

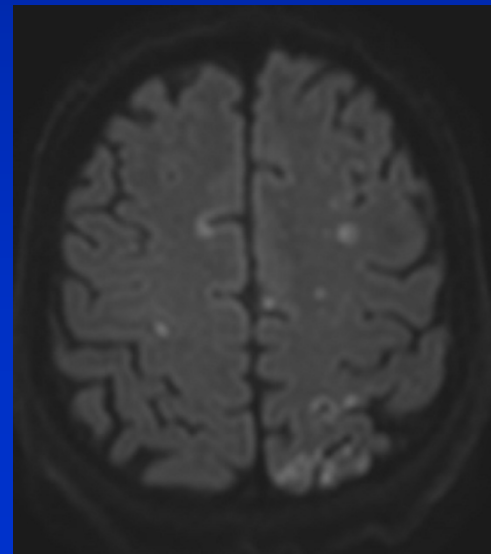
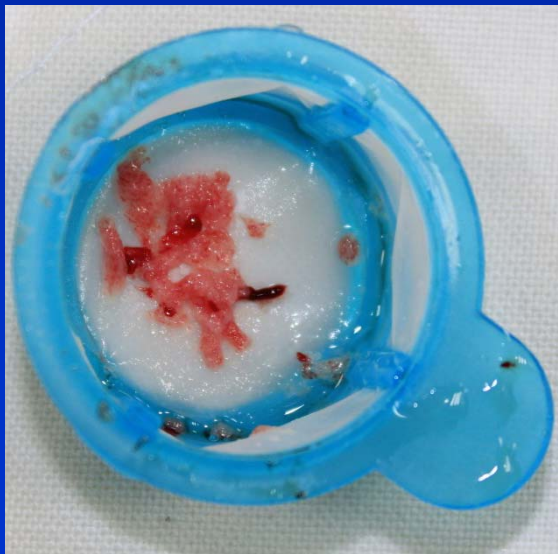
Doppler Analysis During CAS in Symptomatic Patients

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CAS Risk

- The greatest risk associated with CAS is periprocedural stroke or asymptomatic brain infarction due to embolization



Clinical Impact of Silent Brain Infarcts Seen On MRI

- Large Population Based Study -

- More than doubled the risk of dementia
- Worse performance of neuropsychological tests
- Steeper decline in global cognitive function

Vermeer SE et al. NEJM 2003;348:1215-22

Silent Infarcts after CAS

100% MES (TCD)

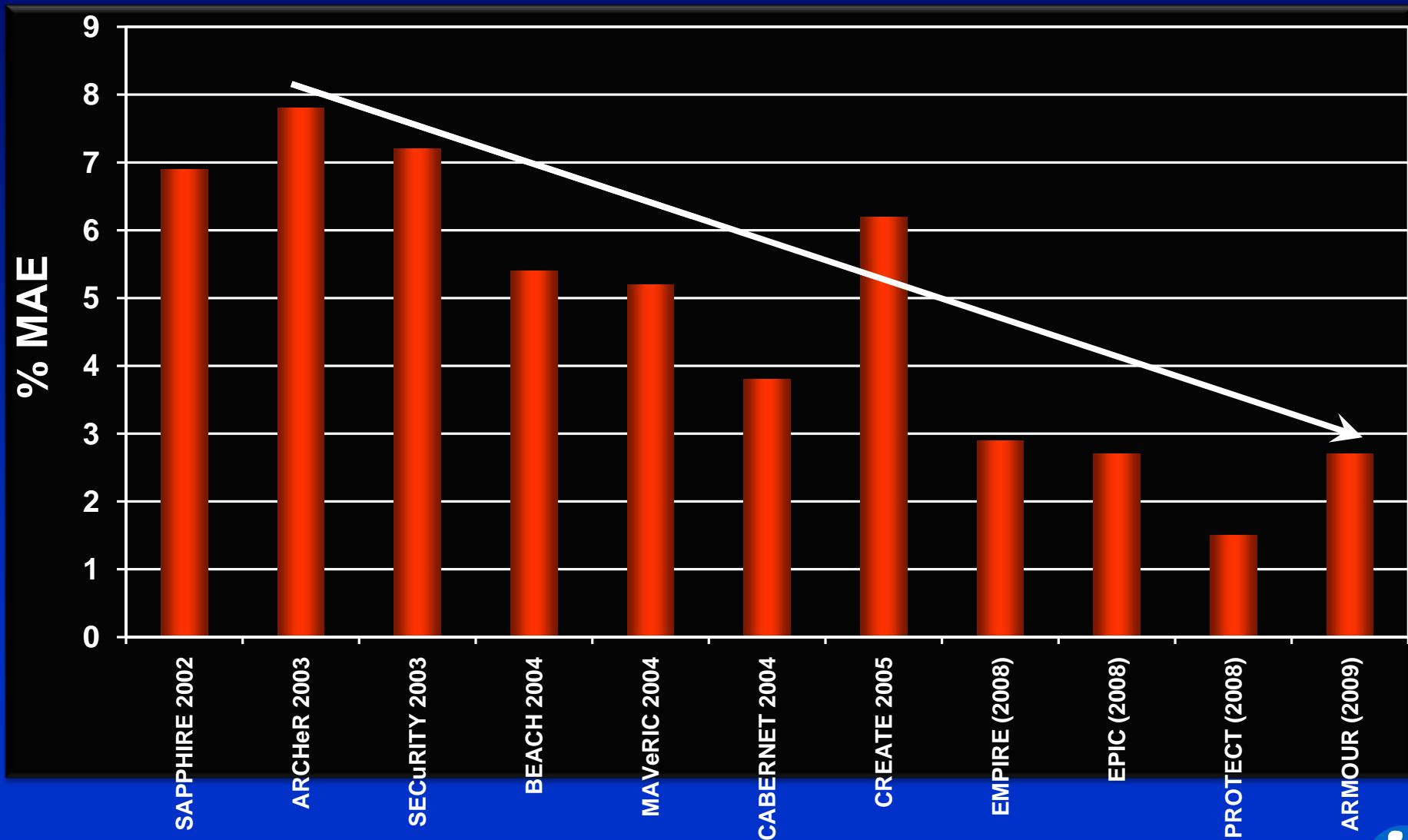


19-32% HSI on DWMRI – Silent Infarcts



Decline in Cognitive Function?
Vascular Dementia?

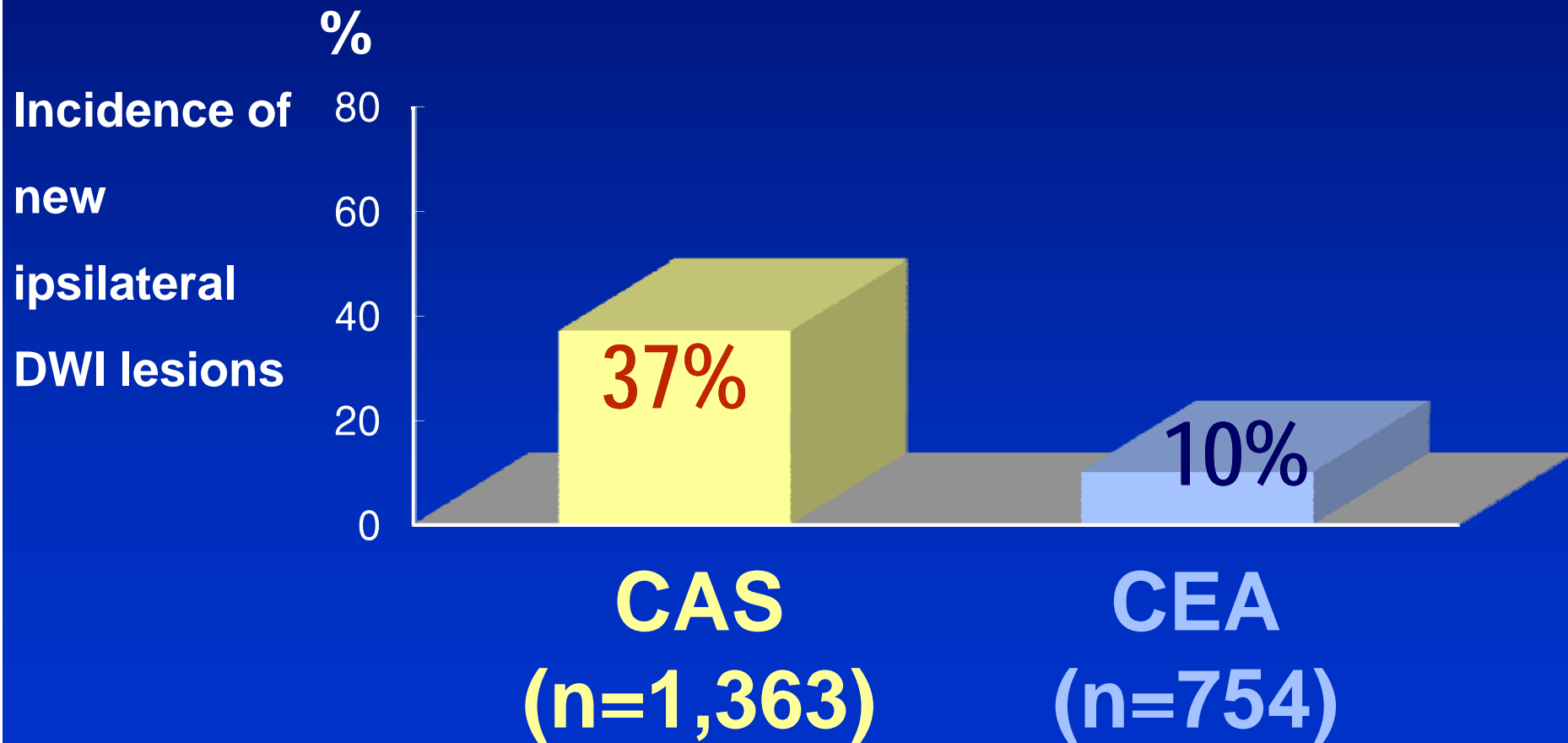
Incidence of stroke and death in high risk carotid stent IDE trials: 2002-2009 (n>4000)



