STROKE PREVENTION IN AORTIC ARCH PROCEDURES

RICHARD GIBBS

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Disclosure

Speaker name:Richard Gibbs

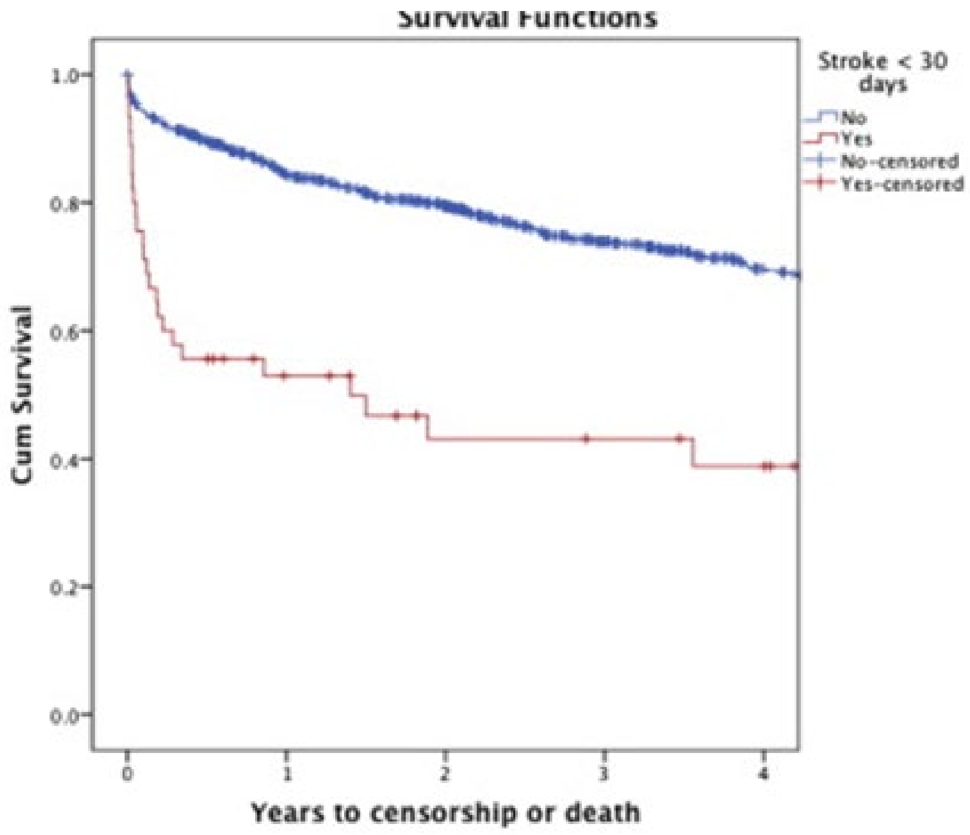
....

I have the following potential conflicts of interest to report:

- ☐ Consulting
- ☐ Employment in industry
- ☐ Stockholder of a healthcare company
- ☐ Owner of a healthcare company
- ☐ Other(s)

X I do not have any potential conflict of interest

TEVAR and Stroke

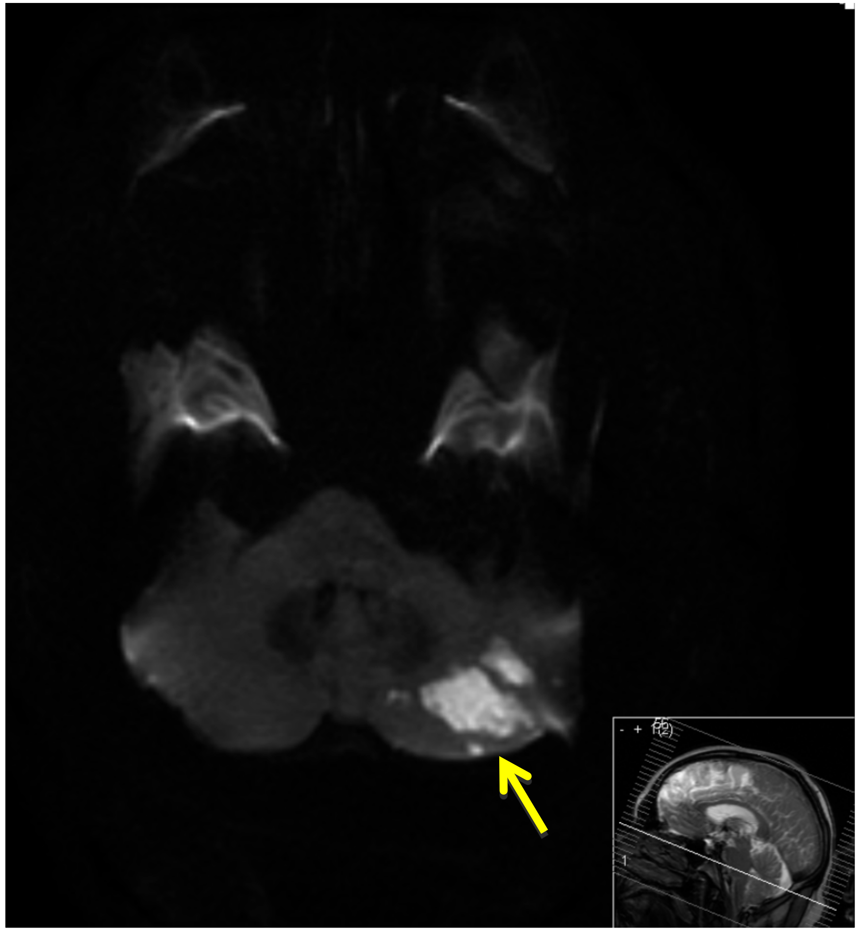


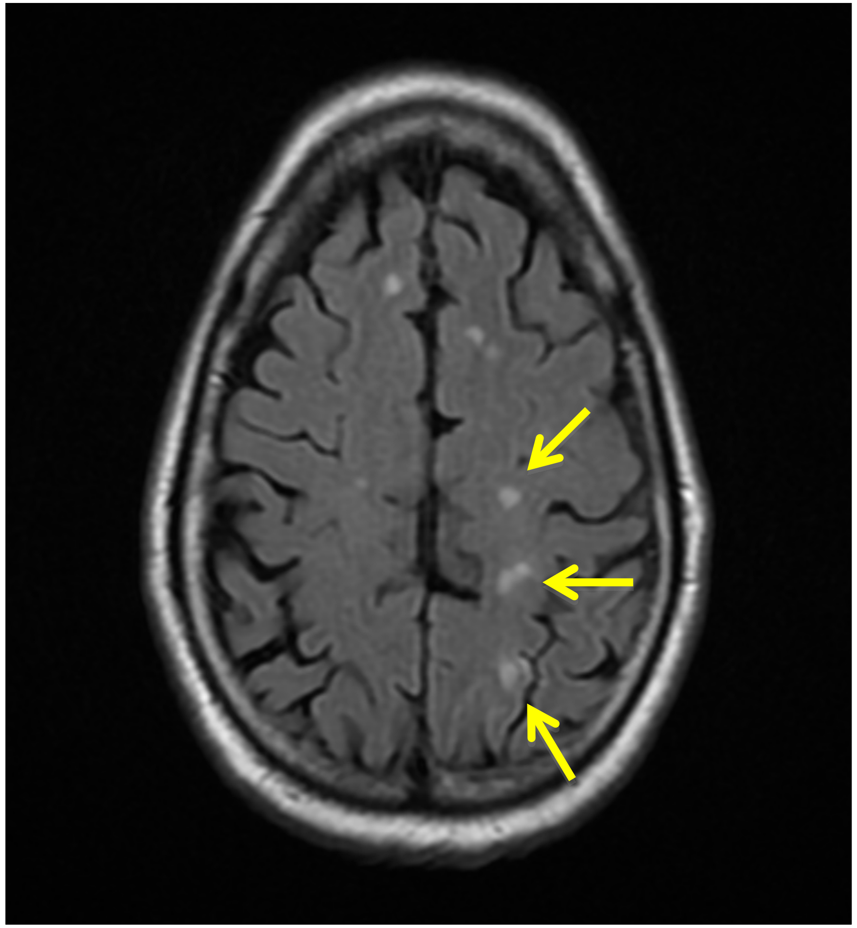
TEVAR

Zone 3: 3-8%

Zone 0: 16%

'Silent' Cerebral Infarction Post-TEVAR





Stroke
Journal of the American Heart Association

American Heart Association | American Stroke Association

Association of MRI Markers of Vascular Brain Injury With Incident Stroke, Mild Cognitive Impairment, Dementia, and Mortality: The Framingham Offspring Study

Stéphanie Debette, Alexa Beiser, Charles DeCarli, Rhoda Au, Jayandra J. Himali, Margaret Kelly-Hayes, Jose R. Romero, Carlos S. Kase, Philip A. Wolf and Sudha Seshadri

