Are mesh covered stents the future of CAS? Evaluation with OCT and IVUS

Main Line Health®
Well ahead.®

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Wynnewood, PA
USA

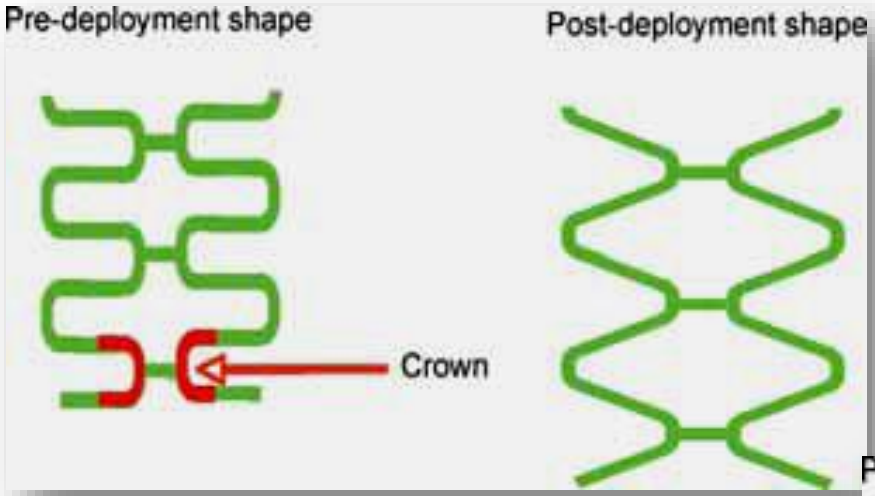
Disclosures

- Consultant to Silk Road Medical, Contego, Abbott Vascular, WL Gore, Medtronic, BSC

What are the possible causes of stroke in CAS?

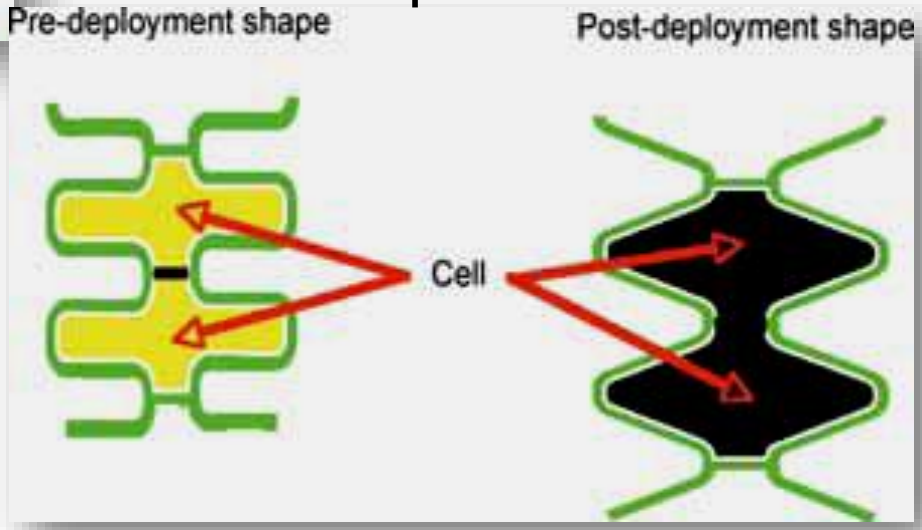
- Operator error
  - Technique (balloon sizing, wire misadventure, EPD error, etc.,)
- Patient factors
  - Vulnerable plaque (lesion, carotid, aorta)
  - Vascular anatomy or characteristics (calcium, thrombus, etc.,)
  - Genetics related to thienopyridine metabolism
- Inadequate technology
  - EPD, stent, procedural pharmacology