New Brain Lesions After Carotid Stenting Versus Carotid Endarterectomy

A Systematic Review of the Literature

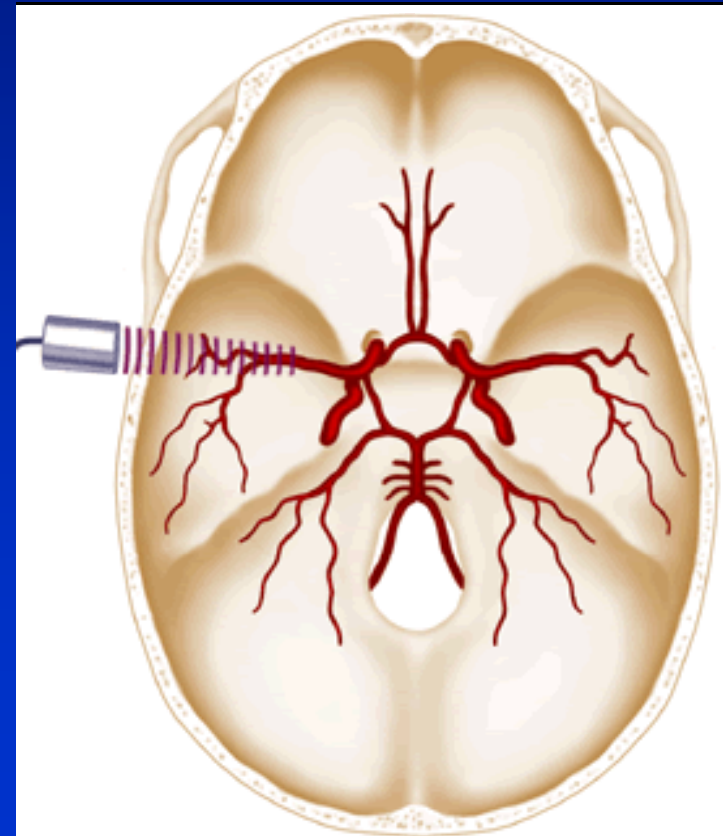
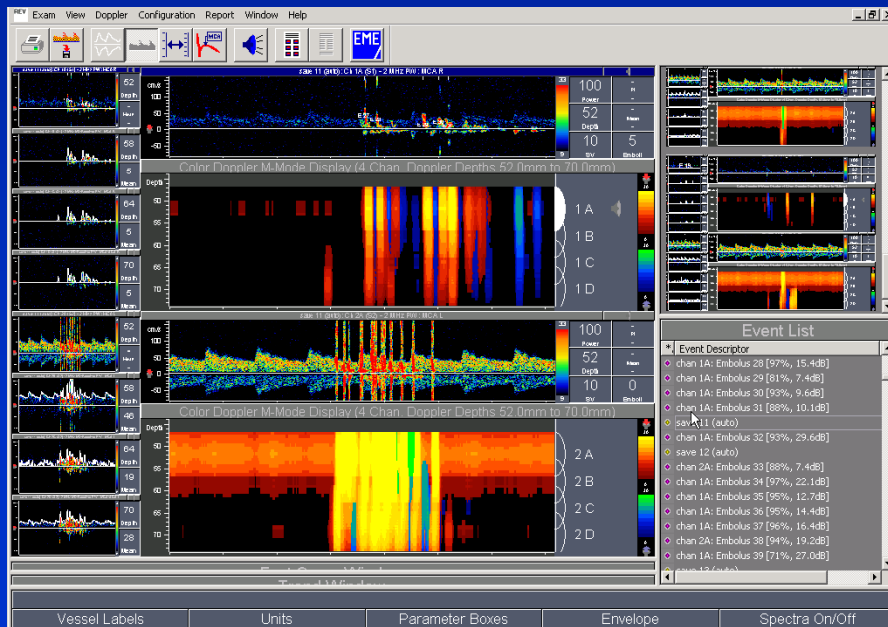
Sonja Schnaudigel, MD; Klaus Gröschel, MD; Sara M. Pilgram, MD; Andreas Kastrup, MD



Stroke 2008;39:1911-19

TransCranial Doppler

- Measurement of blood flow in middle cerebral artery
- Detection of emboli



TCD during CAS



- **The only examination that can monitor intracranial blood flow in real time detecting both symptomatic and asymptomatic embolic events as they occur**

Number of MES

Related with Stroke? Divergent results

- ≥ 8 MES in each phase \rightarrow more stroke ¹
- ≥ 5 MES during CAS \rightarrow more HSI on MRI ²
- ≥ 5 MES / 15 minutes during immediate postoperative period of CEA \rightarrow more HSI ³

¹ *Martinelli O et al. Intern Angiol 2009;28;249-53*

² *Ackerstaff RGA et al. J Vasc Surg 2005;41:618-24*

³ *Cantelmo NL et al. J Vasc Surg 1998;27:1024-32*

- No correlation btw MES and neurologic events⁴

⁴ *Vos JA et al. Radiology 2005; 234:493-9*

Four TCD Predictors of Adverse Cerebral Outcome

550 TCD Data during CAS

- **Macroembolism**
- **Massive air embolism**
- **Multiple microemboli (>5 showers at postdilation)**
- **Angioplasty-induced asystole and hypotension**
with a significant reduction of MCA flow velocity

Ackerstaff RGA et al. J Vasc Surg 2005;41:618-24

Interpretation of TCD Spectral Patterns Detected During Carotid Artery Stent Interventions

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Si Wan Choi, MD, PhD²; and Jei Kim, MD¹

Departments of ¹Neurology and ²Internal Medicine, Chungnam National University Hospital and College of Medicine, Daejeon, South Korea.



Purpose: To classify transcranial Doppler (TCD) spectral patterns and analyze the significance of the patterns in the determination of hemodynamic alterations occurring during filter-protected carotid artery stent (CAS) procedures.

Methods: Data on middle cerebral artery (MCA) monitoring and post-CAS diffusion weighted magnetic resonance imaging (DWMRI) were reviewed for 53 patients (45 men; mean age 67.6±8.3 years) who underwent TCD evaluation before CAS and TCD monitoring during the procedure. TCD spectral patterns were classified according to the hemodynamic

Results: TCD spectral changes were classified into 4 patterns: (1) microemboli signals (53, 100%), (2) right-left collateral signals (31/53, 58%), (3) spectral suppression after balloon inflation (31/44, 70%), and (4) continuous spectral suppression after balloon removal (4/44, 9%). Even though microembolic signals were frequently observed during CAS, the new

inflation (31/44, 70%), and (4) continuous spectral suppression after balloon removal (4/44, 9%). Even though microembolic signals were frequently observed during CAS, the new DWMRI lesions were more frequently observed outside of the cerebral territory (78%) rather than in the territory ipsilateral to CAS (47%). The presence of right-left collaterals was related to less severe balloon-related spectral suppression on ipsilateral MCA ($p<0.05$). Continuous spectral suppression appeared after stent deployment and balloon dilation and was immediately reversed after removal of the filter device.