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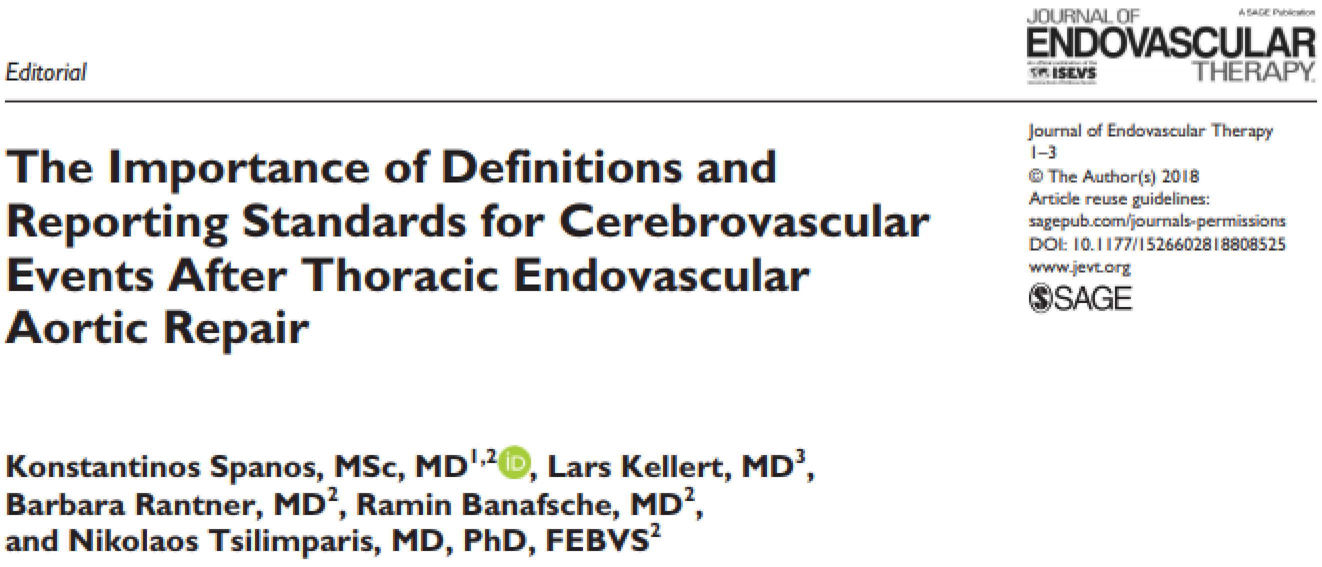
Editorial

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1–3

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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], Lars Kellert, MD[3], Barbara Rantner, MD[2], Ramin Banafsche, MD[2], and Nikolaos Tsilimparis, MD, PhD, FEBVS[2]

Procedural Stroke:

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

Neurologic Academic Research Consortium 2017

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

Cerebral embolization, silent cerebral infarction and neurocognitive decline after thoracic endovascular aortic repair

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Background: Silent cerebral infarction is brain injury detected incidentally on imaging; it can be associated with cognitive decline and future stroke. This study investigated cerebral embolization, silent cerebral infarction and neurocognitive decline following thoracic endovascular aortic repair (TEVAR).

Methods: Patients undergoing elective or emergency TEVAR at Imperial College Healthcare NHS Trust and Guy's and St Thomas' NHS Foundation Trust between January 2012 and April 2015 were recruited. Aortic atheroma graded from 1 (normal) to 5 (mobile atheroma) was evaluated by preoperative CT. Patients underwent intraoperative transcranial Doppler imaging (TCD), preoperative and postoperative cerebral MRI, and neurocognitive assessment.

Results: Fifty-two patients underwent TEVAR. Higher rates of TCD-detected embolization were observed with greater aortic atheroma (median 207 for grade 4–5 *versus* 100 for grade 1–3; $P = 0{\cdot}042$), more proximal landing zones (median 450 for zone 0–1 *versus* 72 for zone 3–4; $P = 0{\cdot}001$), and during stent-graft deployment and contrast injection ($P = 0{\cdot}001$). In univariable analysis, left subclavian artery bypass (β coefficient 0·423, s.e. 132·62, $P = 0{\cdot}005$), proximal landing zone 0–1 (β coefficient 0·504, s.e. 170·57, $P = 0{\cdot}001$) and arch hybrid procedure (β coefficient 0·514, s.e. 182·96, $P < 0{\cdot}001$) were predictors of cerebral emboli. Cerebral infarction was detected in 25 of 31 patients (81 per cent) who underwent MRI: 21 (68 per cent) silent and four (13 per cent) clinical strokes. Neurocognitive decline was seen in six of seven domains assessed in 15 patients with silent cerebral infarction, with age a significant predictor of decline.

Conclusion: This study demonstrates a high rate of cerebral embolization and neurocognitive decline affecting patients following TEVAR. Brain injury after TEVAR is more common than previously recognized, with cerebral infarction in more than 80 per cent of patients.

Presented in part to the scientific prize session of the Vascular Society Annual General Meeting, Glasgow, UK, November 2014; published in abstract form as *Br J Surg* 2015; **102**(Suppl 2): 5

Paper accepted 4 September 2017

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Cerebral embolisation, SCI and neurocognitive decline after TEVAR

1. CT Evaluation of Aortic atheroma

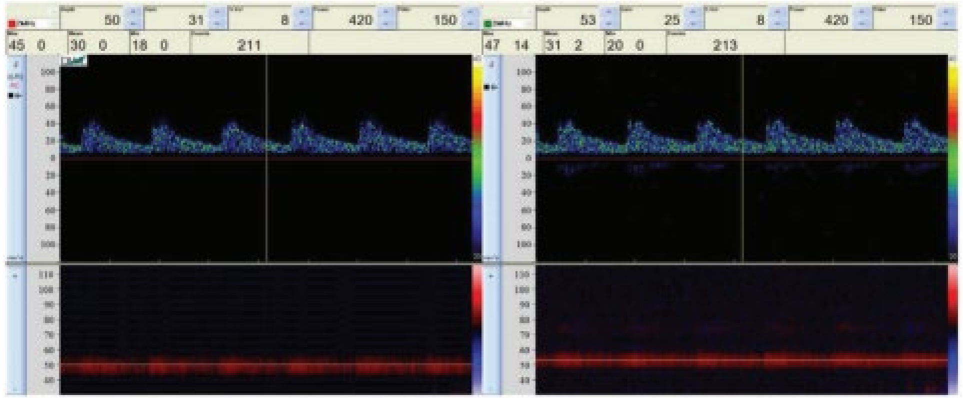
2. Procedural TCD

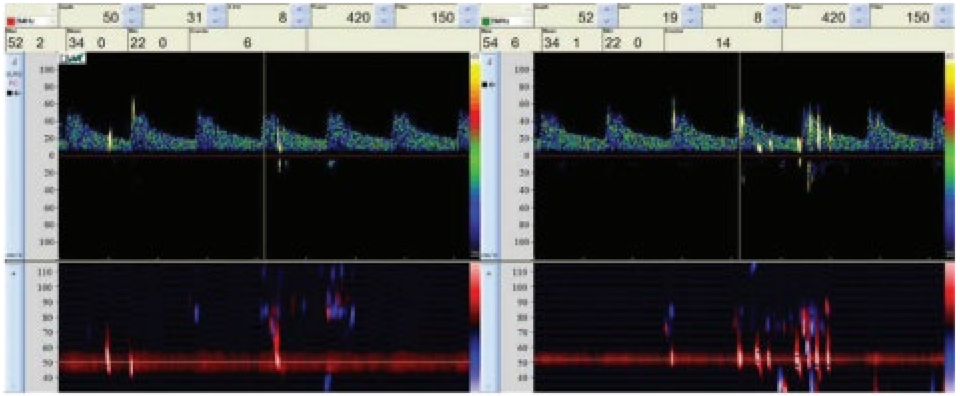
3. Pre and post procedural DW cerebral MRI