Open and closed cell design elements

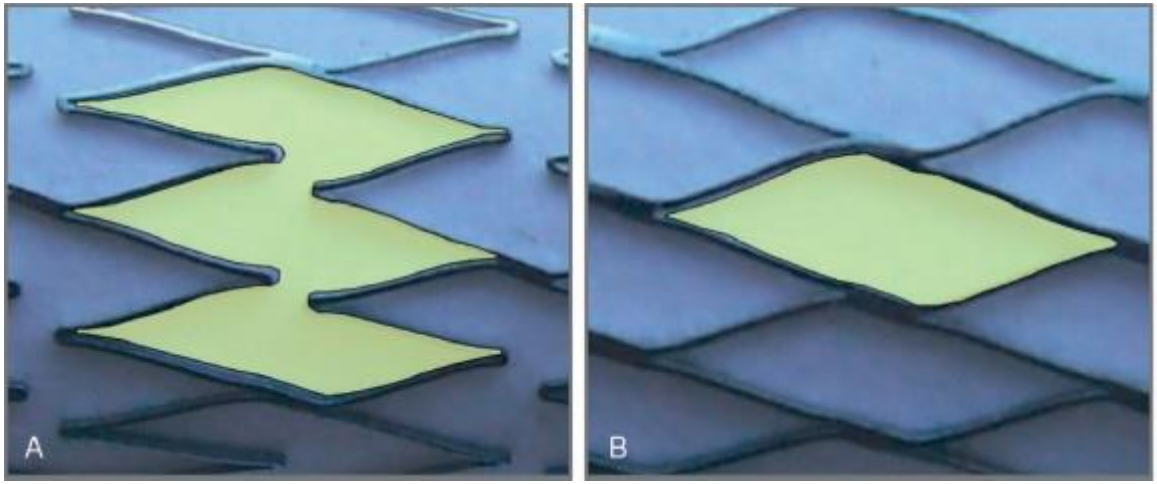


Closed cell

Open cell



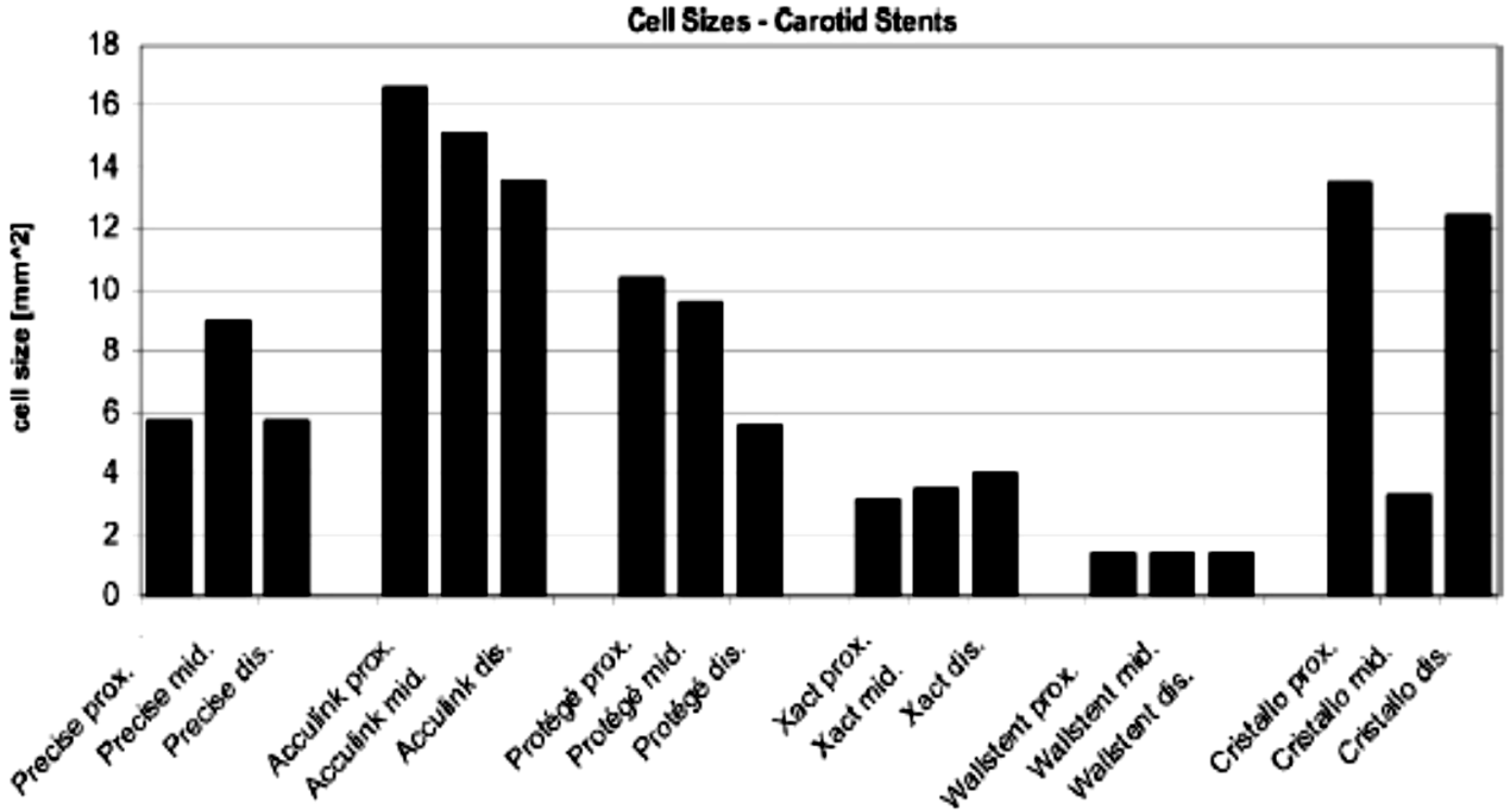
Stent design: open vs. closed cell



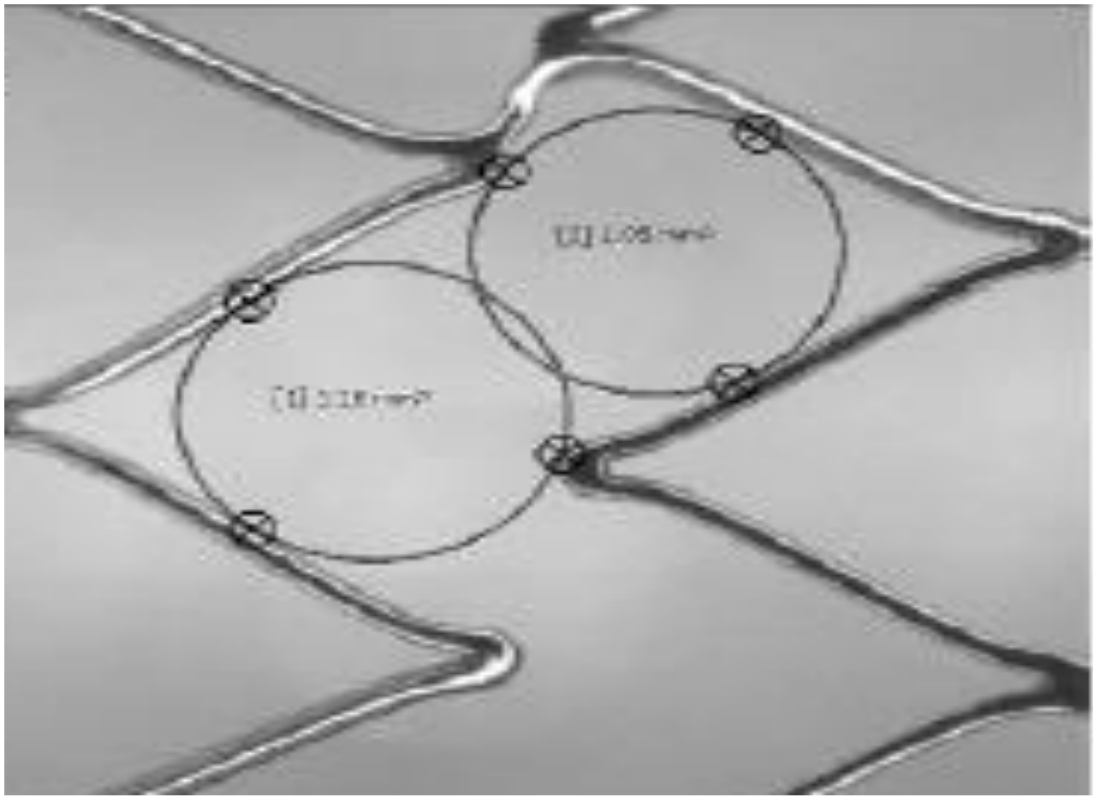
Closed cell stent leading to kinking