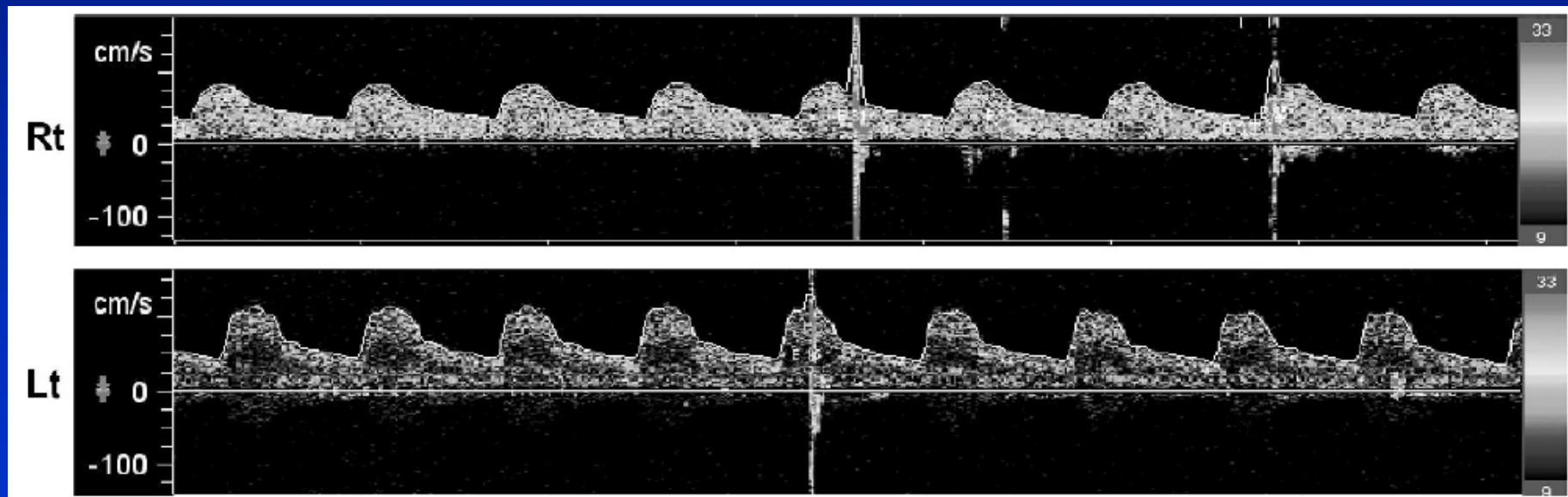
Conclusion: The spectral patterns classified in the present study may prove useful in anticipating CAS procedure-related hemodynamic alterations. Close hemodynamic observation using these spectral patterns could be helpful in preventing serious complications during CAS.

J Endovasc Ther. 2011;18:518-526

Four Spectral Patterns

1. MES

- observed in 100% patients
- observed in all stages

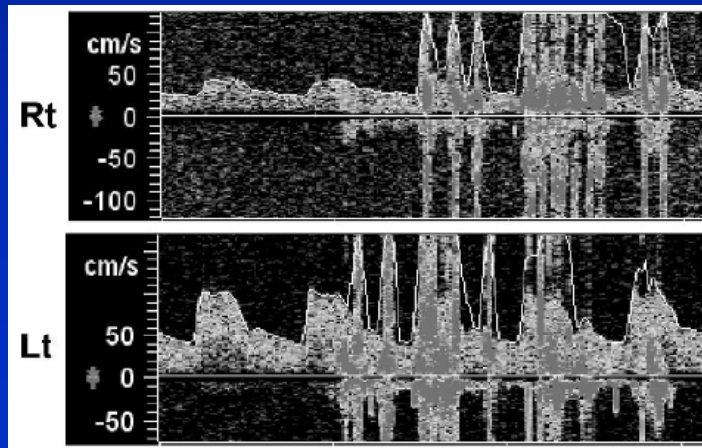


Jeong HS et al. J Endovasc Ther 2011;18:518-26

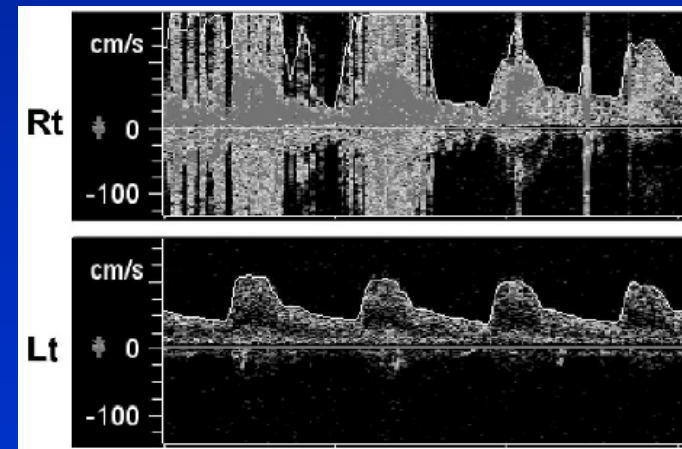
Four Spectral Patterns

2. Right-Left collateral signal

- simultaneously detected in the MCA bilaterally after injection of contrast material in a proximal ICA
- indicating collateral flow btw right and left anterior circulation



Positive; 58%

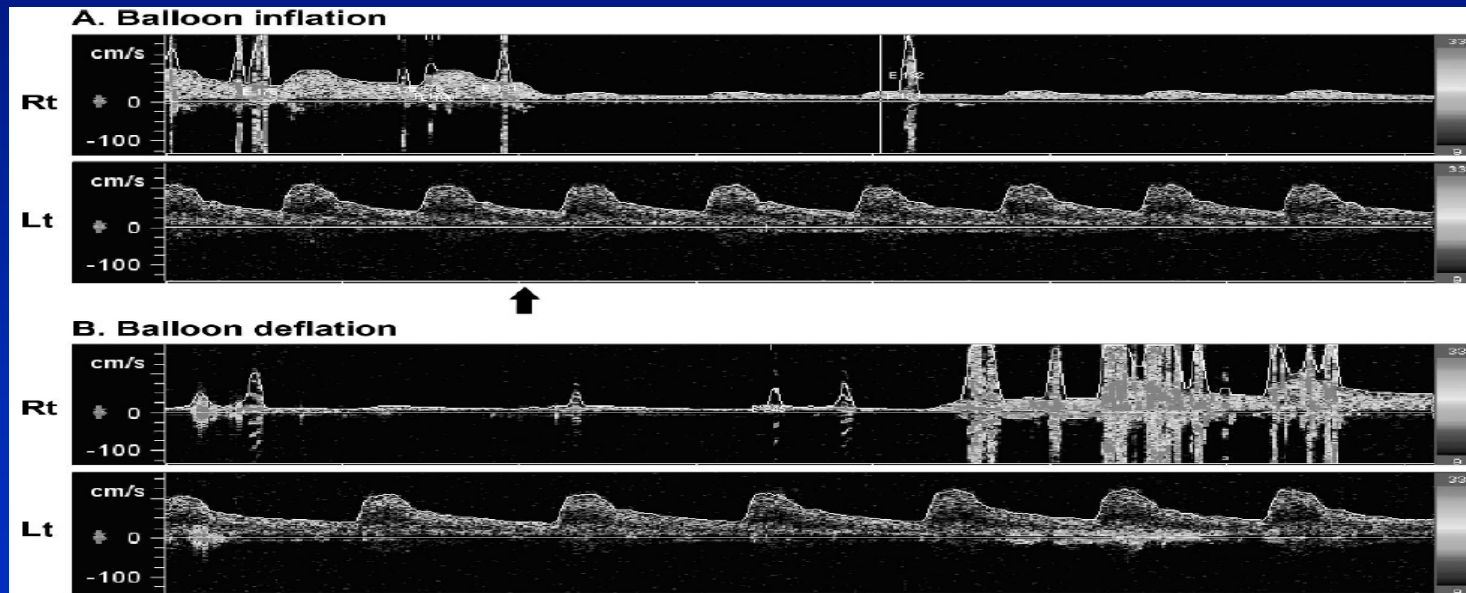


Negative; 42%

Jeong HS et al. J Endovasc Ther 2011;18:518-26

Four Spectral Patterns

3. Spectral suppression after balloon inflation
 - transient collapse of blood flow in the ipsilateral anterior circulation during balloon inflation