4. Pre and post procedural neurocognitive function

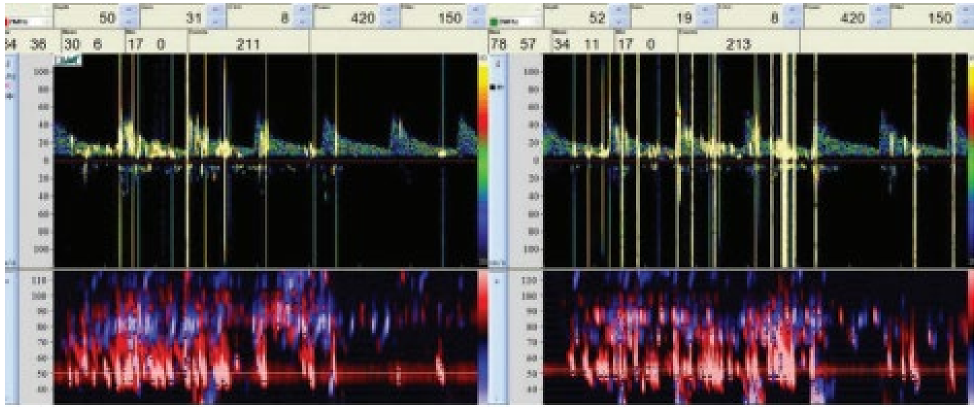
14(4):568-73.
int captured

3. TCD Detection of Procedural Micro-embolisation



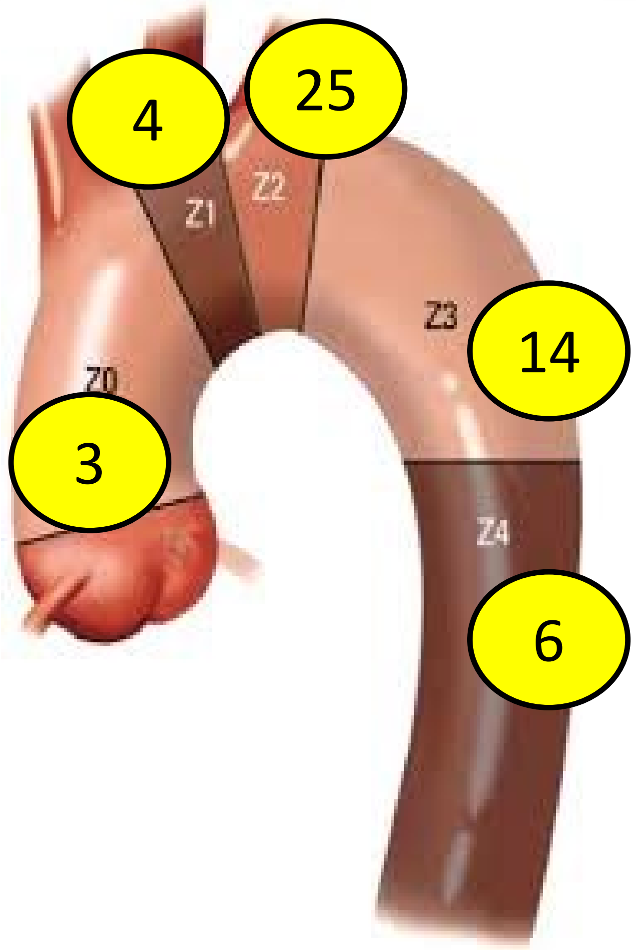


Wire/catheter exchange



Stent graft deployment

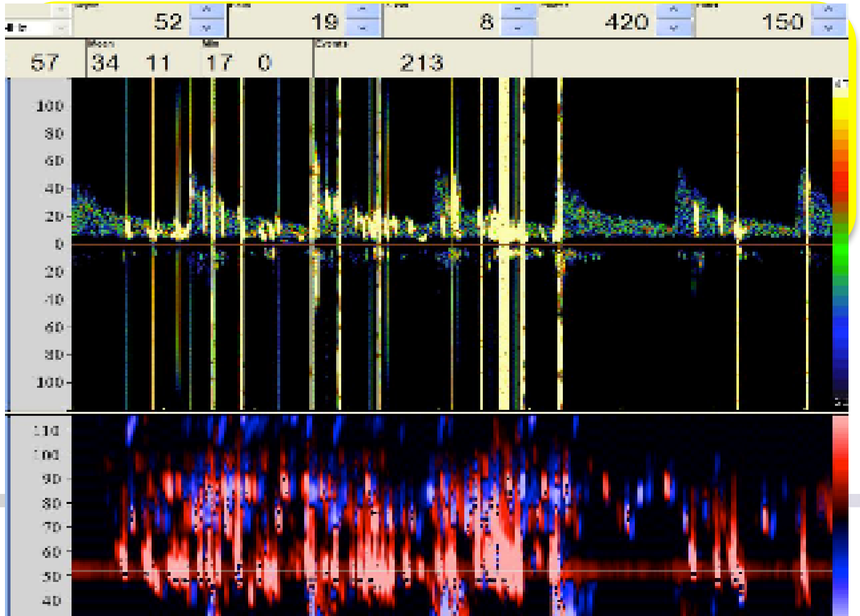
Procedures + Stent Graft Landing Zone

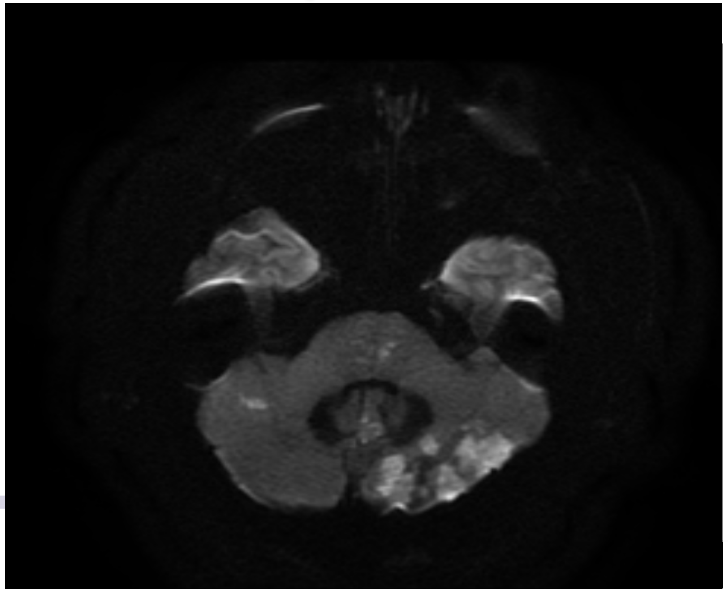


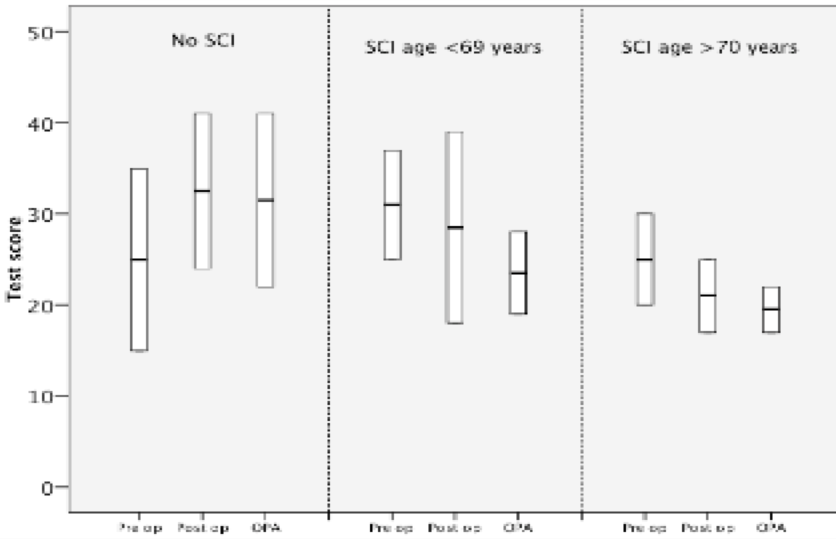
TEVAR	**20**
TEVAR + L carotid – subclavian Bypass	**14**
TEVAR + LSCA coverage	**4**
Arch Hybrid	**5**
Arch Branch	**1**
Visceral Hybrid	**5**
TEVAR + FEVAR	**3**

TEVAR
N=52
Median age 69

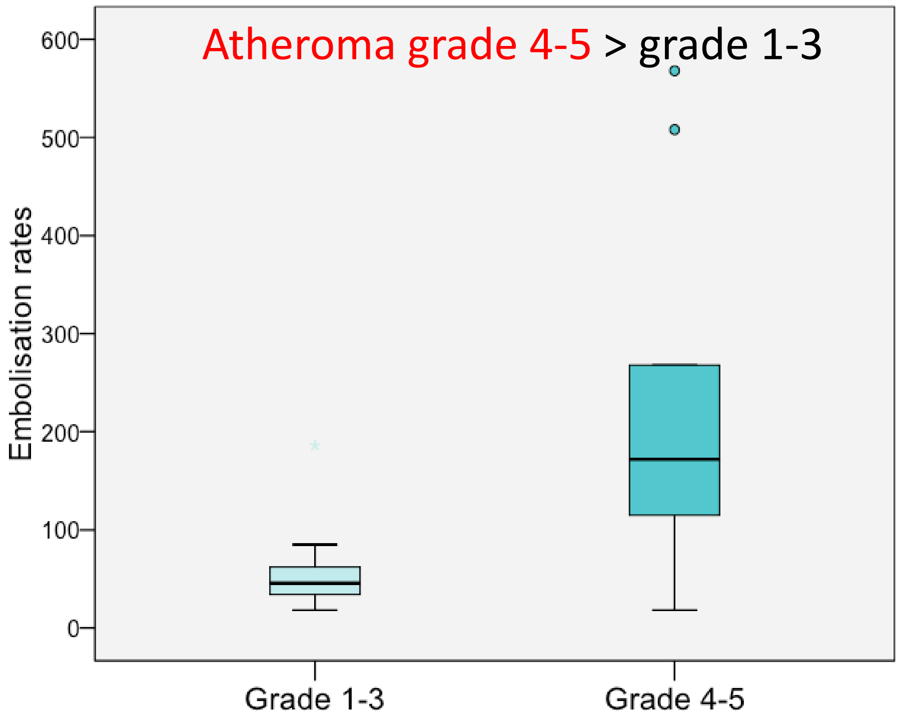
TCD	DW-MRI	Neurocognitive assessment
N=42	N=31	N=17
100% HITS	13% Stroke 68% SCI	88% Decline 6/7 domains age>69







