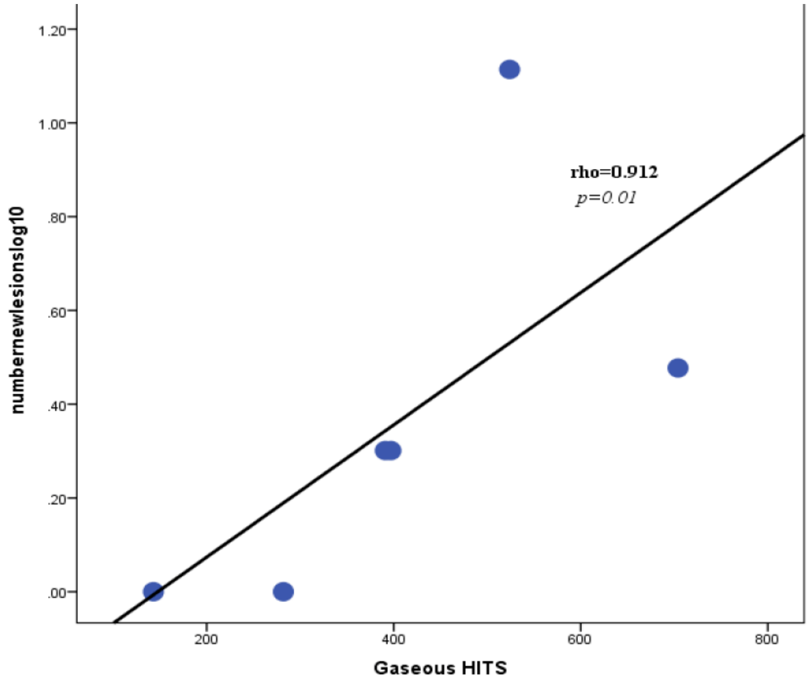


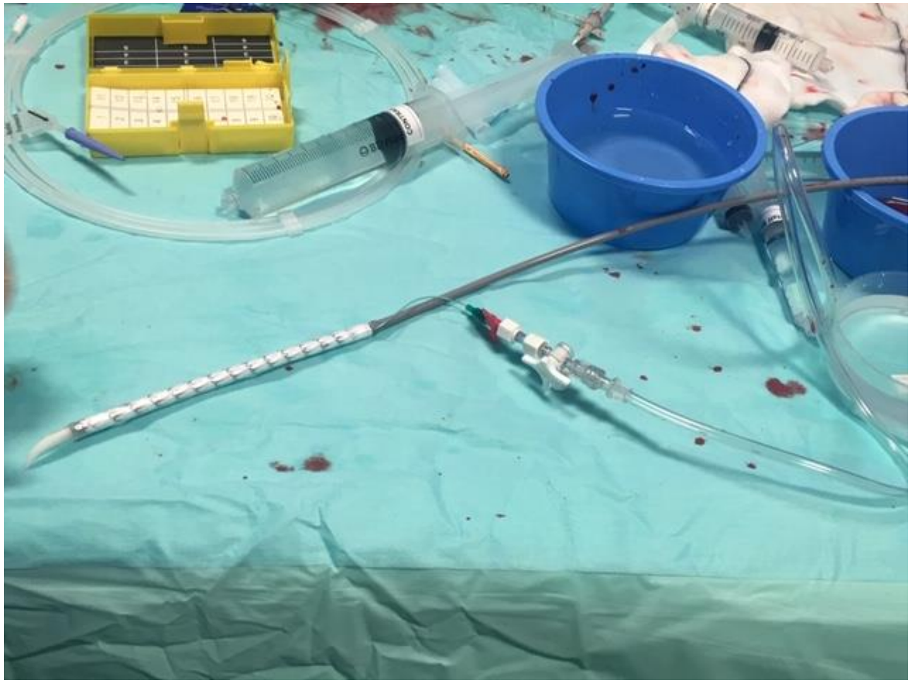
Maximum NUMBER of TOTAL HITS – CEPD 95% gas 5% solid