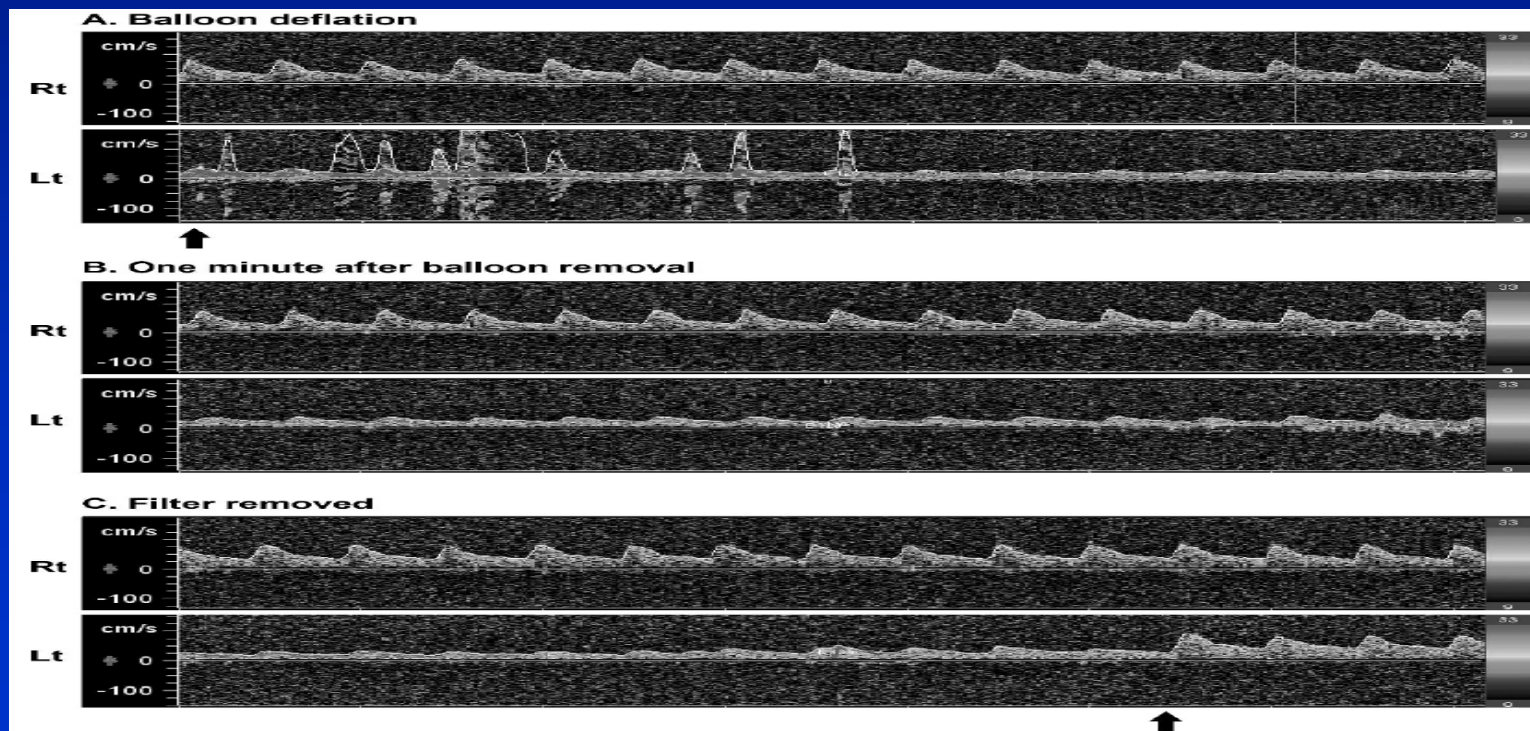
Marked spectral suppression ($\geq 50\%$ change from baseline)

- More frequent in no RL collateral signal patient
- 65% vs. 22%

Jeong HS et al. *J Endovasc Ther* 2011;18:518-26

Four Spectral Patterns

4. Continuous spectral suppression after balloon removal
 - sustained spectral suppressions that continued even after the removal of the balloon
 - 7% of patients



Jeong HS et al. *J Endovasc Ther* 2011;18:518-26

New DWMRI Lesion

- 37% (19 of 51 patents)
 - 9 ipsilateral
 - 10 contralateral or posterior circulation



may caused by

- catheter manipulation in the aortic arch
- contralateral embolization via RL collateral

Jeong HS et al. J Endovasc Ther 2011;18:518-26

Proximal vs. Distal Protection

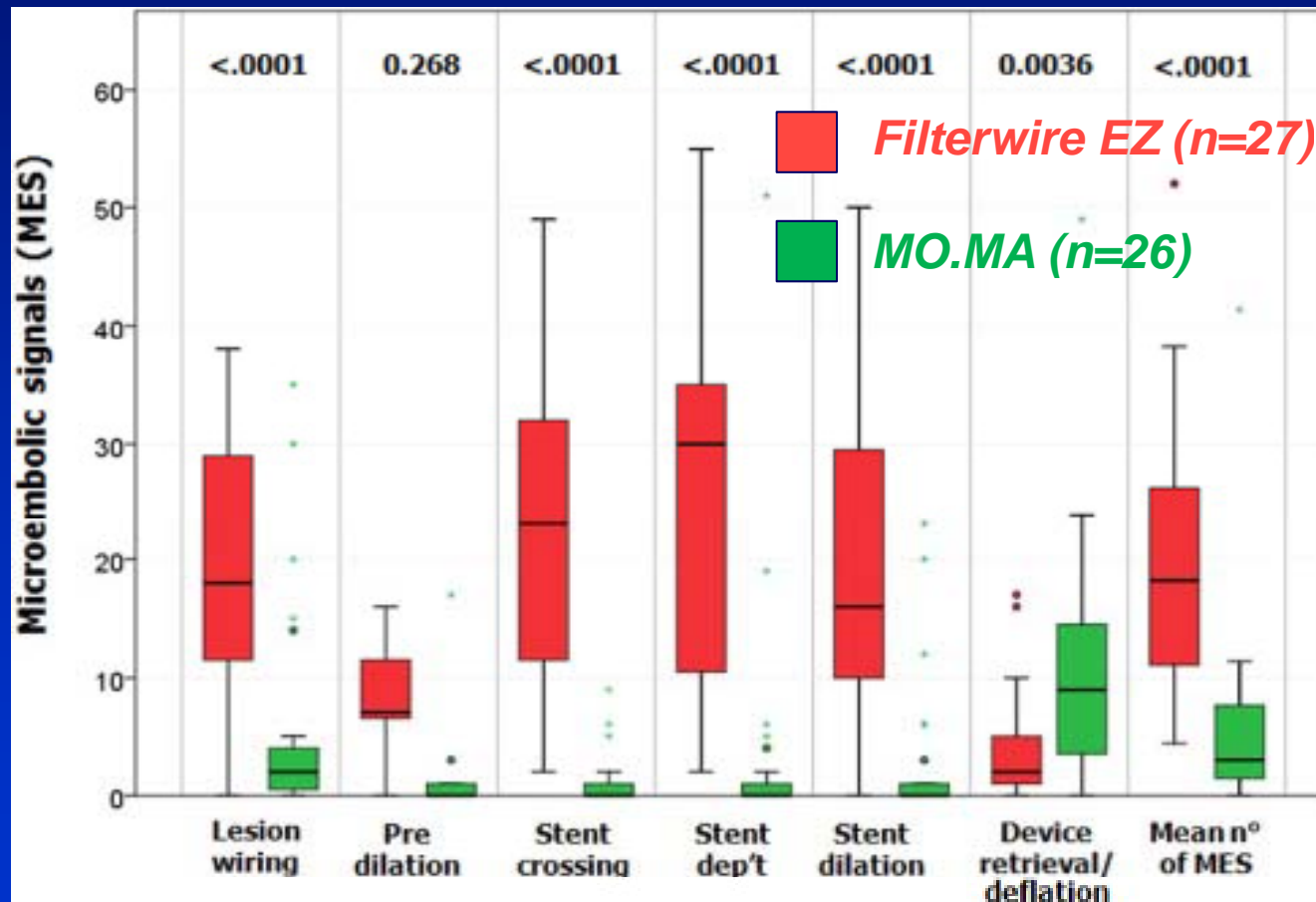
Randomized TCD MES Comparison for High-Risk, Lipid-Rich Plaque

Steps	FilterWire EZ (n = 27)	MO.MA (n = 26)	p Value
Lesion wiring	26 (96%)	19 (73%)	0.145
Pre-dilation	6/7 (86%)	4/10 (40%)	0.578
Stent crossing of the lesion	27 (100%)	7 (27%)	<0.0001
Stent deployment	27 (100%)	7 (27%)	<0.0001
Stent post-dilation	26 (96%)	7 (27%)	<0.0001
Device retrieval/deflation	22 (81%)	25 (96%)	0.721