TCD HITS Relate To Aortic Atheroma Severity

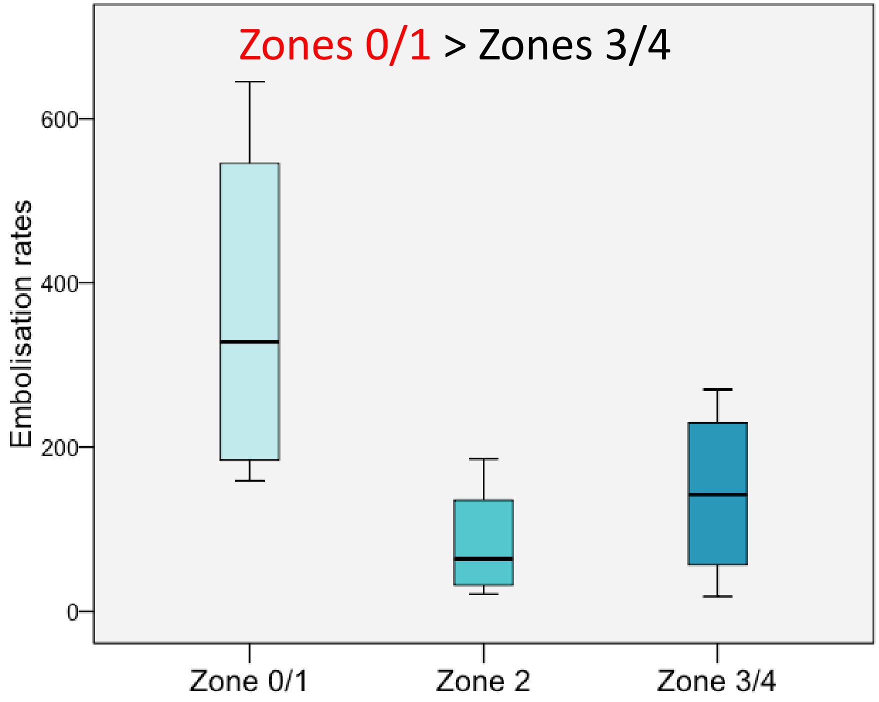


100

207

p=0.042

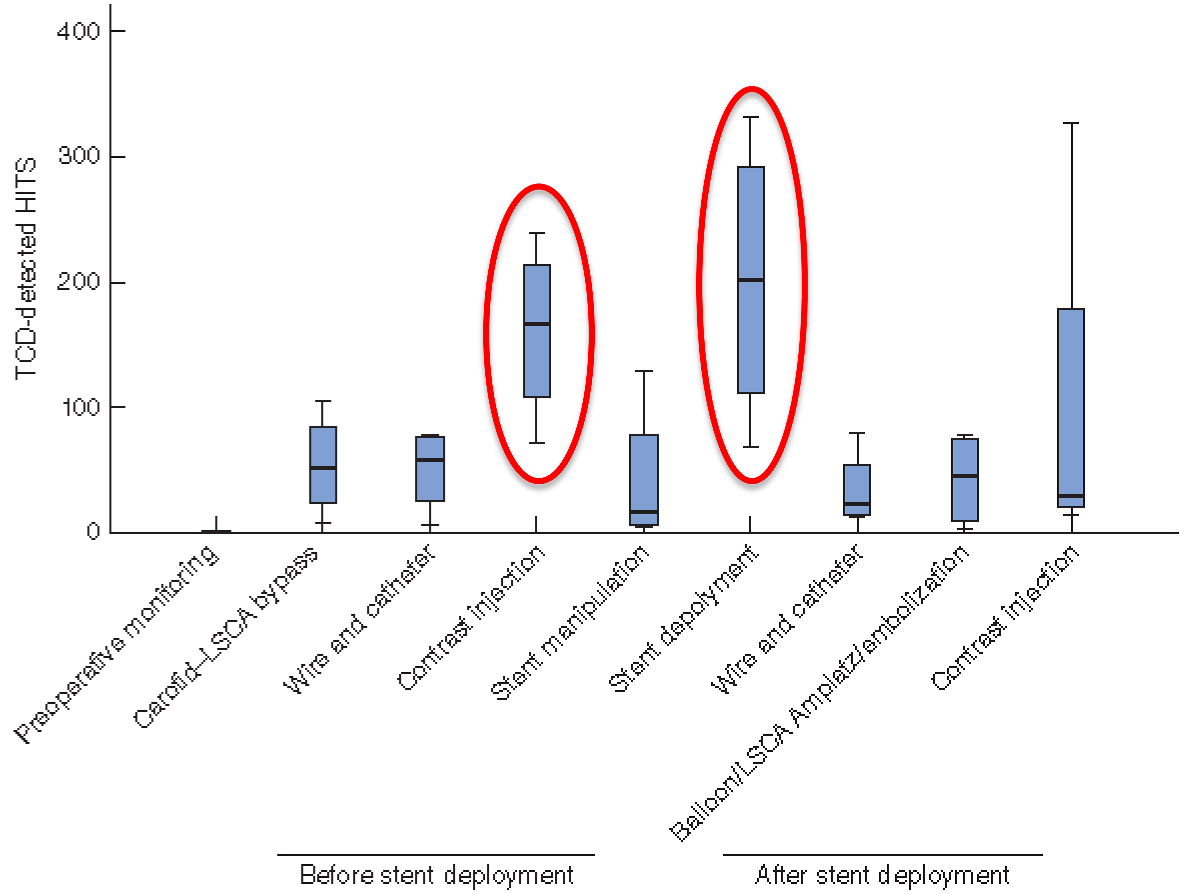
TCD HITS Relate To Landing Zone



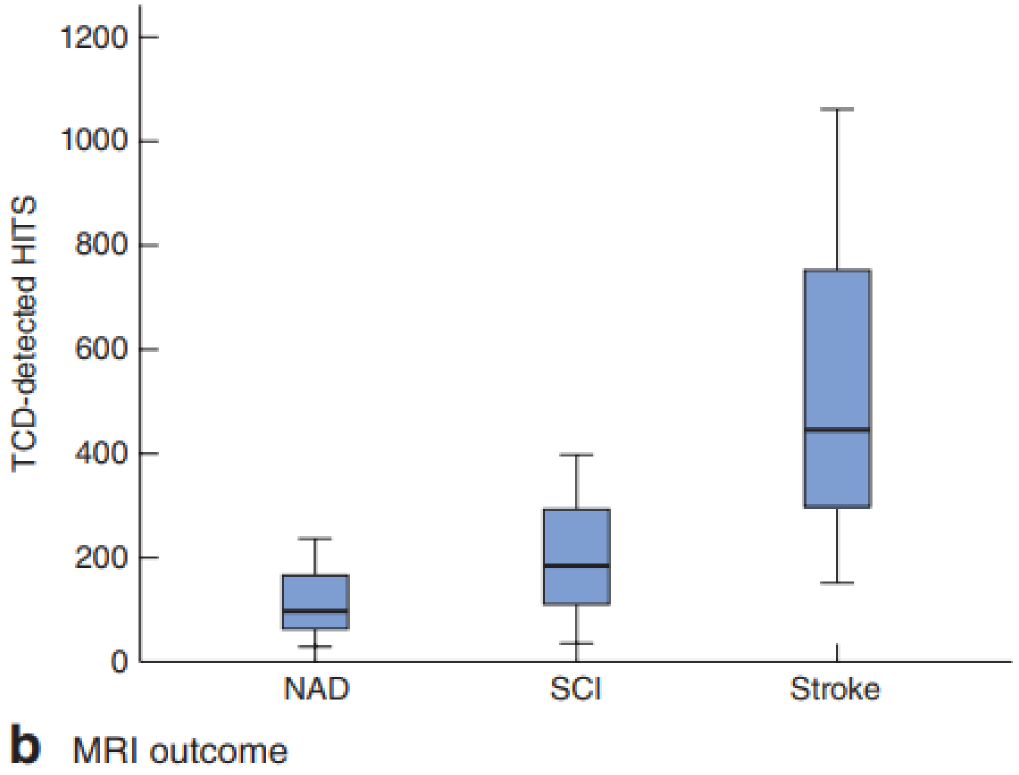
450 207 72

p=0.001

TCD HITS Relate To Procedural Phases Of TEVAR



TCD HITS Relate To Cerebral Outcomes



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.