Open cell stent conforming to vessel

Differences in cell size by stent

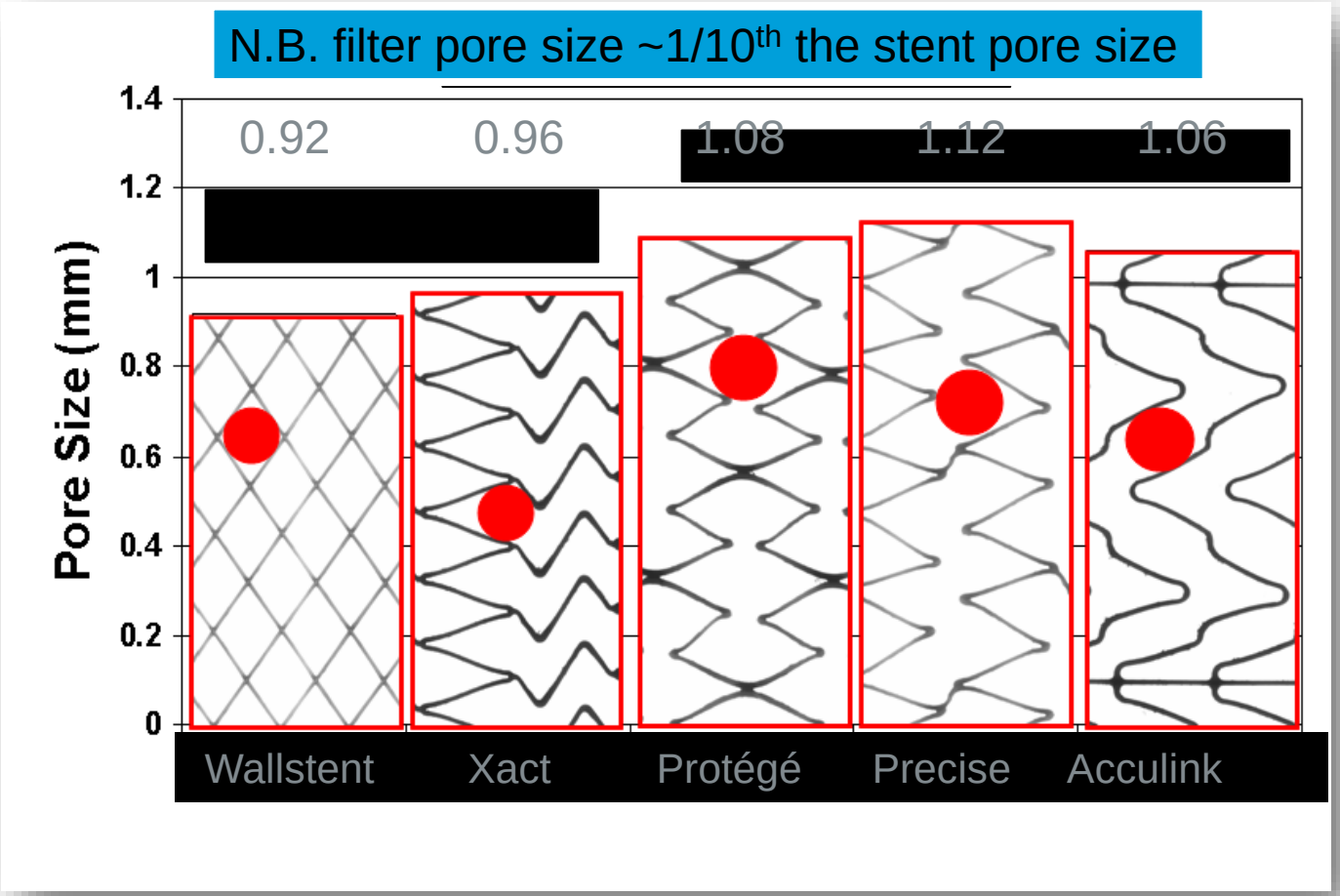


Also need to consider MCUSA



Pore (MCUSA) sizes

No significant difference between OC and CC stents



Xact, PROTÉGÉ RX and Acculink = 8-6mm tapered stents (distal portion)