Montorsi P et al. JACC 2011;58:1656-63

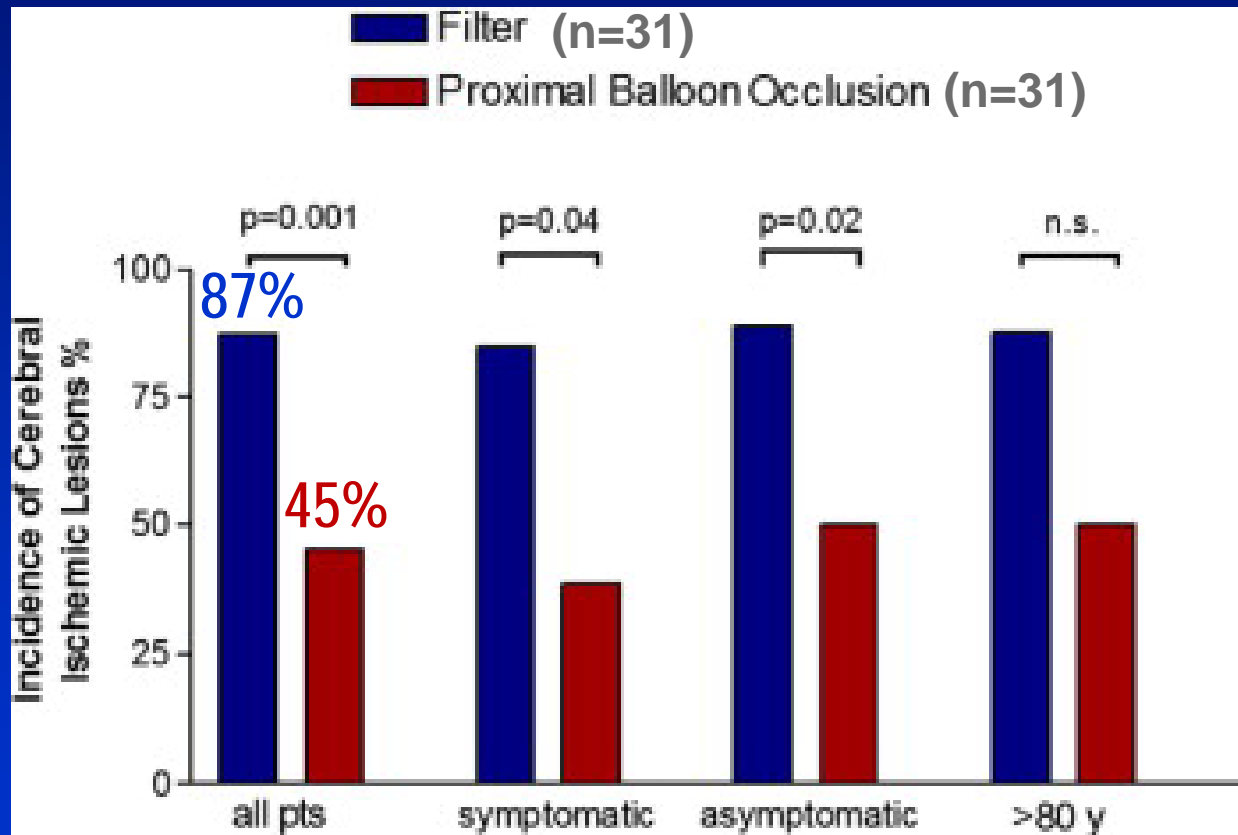
Proximal vs. Distal Protection

Randomized TCD MES Comparison for High-Risk, Lipid-Rich Plaque



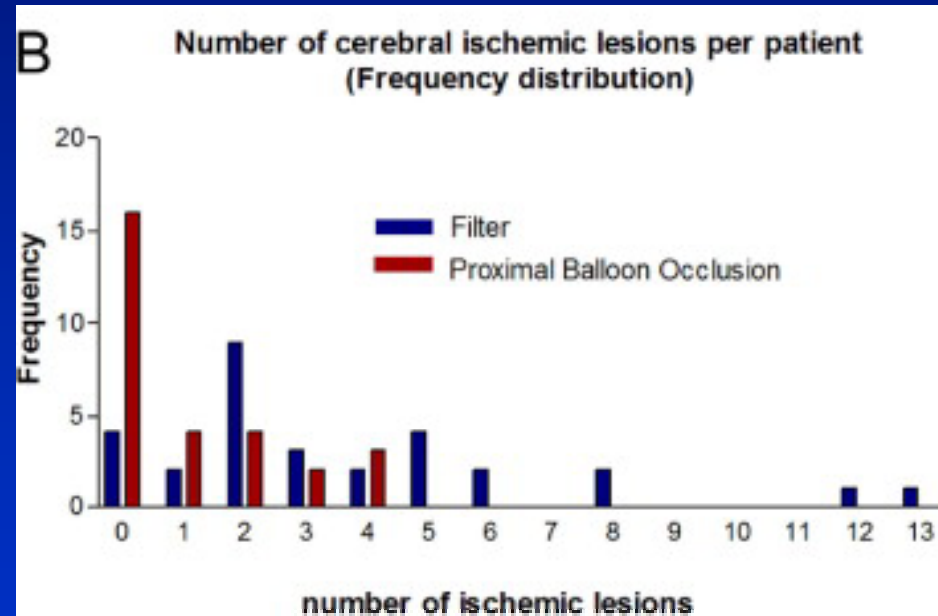
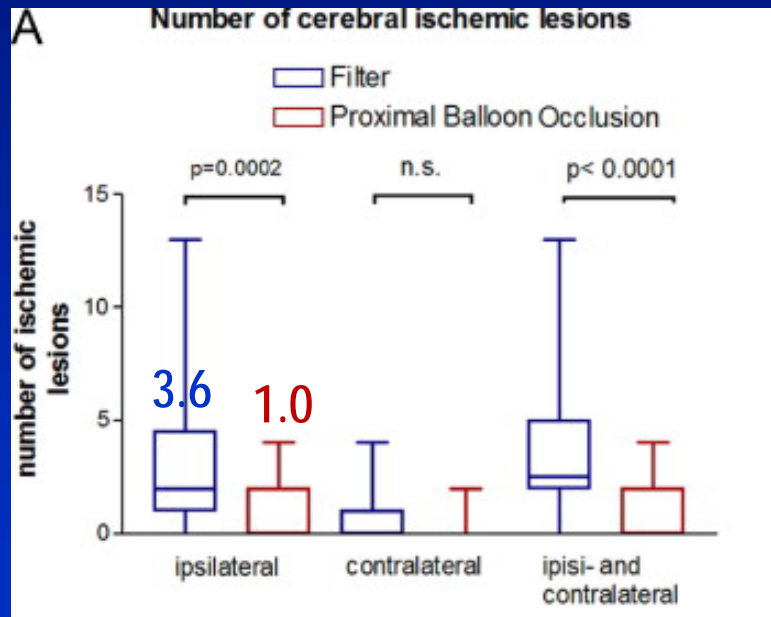
Montorsi P et al. JACC 2011;58:1656-63

Proximal vs. Distal Protection *Randomized DWMRI Comparison*



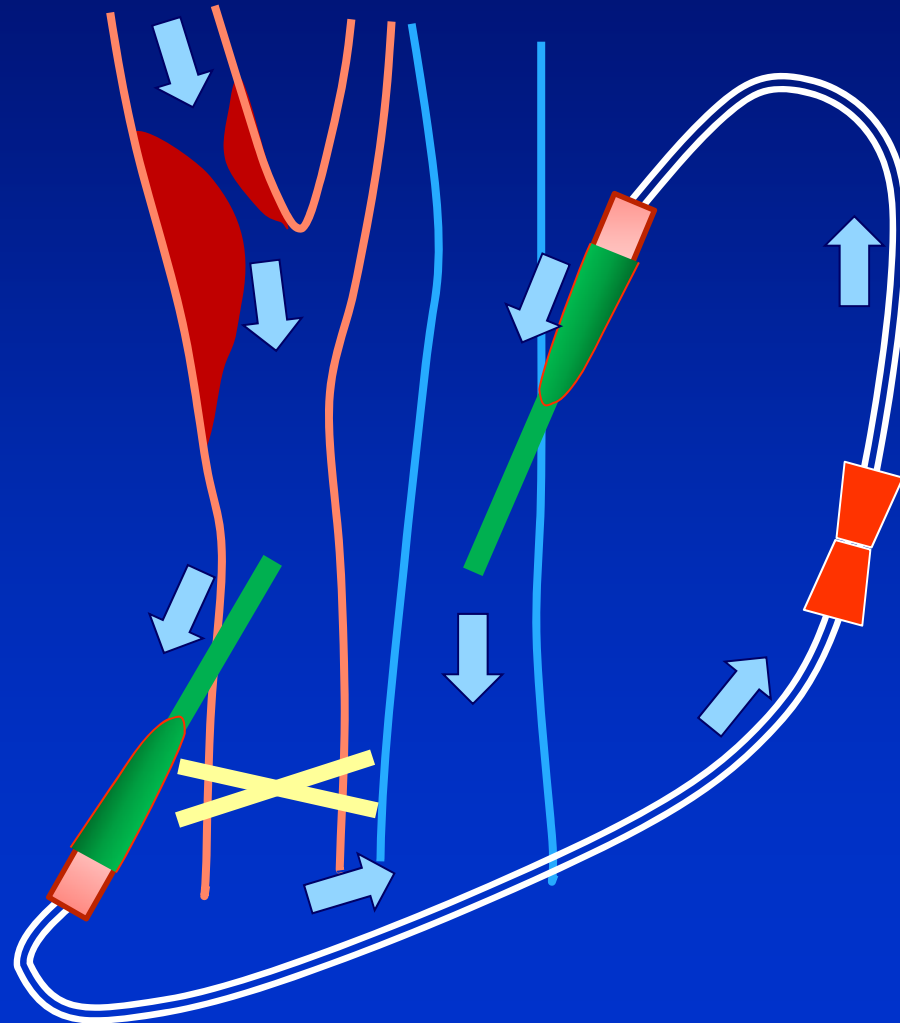
Bijuklic K et al. JACC 2012;59:1383-89

Proximal vs. Distal Protection *Randomized DWMRI Comparison*



Bijuklic K et al. JACC 2012;59:1383-89

Transcervical Access



TCD During CAS

Practical Issues

- **Cost**
- **Availability of trained personnel**
- **Unavoidably distracts and stresses the operator**
- **Inability to monitor throughout the entire CAS procedure d/t patient motion and table movement**