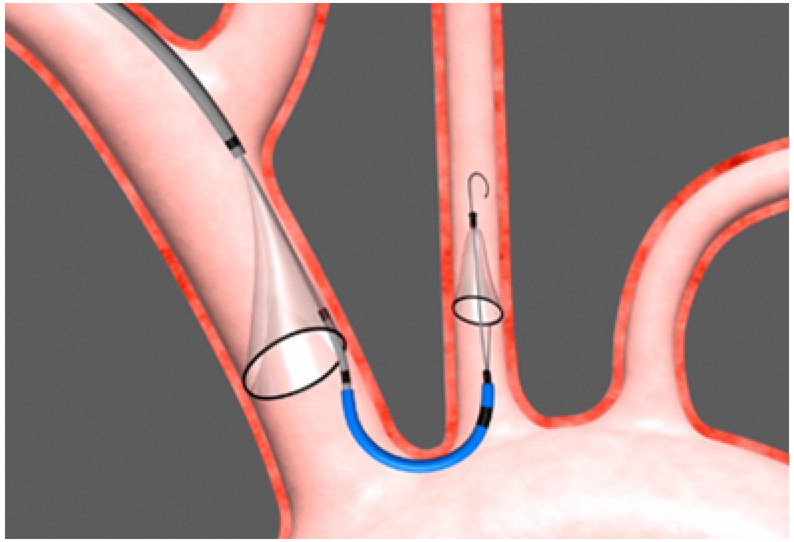
Methods: Patients anatomically suitable underwent TEVAR with CEPD, together with intraoperative transcranial Doppler to detect gaseous and solid high-intensity transient signals (HITSs), pre- and postoperative DW-MRI, and clinical neurologic assessment ≤6 months after the procedure.

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

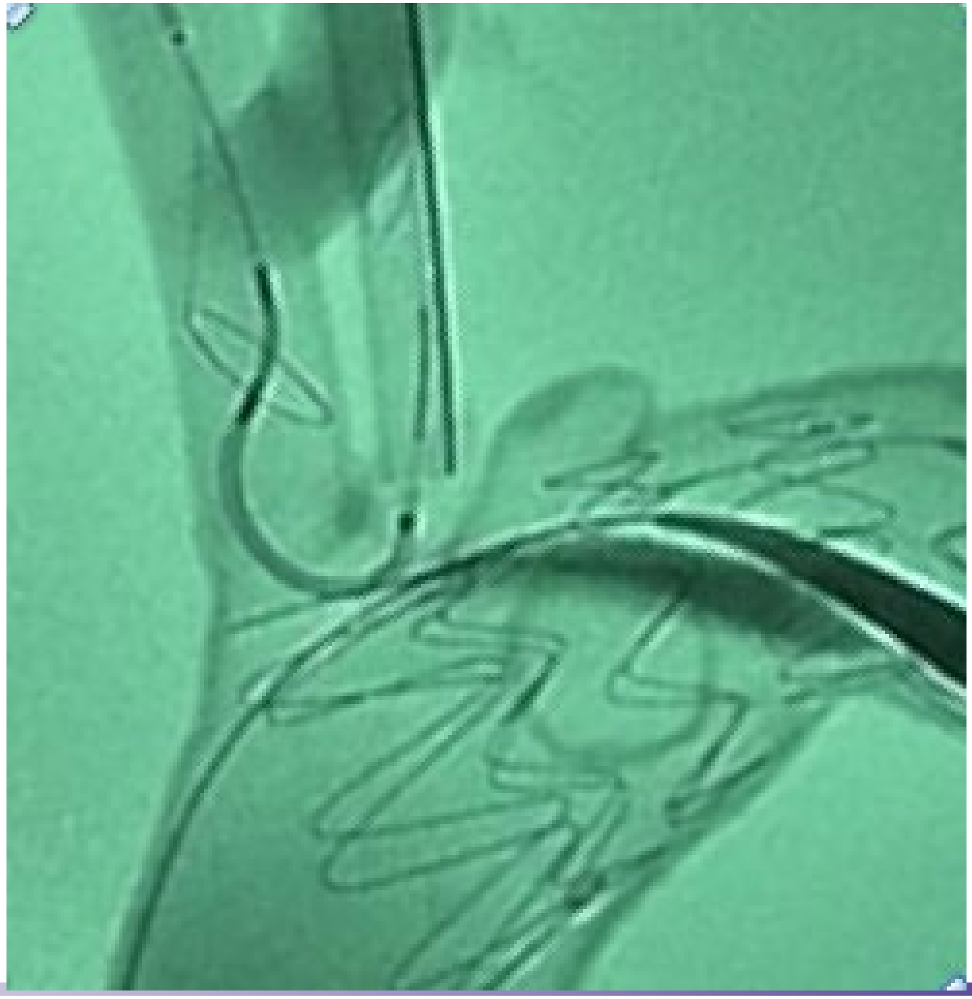
Cerebral Protection: Sentinel



- Percutaneous device via brachial artery
- **6 Fr** compatible sheath, 0.014 guide wire
- **140$_{um}$ diameter** pore filters in brachiocephalic and left common carotid

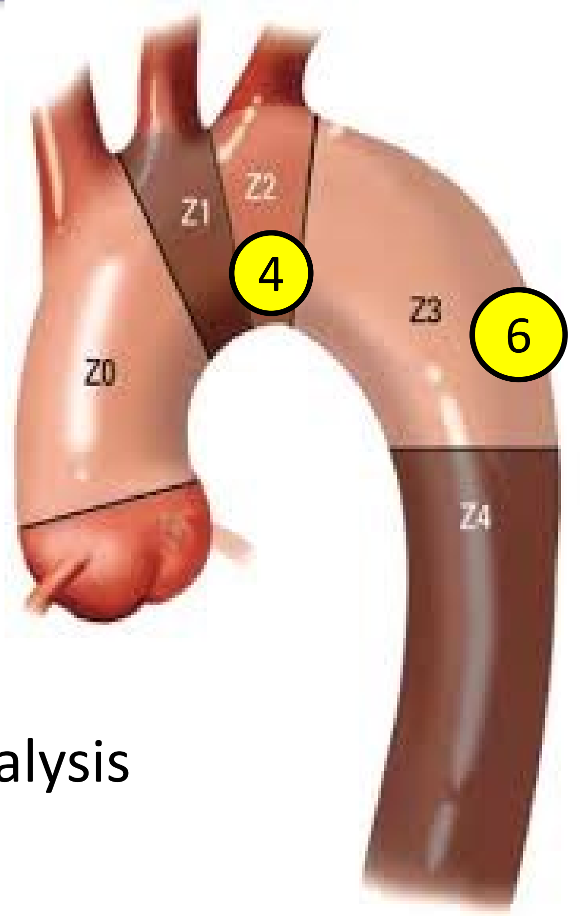
Sentinel: Feasibility In TEVAR

- Physical compatibility of Sentinel CPD device and TEVAR assessed using pulsatile flow benchtop model (n=8)
- 4 aortic stent grafts tested (Bolton, Medtronic, Gore, Cook)
- No impediment to deployment of aortic stent graft or retrieval of device



Cerebral Embolic Protection during TEVAR

- 10 patients
- Inclusion criteria : PLZ 2,3,4
- Innominate diameter: 9-15mm
- L carotid diameter: 6.5-10mm



- TCD
- pre +post op MRI
- cognitive function
- Recovered embolic debris – histopathological analysis

Solid vs Gaseous Emboli?

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

Check for updates

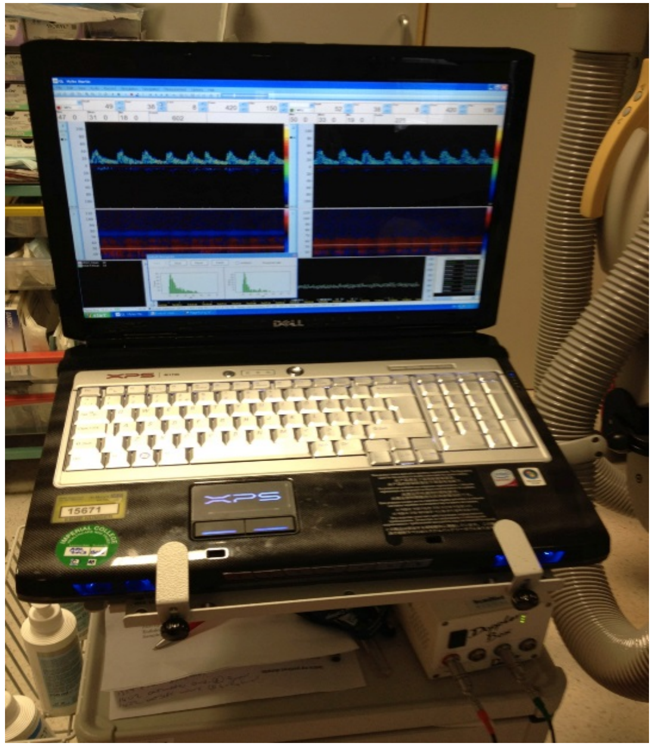
Vladimir Makaloski, MD,[a,b,] Fiona Rohlffs, MD,[a] Konstantinos Spanos, MD,[a] Sebastian Debus, MD,[a] Nikolaos Tsilimparis, MD,[a] and Tilo Kölbel, MD[a]*