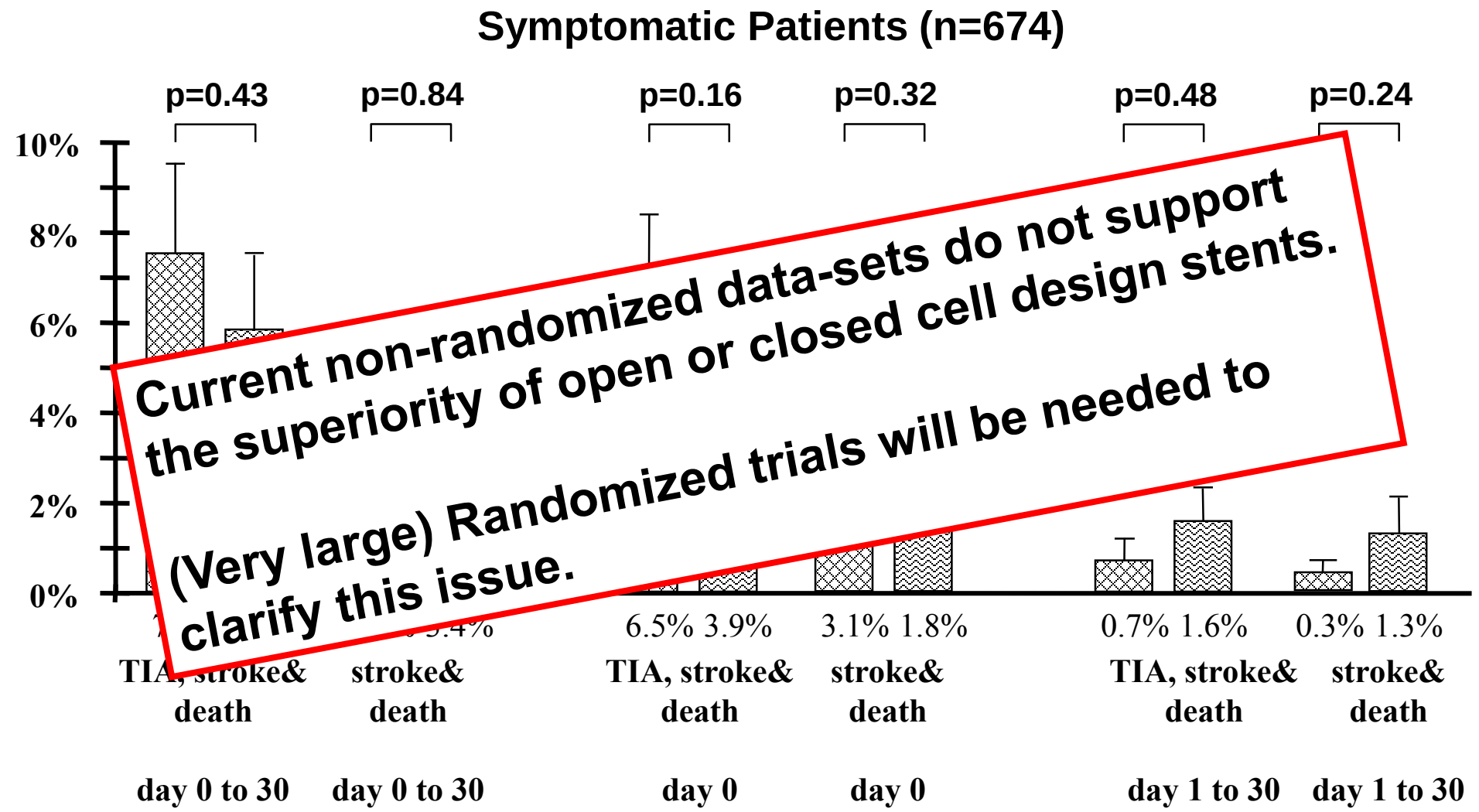
Precise and Wallstent = 8mm straight stent

Clinical event rates vary by free cell area?

	Total population			Symptomatic population			Asymptomatic population		
	Patients	All events	Post-procedural events	Patients	All events	Post-procedural events	Patients	All events	Post-procedural events
Free cell area									
<2,5 mm^2	2107	48	26	882	20	11	1225	28	15
2,5–5 mm^2	135	3	3	52	1	1	83	2	2
5–7,5 mm^2	327	16	11	155	10	8	172	6	3
>7,5 mm^2	610	23	21	228	17	16	382	6	5
Total	3179	90	61	1317	48	36	1862	42	25
Free cell area									
<2,5 mm^2		2.3%	1.2%		2.3%	1.2%		2.3%	1.2%
2,5–5 mm^2		2.2%	2.2%		1.9%	1.9%		2.4%	2.4%
5–7,5 mm^2		4.9%	3.4%		6.5%	5.2%		3.5%	1.7%
>7,5 mm^2		3.8%	3.4%		7.5%	7.0%		1.6%	1.3%
Total	3179	2.83%	1.9%	1317	3.6%	2.73%	1862	2.25%	1.3%

Bosiers M, de Donato G, Deloose K, Verbist J, Peeters P, Castriota F, Cremonesi A, Setacci C. Does free cell area influence the outcome in carotid artery stenting? Eur J Vasc Endovasc Surg. 2007 Feb;33(2):135-41;