Maximum proportion of SOLID HITS – Wire& pigtail 13% solid, Stent deployment 11%

Gaseous Emboli

Number of new MRI lesions vs gaseous HITS





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Spinal cord blood supply

Extrinsic blood supply

Vertebral arteries

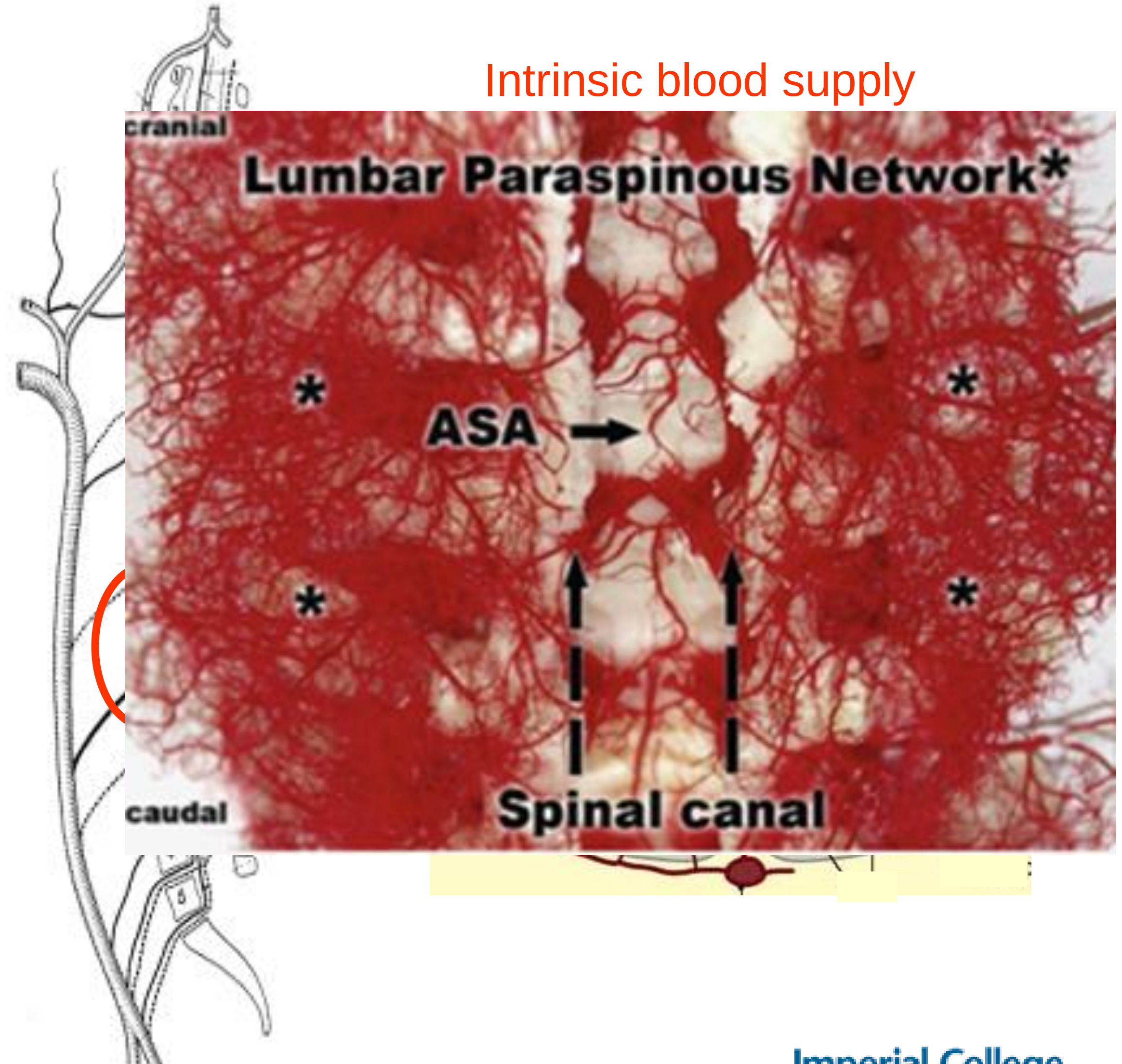
Intercostals

Adamkiewicz

Lumbars

Internal Iliac

Intrinsic blood supply



Eur J Vasc Endovasc Surg (2010) 40, 729–735

The Incidence of Spinal Cord Ischaemia Following Thoracic and Thoracoabdominal Aortic Endovascular Intervention