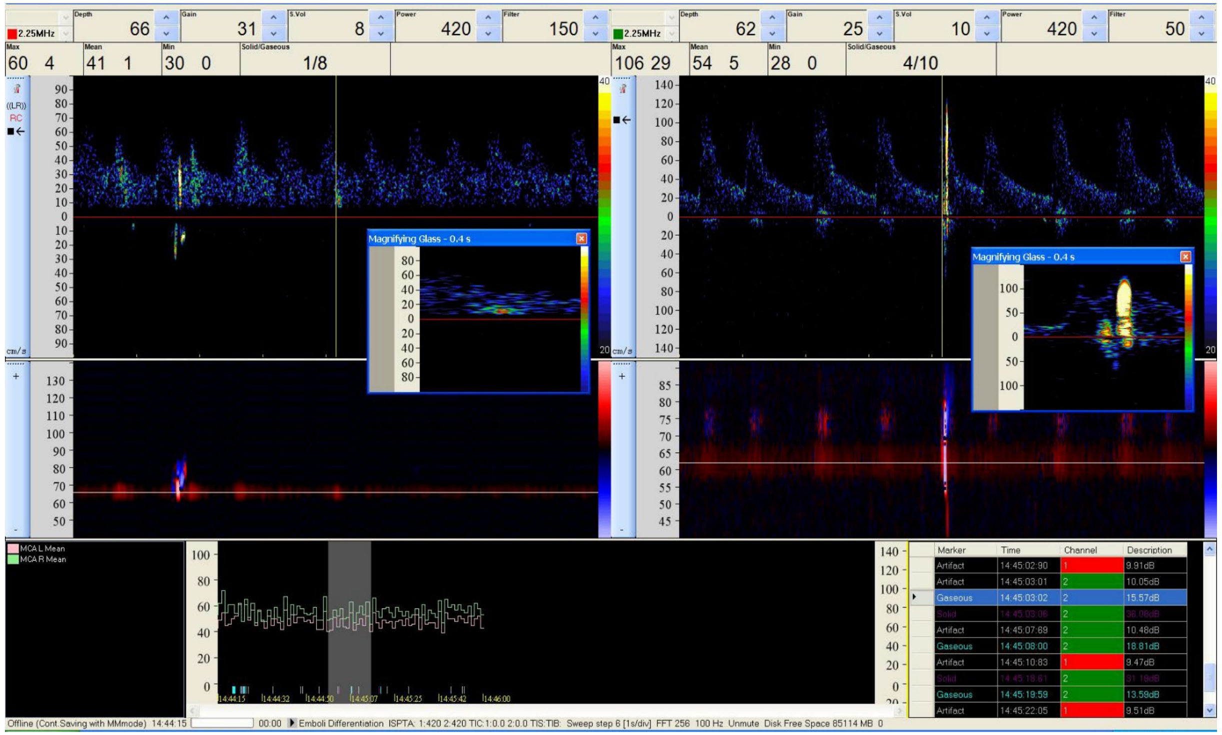
[a] *German Aortic Center, Department of Vascular Medicine, University Heart Center Hamburg-Eppendorf, Hamburg, Germany*

[b] *Department of Cardiovascular Surgery, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland*

'A significant number of air bubbles are released during of tubular thoracic stent grafts in an aortic flow model'