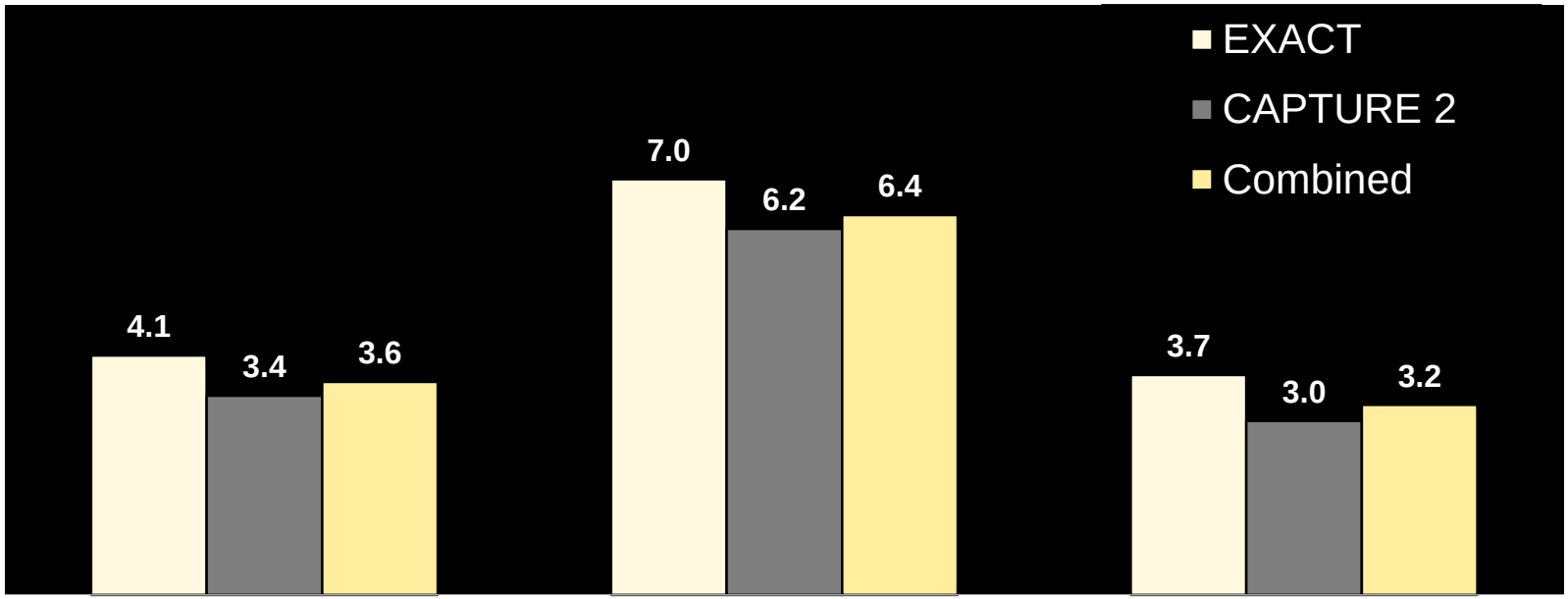
European Registry: no effect of stent type on outcomes



Current non-randomized data-sets do not support the superiority of open or closed cell design stents.

(Very large) Randomized trials will be needed to clarify this issue.

EXACT (CC) and CAPTURE 2 (OC)
No differences in prospective, adjudicated study

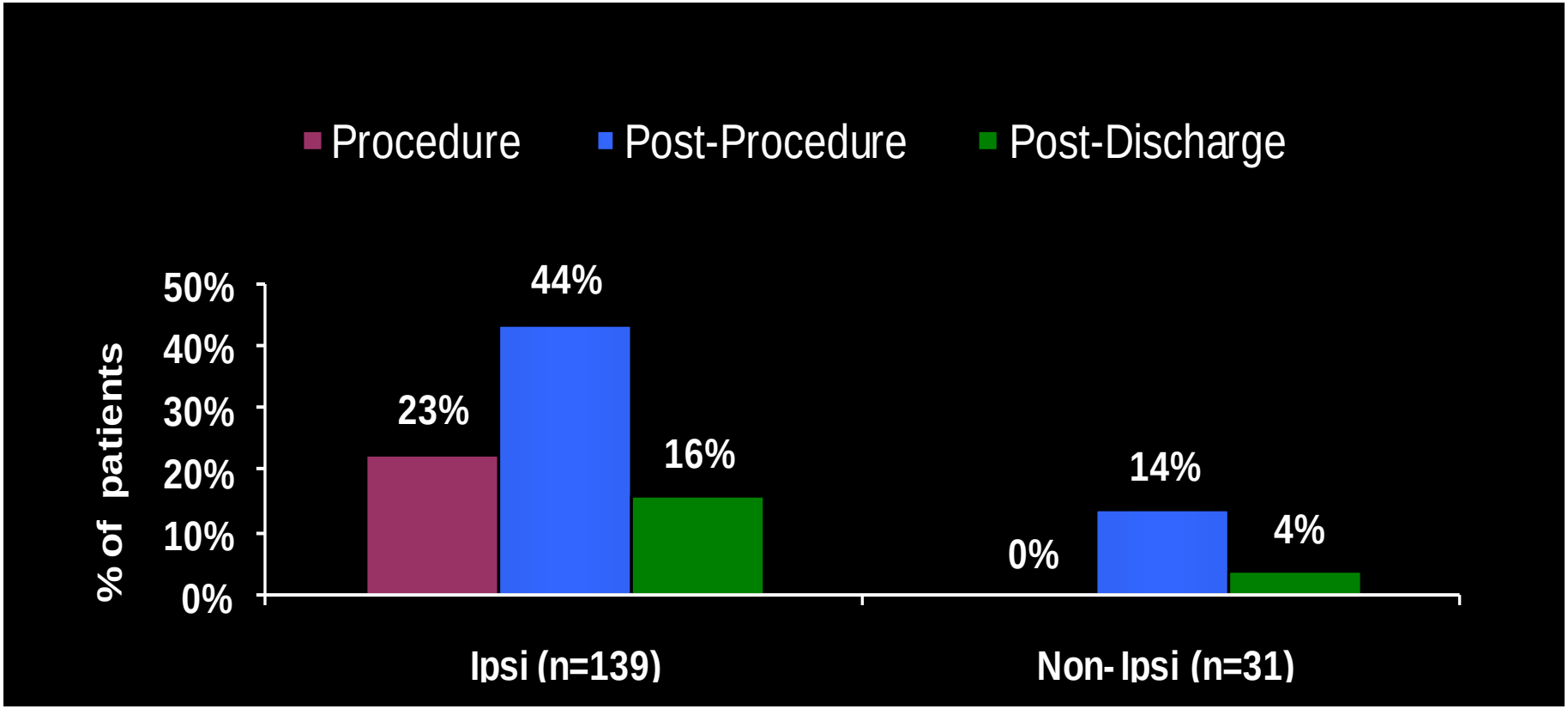


EXACT (N=2145)*
CAPTURE 2 (N=4175)
Combined (N=6320)