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KEYWORDS
Thoracic aortic aneurysm;
Thoracoabdominal aortic aneurysm;
Acute aortic syndrome;
Endovascular repair;
Stent graft;
Paraplegia

Abstract *Objectives:* To determine the incidence and risk factors for spinal cord ischaemi (SCI) following thoracic and thoracoabdominal aortic intervention.
Methods: A prospective database of all thoracic and thoracoabdominal aortic intervention between 2001 and 2009 was used to investigate the incidence of SCI. All elective and emer gency cases for all indications were included. Logistic regression was used to investigate whic factors were associated with SCI.
Results: 235 patients underwent thoracic aortic stent grafting; 111(47%) thoracic aortic stent-grafts alone, with an additional 14(6%) branched or fenestrated thoracic grafts, 30(13%) arch hybrid procedures and 80(34%) visceral hybrid surgical and endovascular procedures. The global incidence of SCI for all procedures was 23/235 (9.8%) and this included emergency indications (ruptured TAAA and acute complex dissections) but the incidence varied considerably between types of procedures. Of the 23 cases, death occurred in 4 patients but recovery of function was seen in 6. Thus, permanent paraplegia occurred in 13/235 (5.5%) patients. Of the nine pre-specified factors investigated for association with SCI, only percentage of aortic coverage was significantly associated with the incidence of SCI; adjusted odds ratio per 10% increase in aorta covered = 1.78[95% CI 1.18–2.71], $p = 0.007$. The procedures in patients who developed SCI took longer (463.5 versus 307.2 minutes) and utilised more stents (4 versus 2).
Conclusion: SCI following thoracic and thoracoabdominal aortic endovascular intervention is associated with the proportion of aorta covered. The degree of risk varies between different

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Table 3 Risk of spinal cord ischaemia and permanent paraplegia by type of procedure.

Procedure	Spinal Cord Ischaemia	Paraplegia
TEVAR	2/111 (1.8%)	1/111 (0.9%)
Fenestrated/Branched Graft	2/14 (14.3%)	1/14 (7.1%)
Arch Hybrid	3/30 (10%)	2/30 (6.7%)
Visceral Hybrid	16/80 (20%)	9/80 (11.3%)
Global SCI risk	23/235 (9.8%)	13/235 (5.5%)

Logistic Regression Modelling

Factor	SCI (%)	No SCI (%)	Adjusted Odds Ratio	P value
Mean Aortic Coverage	75	54	1.05	0.007
TEVAR	2	98	Ref	Ref
FEVAR	14	86	4.94	0.36
Arch Hybrid	10	90	5.71	0.13
Visceral Hybrid	19	81	2.19	0.46
Subclavian Occluded				
No	12	88	Ref	Ref
Yes	5	95	0.49	0.31

Adjusted for
Age
Sex
Urgency
Indication
Duration
Procedure
Percentage Covered
Subclavian Occlusion

Factors increasing risk of spinal cord injury during TEVAR

- Extent of aortic coverage
- Coverage of Adamkiewicz artery origin T8-12
- Shaggy aorta
- Compromise of collateral network
    - LSA Coverage
    - Infrarenal aortic AAA or repair
    - Internal iliac occlusion

Risk factors for SCI

Patient Factors

- Aortic pathology
- Extent of disease
- Presentation of disease
- Previous infrarenal graft
- Renal failure