TCD Differentiation



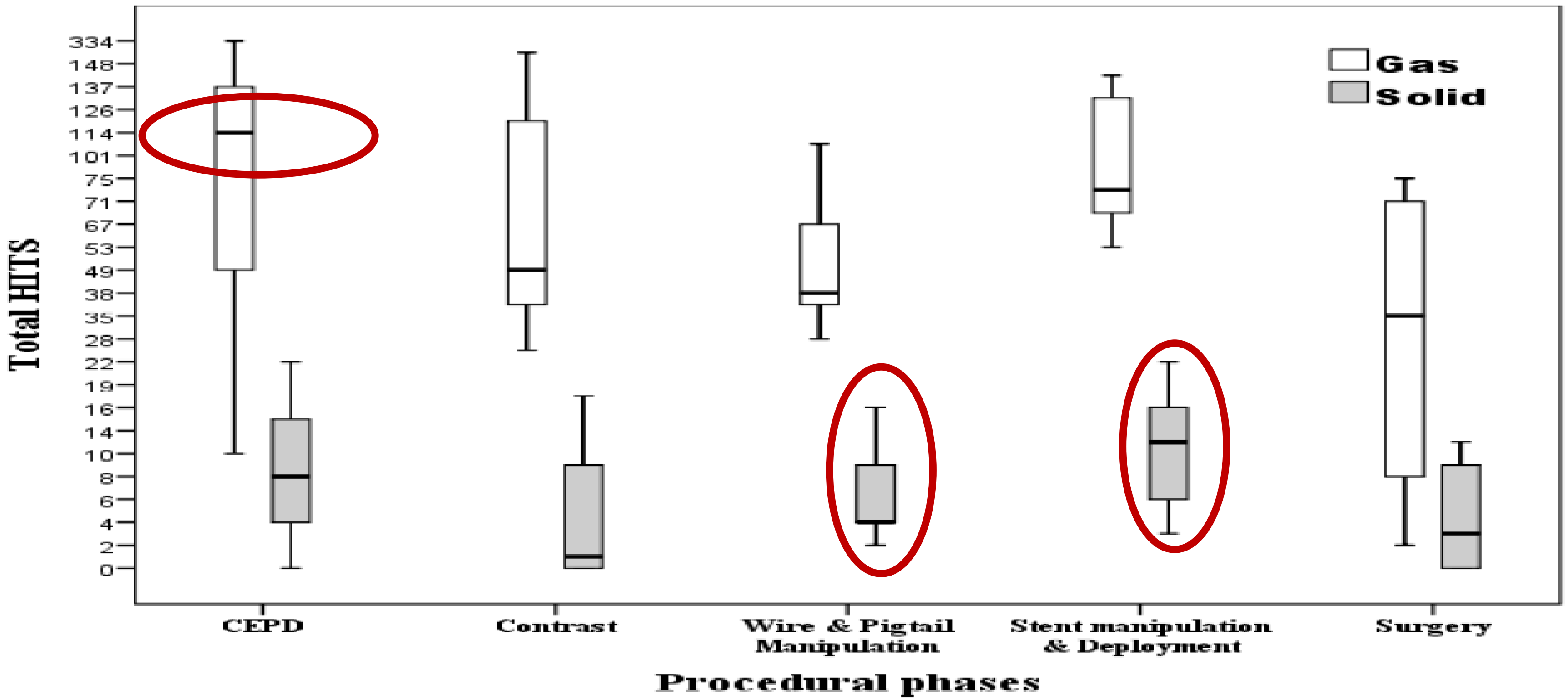


Sentinel Deployment

	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

TCD: Procedural embolization



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

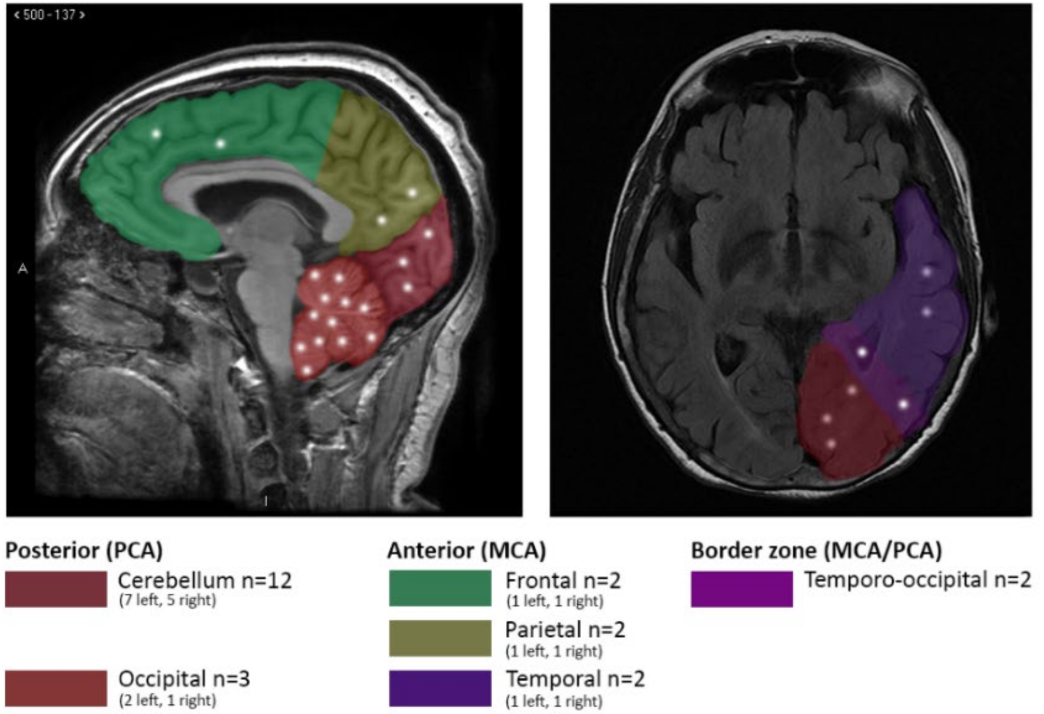
DW MRI Post-TEVAR Infarction

Protected

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

Total SA=**379mm2**

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

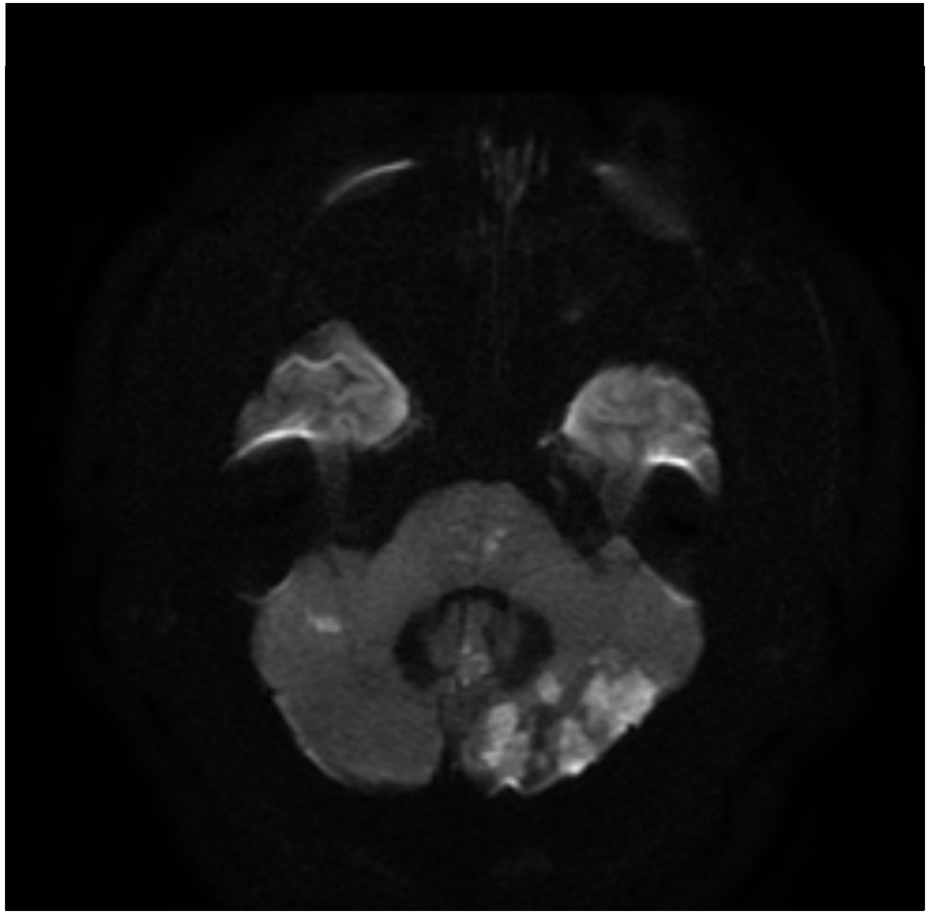


Unprotected

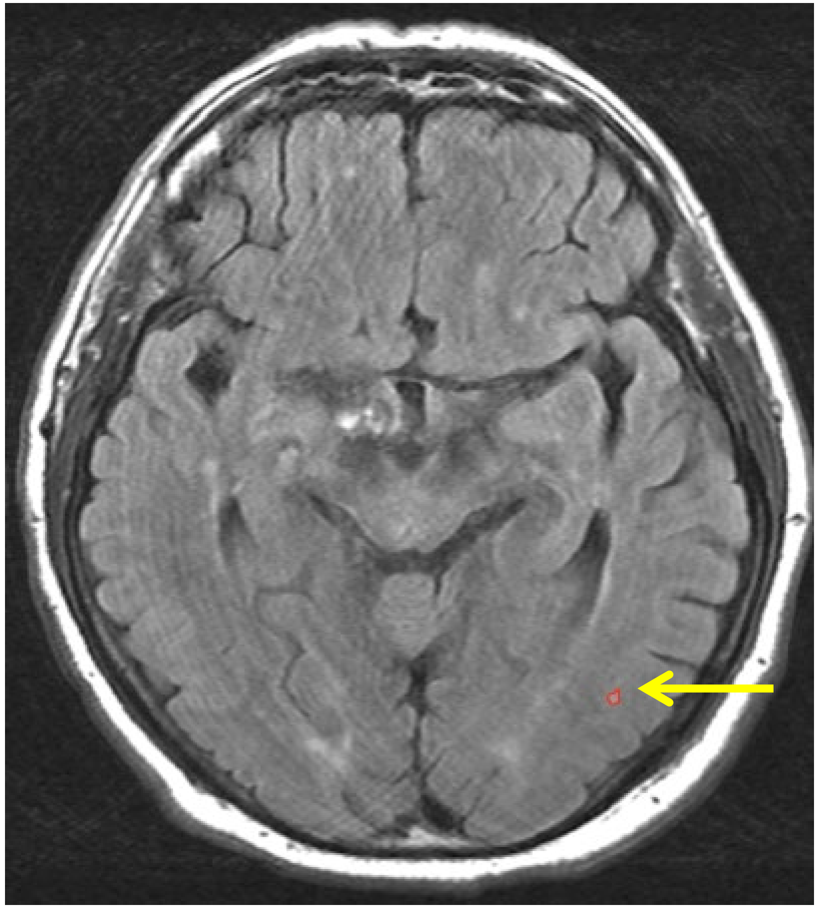
9/12 (75%) **55** new lesions

Total SA=**1534mm2**

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



$6.3mm^2$

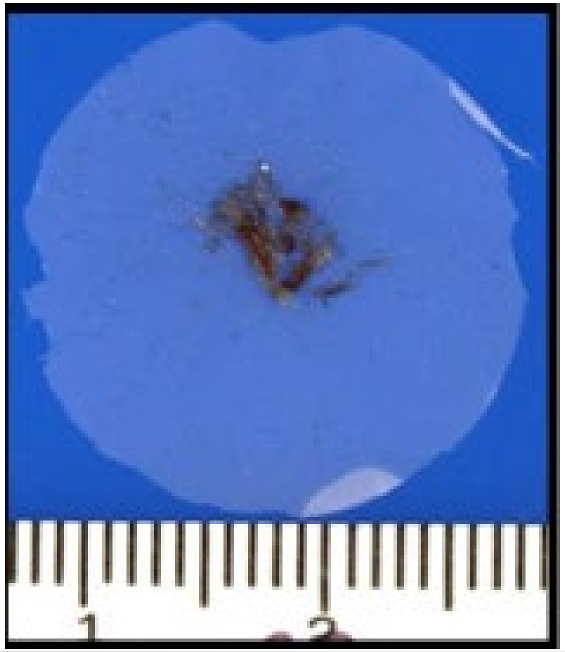


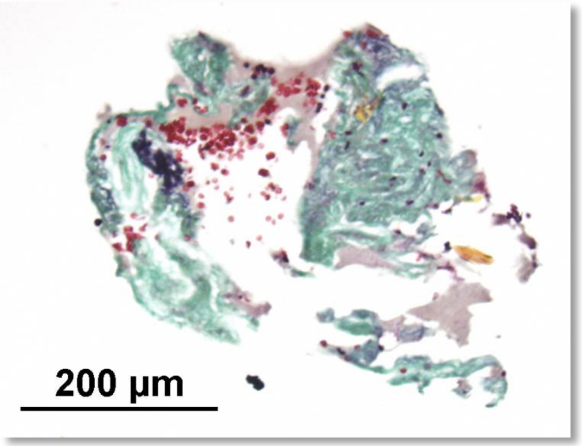
What Was Retrieved From The Filters?