TCD During CAS

Applications

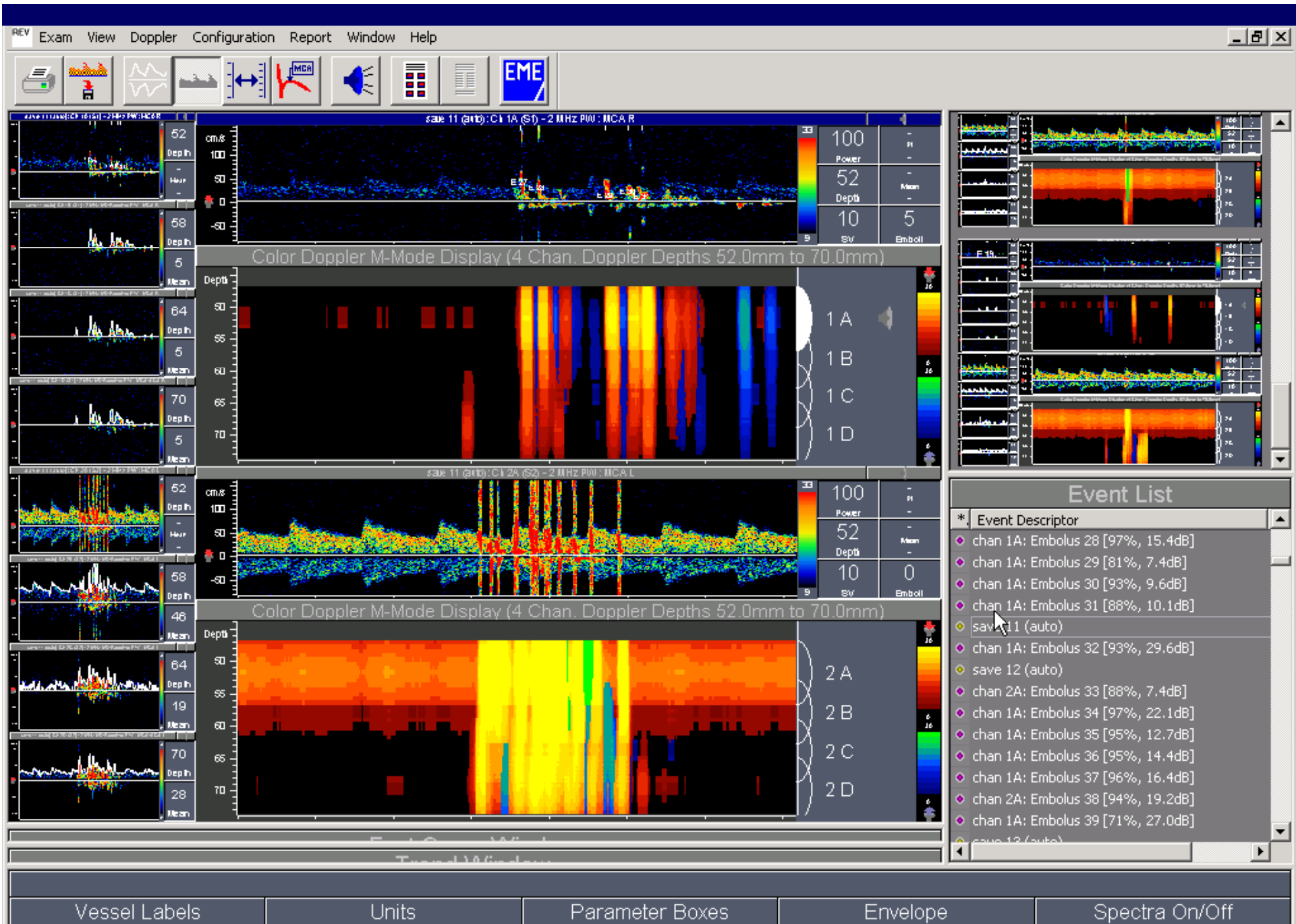
- **Alert the operator to take appropriate measures to avoid brain ischemia**
- **Accurately detects intra-procedural cerebral emboli**
- **Provides useful data for choice and control of the different DPDs**
- **Can be used to guide further development of cerebral protection devices and skills**

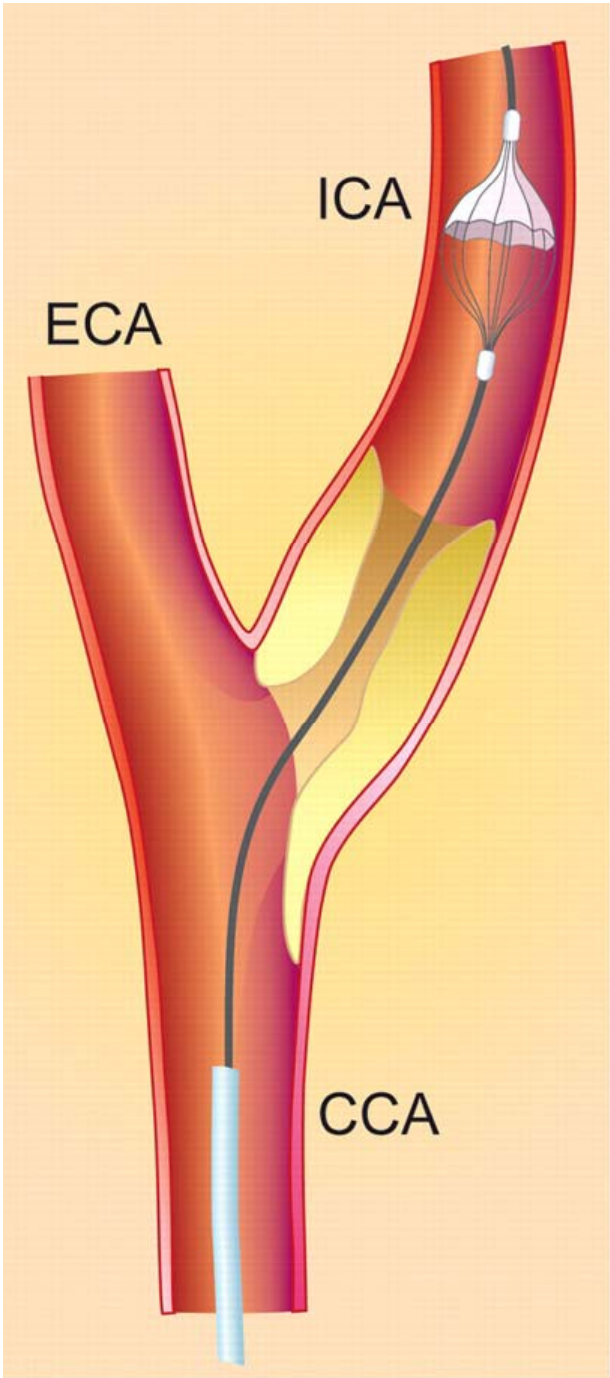
The logo for 'infolive' is located in the top right corner. It features the word 'infolive' in a blue, sans-serif font with a white outline. Above the letter 'i' is a white, stylized mountain peak or triangle shape.A 3D rendered tank is positioned inside a large, semi-transparent blue dome. To the right of the tank, there is a bright yellow and orange explosion. The scene is set against a blue background with a circular white line on the ground.