Procedural Factors

- Length aortic coverage
- Left SCA coverage
- Concomitant abdominal surgery
- Occlusion – T10
- Use adjuncts

Risk factors for SCI

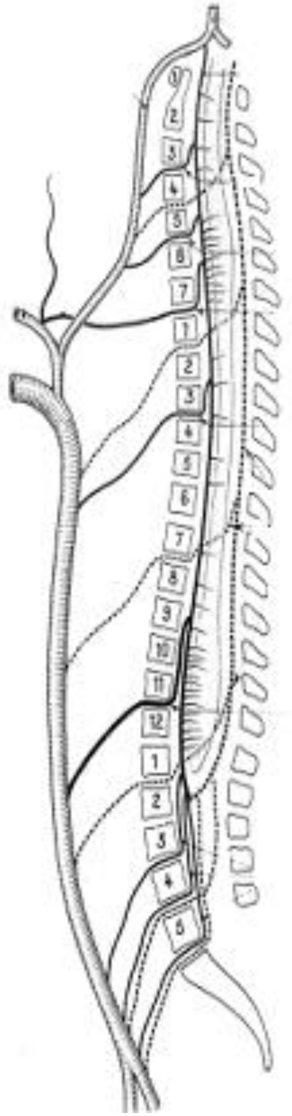
Patient Factors

- Aortic pathology
- Extent of disease
- Presentation of disease
- Previous infrarenal graft
- Renal failure

Procedural Factors

- Length aortic coverage
- Left SCA coverage
- Concomitant abdominal surgery
- Occlusion – T10
- Use adjuncts

LSA Coverage



There is an increased risk of SCI with LSA coverage

SCI No LSA Coverage 2.3%

SCI LSA Coverage 2.8%

p=.005

Cooper *et al* JVS 2009

LSA coverage and revascularization

EUROSTAR (n=606)

- Covered no revascularization:4 %
- Covered revascularization: 0%
- p=.027

MOTHER/SGVI (n=1002)

- Covered no revascularization: 4.1%
- Covered revascularization: 1.5%
- Uncovered : 5%

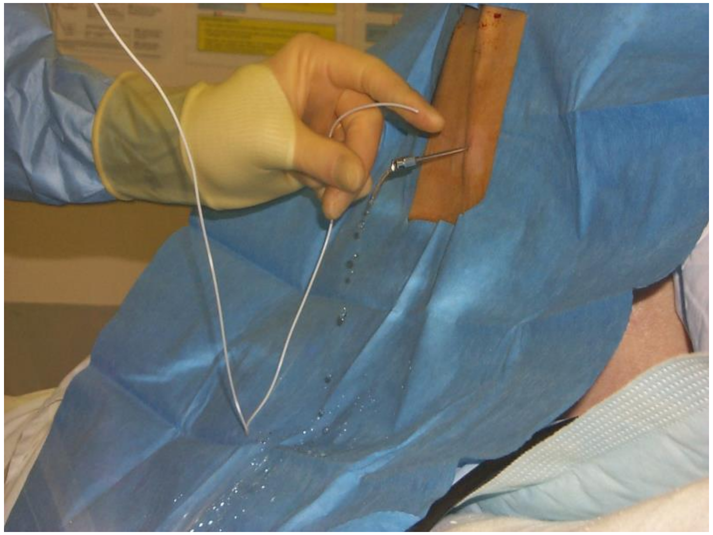
Spinal Protection

SCPP = MAP - CSFP

Loss of autoregulation
Hypotension

Spinal drainage

Embolisation



½ of neurological deficits are delayed
12h-21 days

Adjuncts to prevent SCI

- Avoid peri/post-operative hypotension
- CSF drainage
- Revascularize the covered left subclavian
- Choice of landing zones
- Staged procedures
- Sac perfusion branch
- Collateral Preconditioning -minimally invasive segmental artery coil embolisation (MISACE)

Conclusions

- Stroke & paraplegia are very poor outcomes with associated poor survival
- Robust preventative and rescue protocols must be in place
- Ongoing research needed