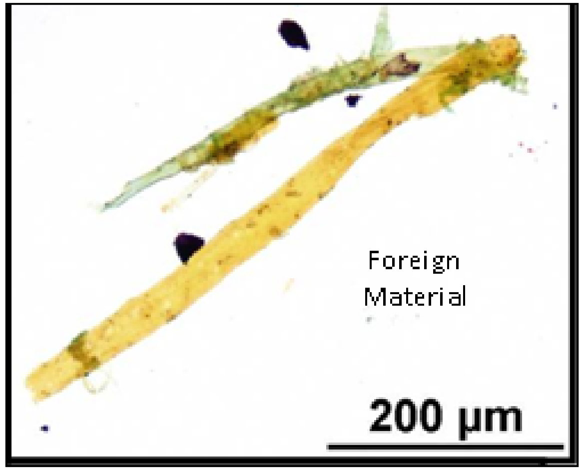
10 Proximal, 9 distal filters: **95%** contained debris

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

Median SA=2.66mm^2

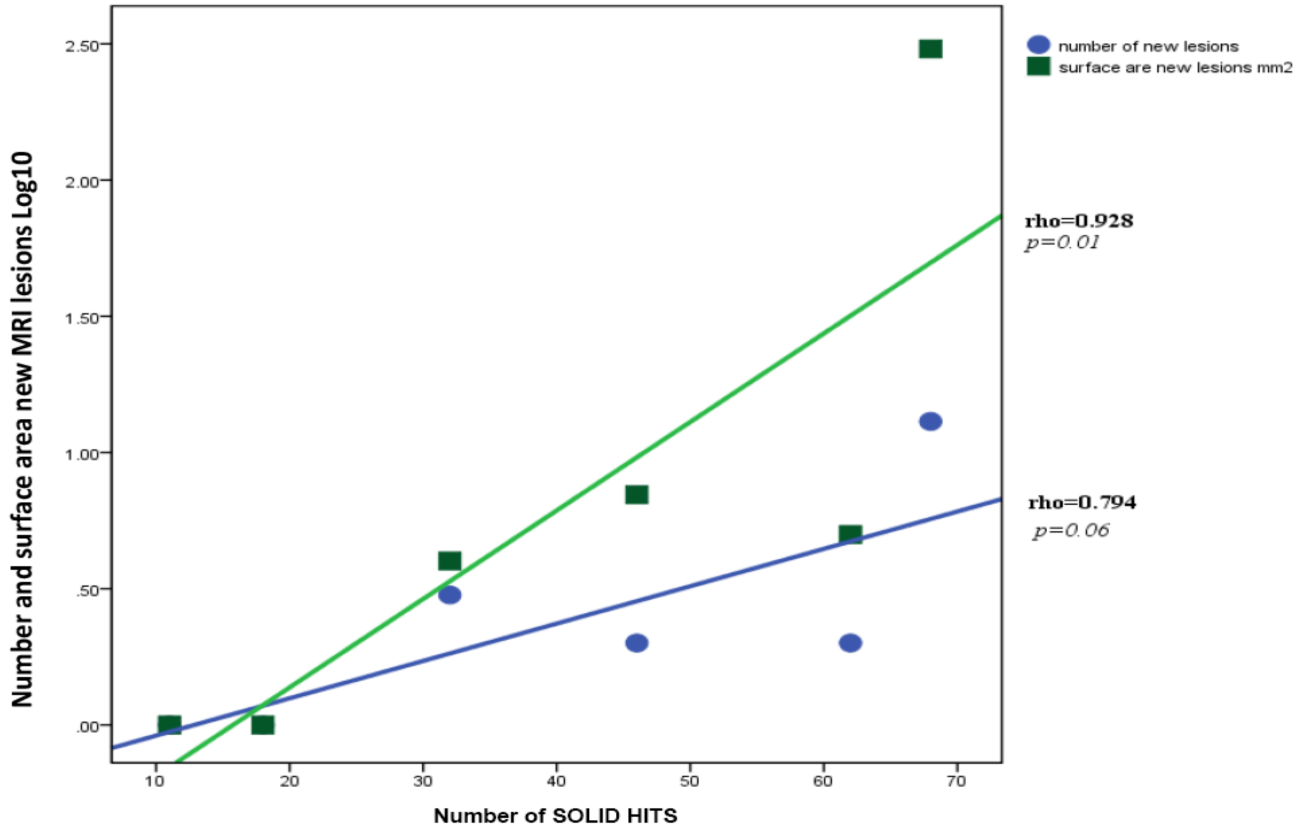




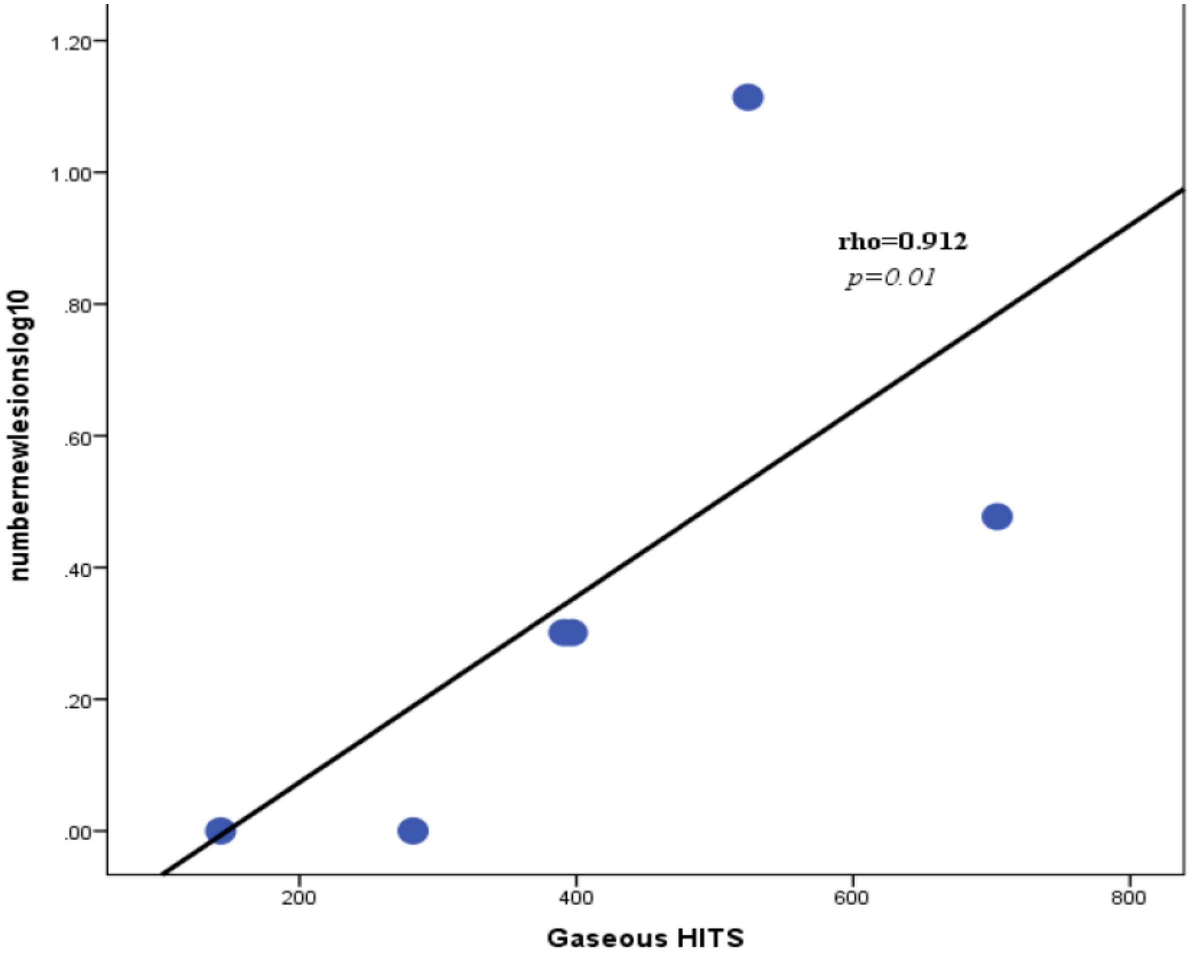


acute thrombus (95%)
arterial wall (63%)
foreign material (32%).

Number and surface area of new MRI lesions vs solid HITS



Number of new MRI lesions vs gaseous HITS



Total Cerebral Protection : Air Embolism

Experimental Investigation

JOURNAL OF ENDOVASCULAR THERAPY

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Air Embolism During TEVAR: Carbon Dioxide Flushing Decreases the Amount of Gas Released From Thoracic Stent-Grafts During Deployment

Fiona Rohlffs, MD[1], Nikolaos Tsilimparis, MD, PhD[1], Vasilis Saleptsis, MD[1], Holger Diener, MD[1], E. Sebastian Debus, MD, PhD[1], and Tilo Kölbel, MD, PhD[1]

Abstract

Purpose: To investigate the amount of gas released from Zenith thoracic stent-grafts using standard saline flushing vs the carbon dioxide flushing technique. **Methods:** In an experimental bench setting, 20 thoracic stent-grafts were separated into 2 groups of 10 endografts. One group of grafts was flushed with 60 mL saline and the other group was flushed with carbon dioxide for 5 minutes followed by 60 mL saline. All grafts were deployed into a water-filled container with a curved plastic pipe; the deployment was recorded and released gas was measured using a calibrated setup. **Results:** Gas was released from all grafts in both study groups during endograft deployment. The average amount of released gas per graft was significantly lower in the study group with carbon dioxide flushing (0.79 vs 0.51 mL, $p=0.005$). **Conclusion:** Thoracic endografts release significant amounts of air during deployment if flushed according to the instructions for use. Application of carbon dioxide for the flushing of thoracic stent-grafts prior to standard saline flush significantly reduces the amount of gas released during deployment. The additional use of carbon dioxide should be considered as a standard flush technique for aortic stent-grafts, especially in those implanted in proximal aortic segments, to reduce the risk of air embolism and stroke.

Conclusions

- Embolic showering causes stroke and covert cerebral injury
- The more proximal the landing zone and the more diseased the aorta -the greater the risk
- CEPD reduced both number and size of new infarcts
- L SCA and vertebral protection
- Protection against gaseous emboli