EXACT (N=213)
CAPTURE 2 (N=548)
Combined (N=761)

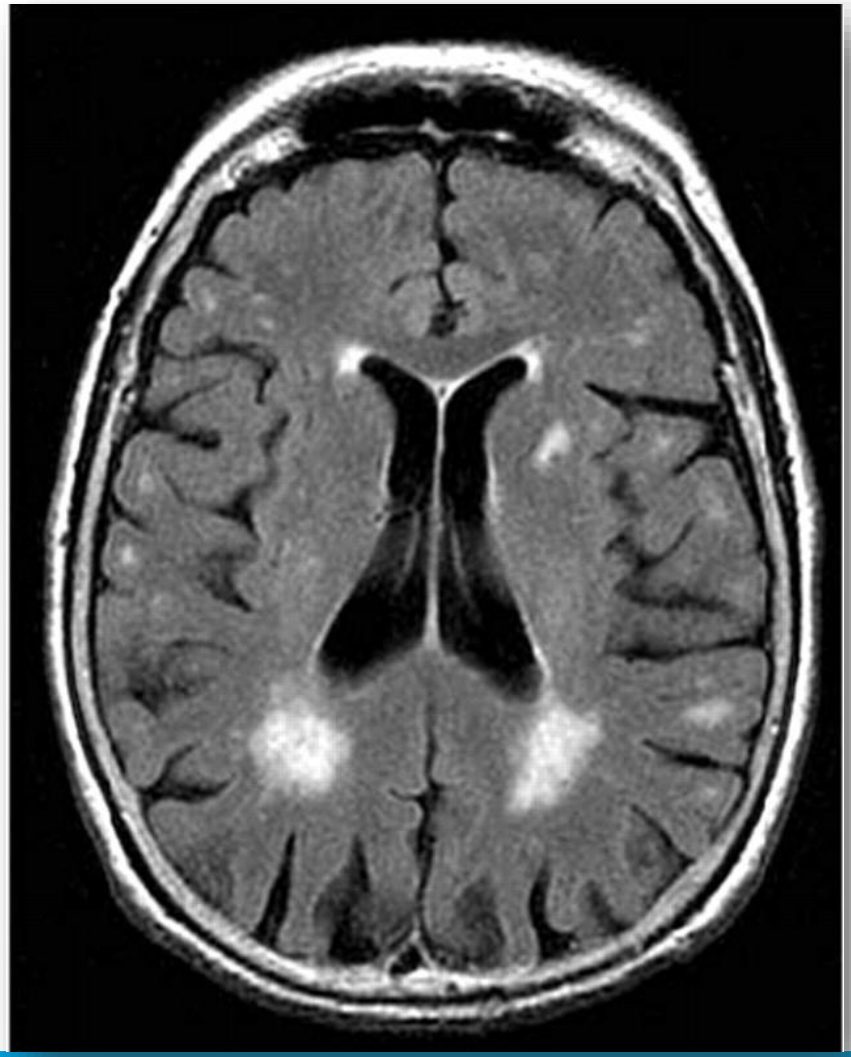
EXACT (N=1931)
CAPTURE 2 (N=3627)
Combined (N=5558)

Stroke timing paradox: Not all strokes appear on the day of the procedure



Fairman R, Gray W, Scicli A et al. Ann Surg 246 (4) Oct 2007

MRI DWI white matter changes post CAS are greater than CEA: numerically but not by volume



Fly-through of a conventional stent

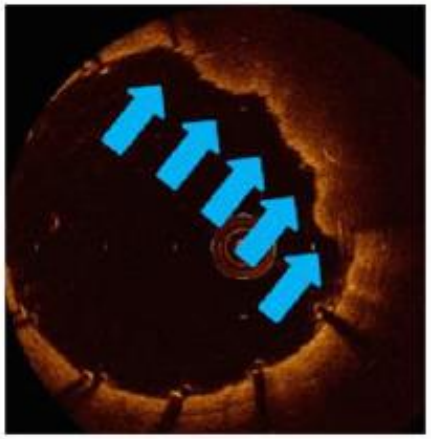
Post-procedural **PLAQUE PROLAPSE** through **conventional stent** struts

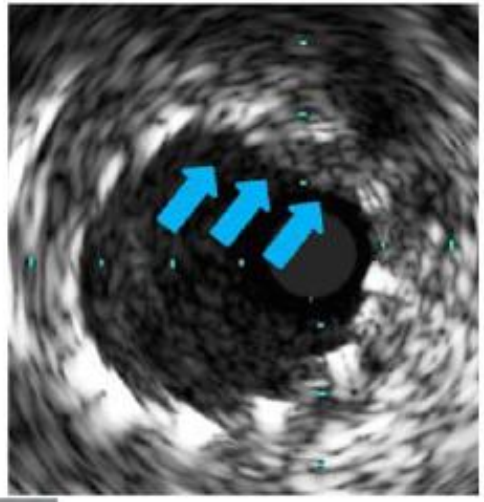
Suzuki M et al.
ESC 2014
Presentation
www.escardio.org