Thanks for Your Attention

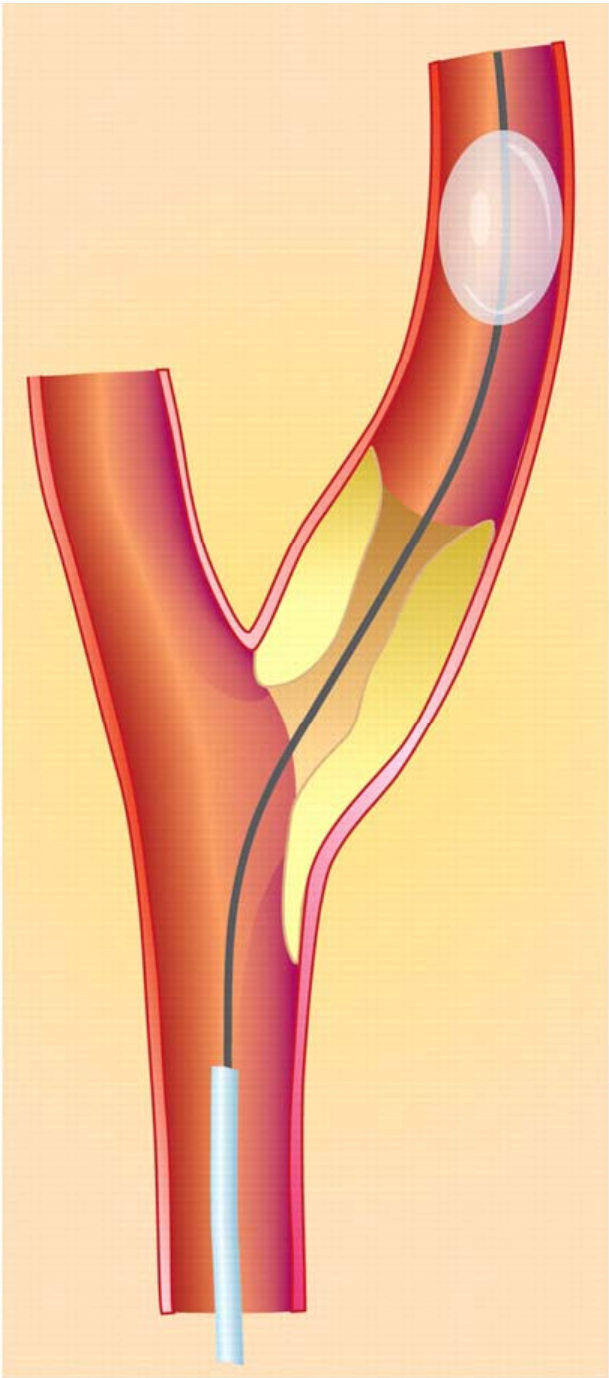
TROPHY

DETECTS, TRACKS AND CLASSIFIES

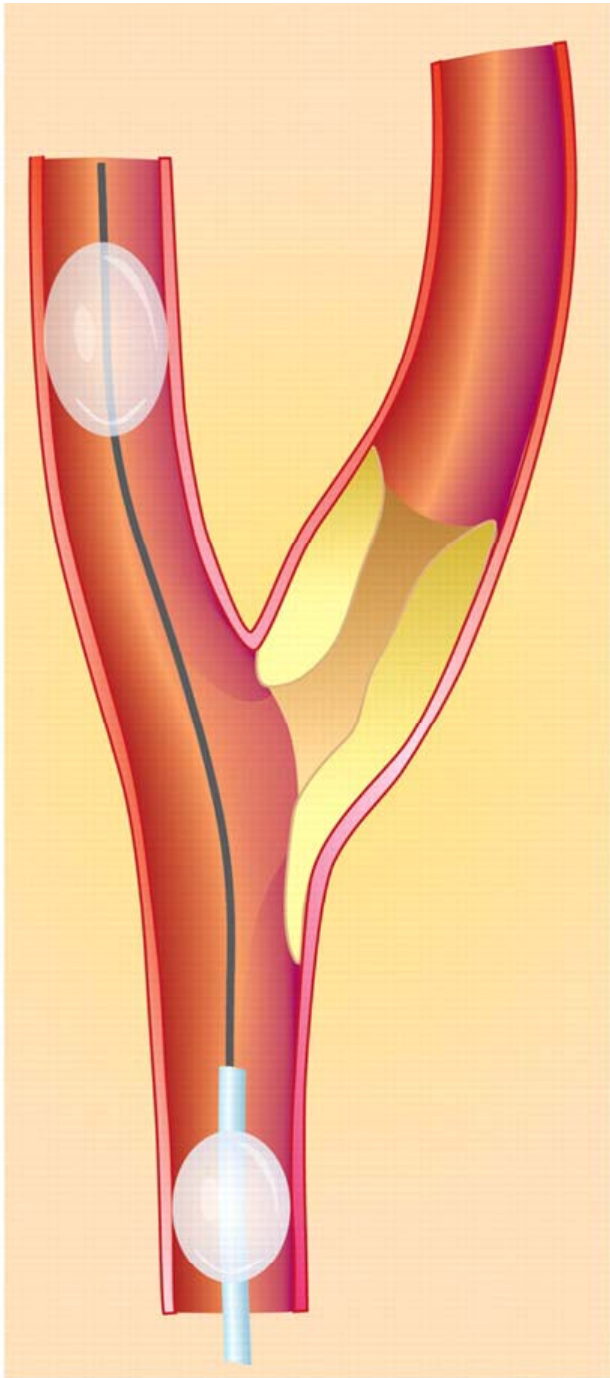




Filter



Distal occlusion



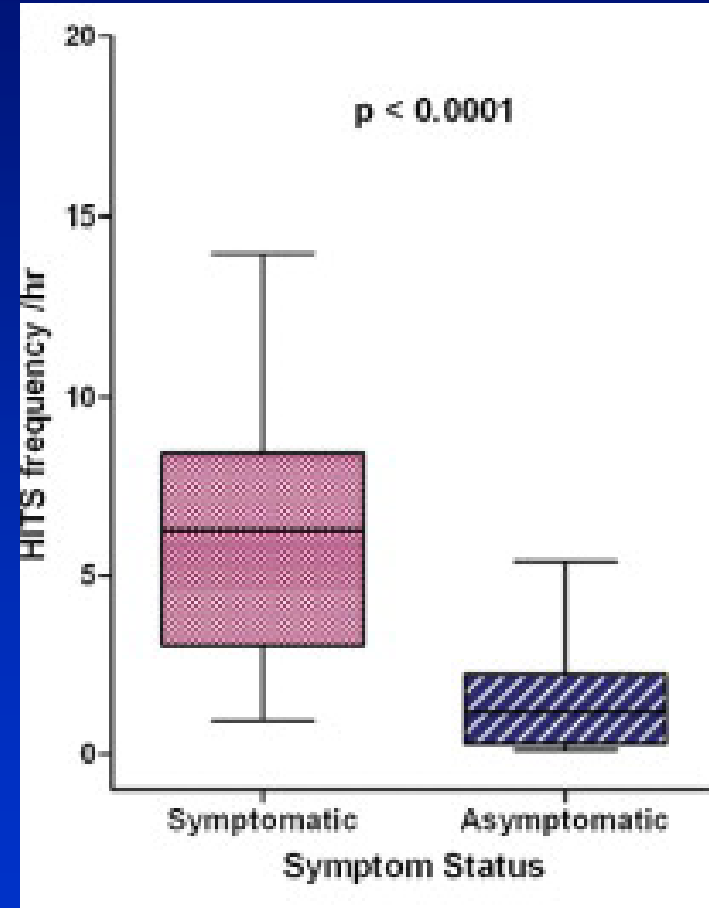
Proximal Occlusion

TCD-detected HITS in Asymptomatic Carotid Stenosis

- Reflec

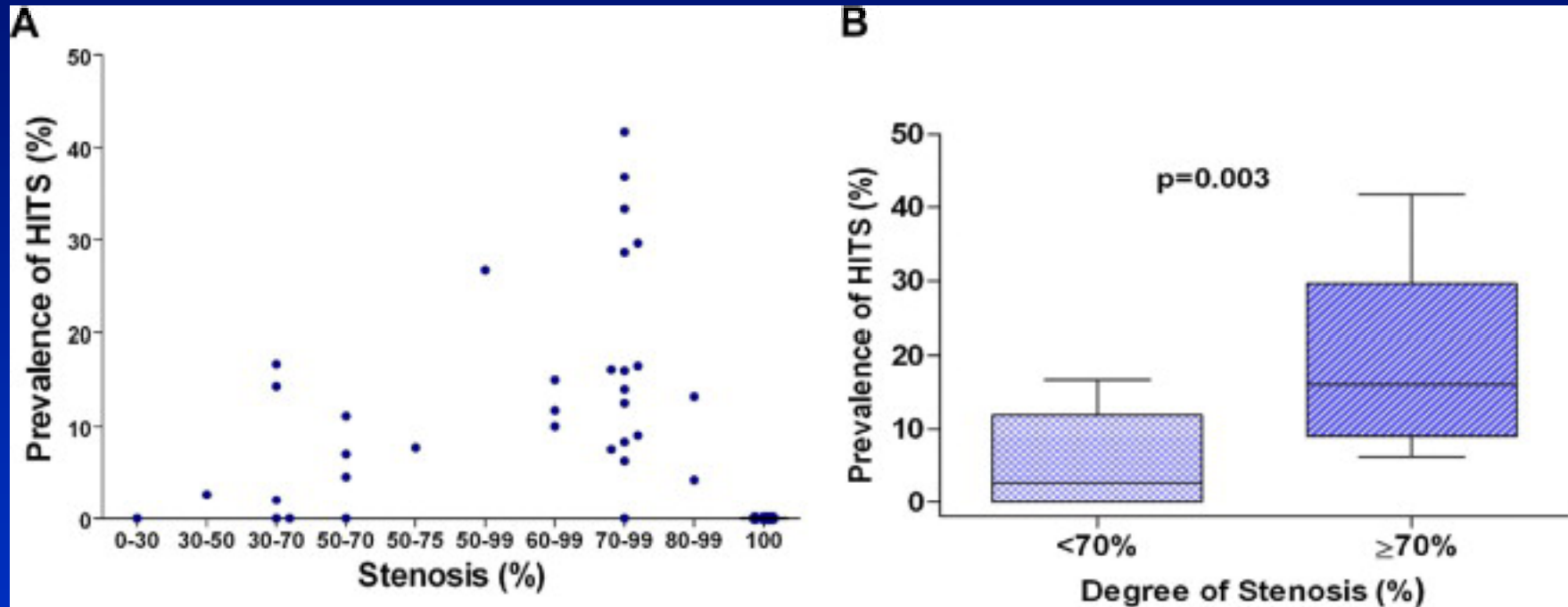
Symptom Status & TCD HITS

- Symptomatic stenosis had more TCD-HITS



Jayasooriya G et al. *J Vasc Surg* 2011;54: 227-36, Meta analysis

Stenosis & TCD HITS

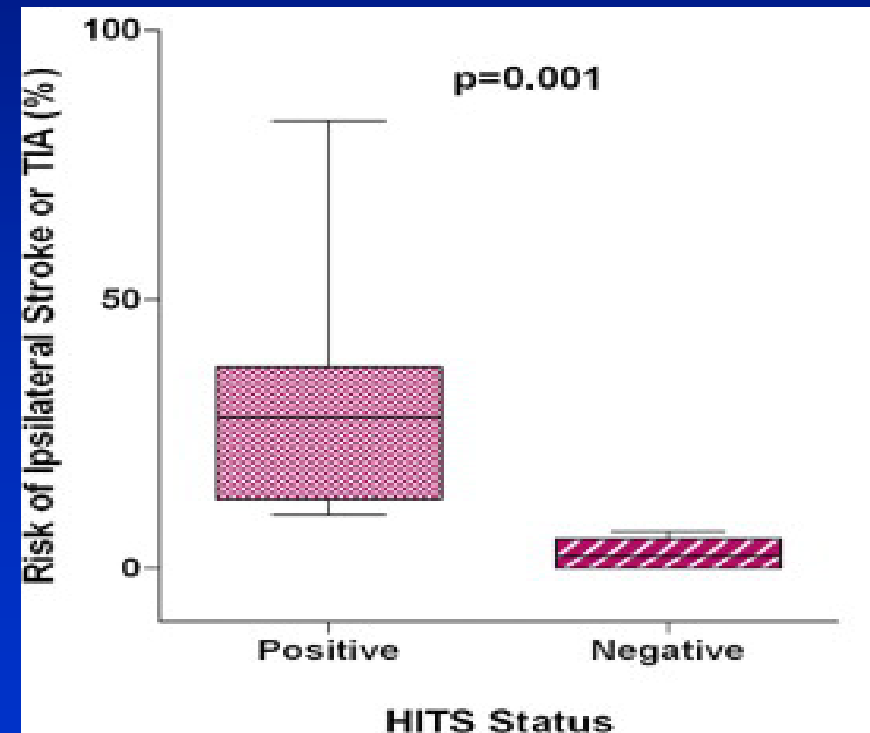


- Prevalence of HITS is increased with degree of stenosis in asymptomatic stenosis

Jayasooriya G et al. J Vasc Surg 2011;54: 227-36, Meta analysis

HITS & Long-term Stroke

- Seven studies with Asx stenosis
- Mean FU; 9-34 months
- Stroke+TIA; 28% vs. 2%



Jayasooriya G et al. *J Vasc Surg* 2011;54: 227-36, Meta analysis

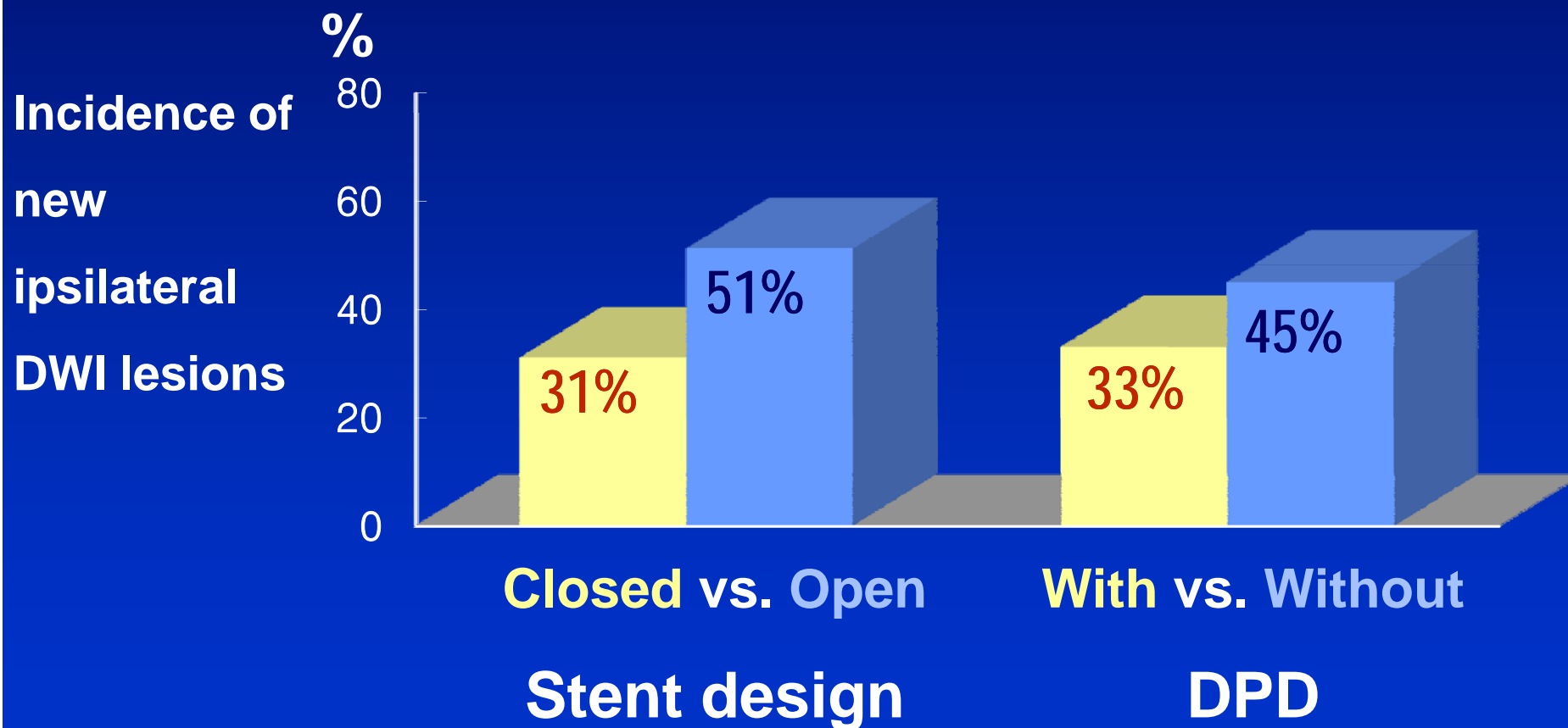
No Flow Beyond Distal Filter

- Arterial spasm
 - Dissection by filter
 - Dissection by balloon catheter
 - Full basket
- Thrombi aspiration followed by filter removal

New Brain Lesions After Carotid Stenting Versus Carotid Endarterectomy

A Systematic Review of the Literature

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Stroke 2008;39:1911-19