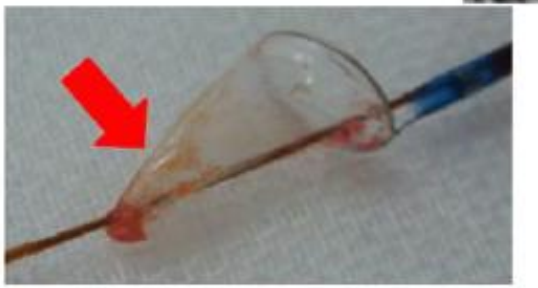
30.7%

1/3 stents = **Precise**
2/3 stents = **Carotid Wallstent**

81 y.o. Female, Symptomatic



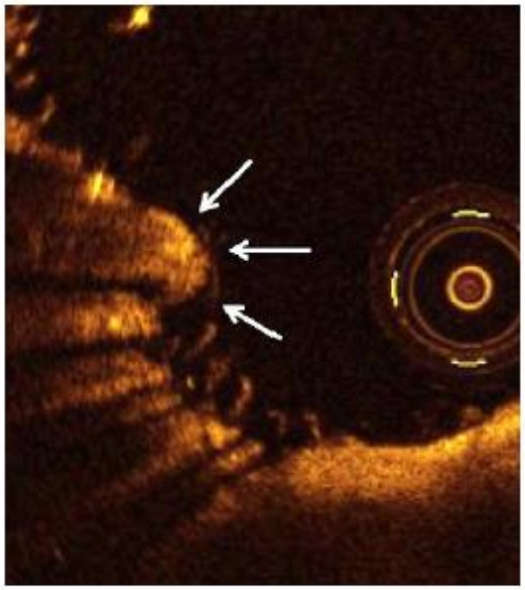




Images: Dr M. Suzuki
ESC 2014
www.escardio.org

Eur Heart J. 2014;35(Abstr Suppl):178

Plaque prolapse on OCT common



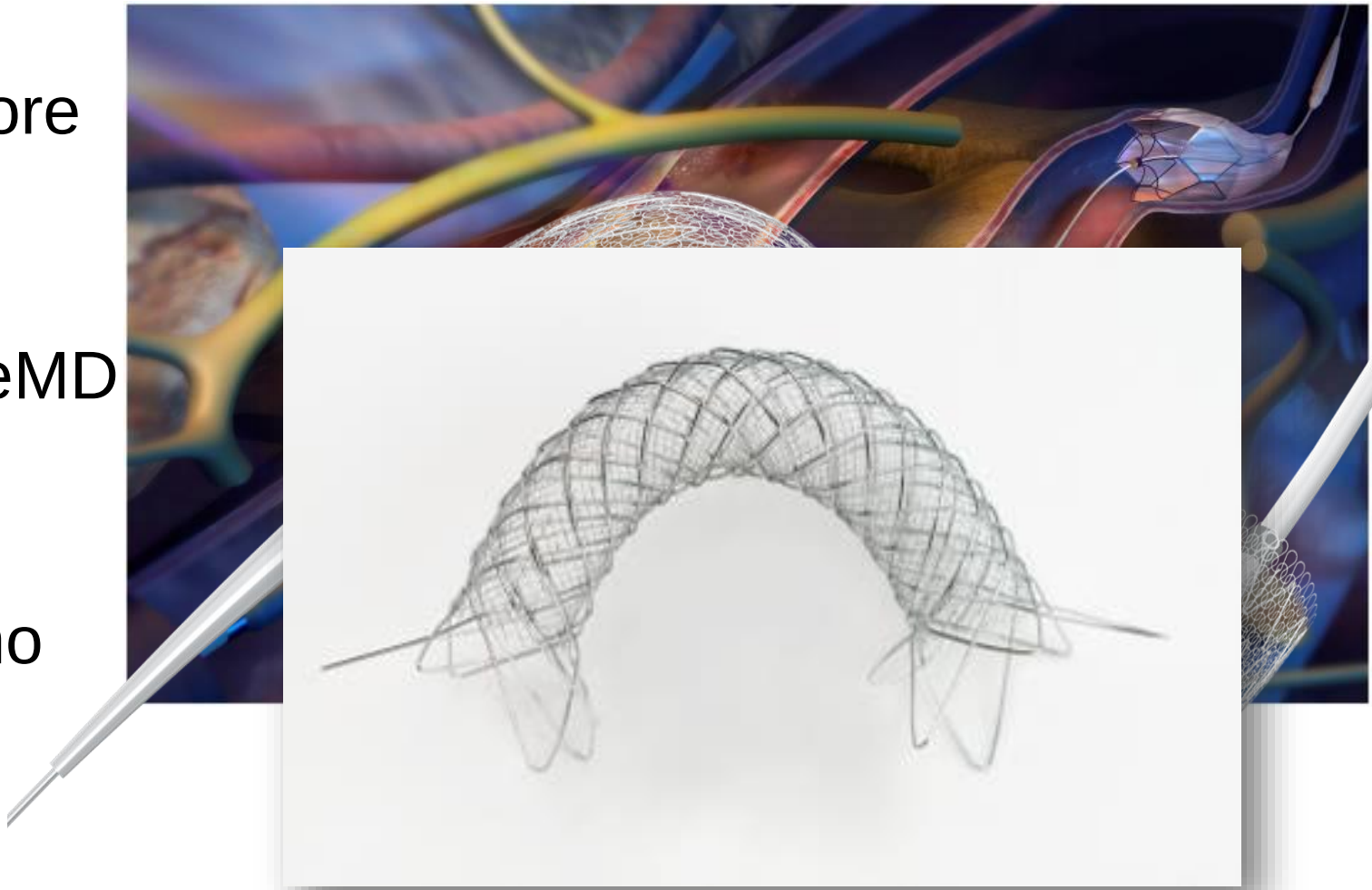
	Closed cell ($n = 17$)	Open cell ($n = 13$)	Hybrid cell ($n = 10$)
Plaque prolapse[b]	17.6%, (3)	61.5%, (8)	30%, (3)