TCD MES During CAS

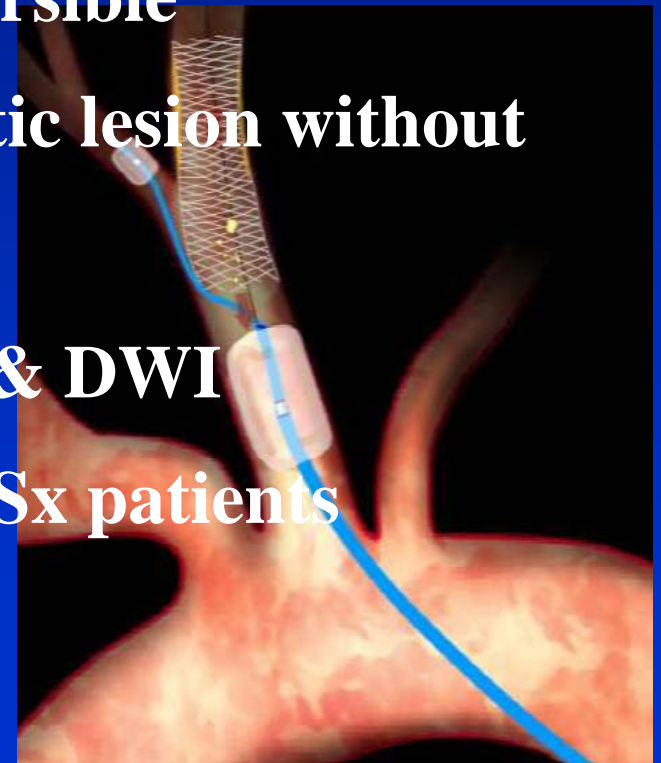
Solid vs. Gaseous emboli

- Reflect all solid or gaseous emboli, contrast, or artifacts.
- Intensity of MES – higher in gaseous emboli
- But, signal intensity also increases with emboli size.
- Need automated frequency analysis of HITS and power M-mode Doppler.

Proximal Embolic Protection

Advantages

- Easy to use with experience
- Intolerance is rare, and usually reversible
- Do not require crossing of the stenotic lesion without protection
- Less emboli get to brain... on TCD & DWI
- Great results especially elderly and Sx patients



Proximal Embolic Protection

Disadvantages

- Intolerance possible with poor collateral or contralateral occlusion
- Some loss of visualization due to occluded flow
- Larger device (8~9 Fr introducer)
- Manipulation of aortic arch

Transcervical Access

Advantages

- Avoid all maneuvers in the aortic arch, decreasing the potential embolic risk
- Allow a quick and easy procedure
- Do not require much catheterization skills (especially in case of severe tortuosities)
- Do not need special guiding catheters or stiff GW
- Always possible and often the only way (up to 5%)
- Does not carry a high risk of bleeding