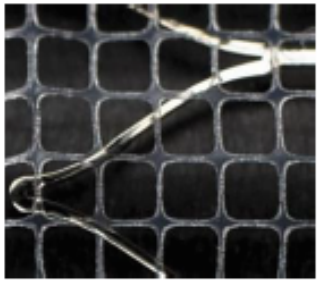
[b] At least 10 appreciable tissue prolapses between the stent struts per patient.

De Donato et al. *Eur J Vasc Endovasc Surg* 2013;45:579-587

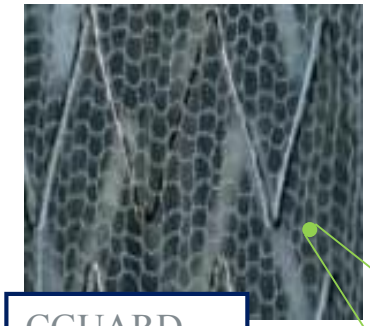
New mesh stent designs

- WL Gore
- InspireMD
- Terumo



			
Name	RoadSaver *aka* Casper	Gore® Carotid Stent	CGuard™ Embolic Prevention Stent
Stent frame	closed-cell Nitinol	open-cell Nitinol	open-cell Nitinol
Mesh position in relation to frame	inside	outside	outside
Mesh material	Nitinol	PTFE	PET
Mesh structure	braided	inter-woven	single-fiber knitted
Pore size	375 µm	500 µm	150 - 180 µm

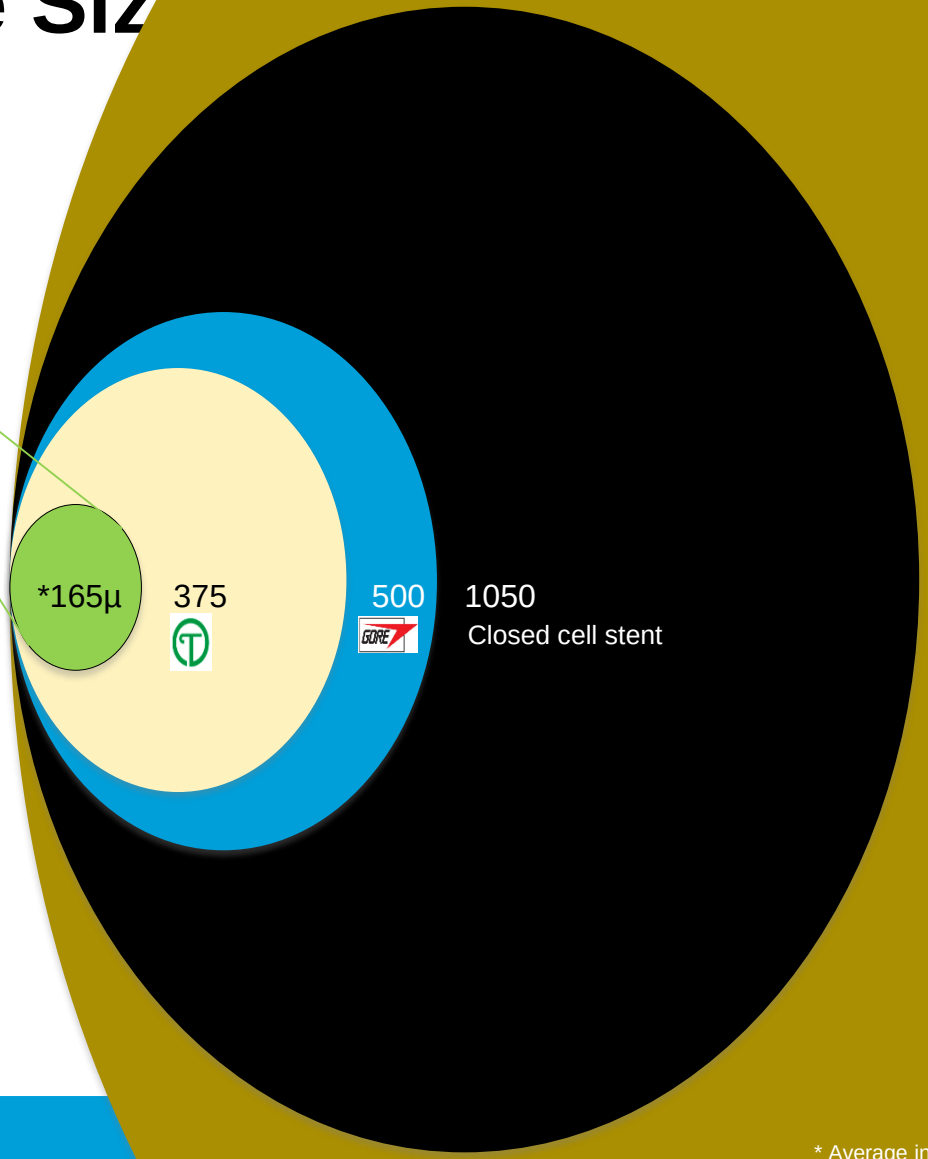
Ideal Pore Siz



CGUARD

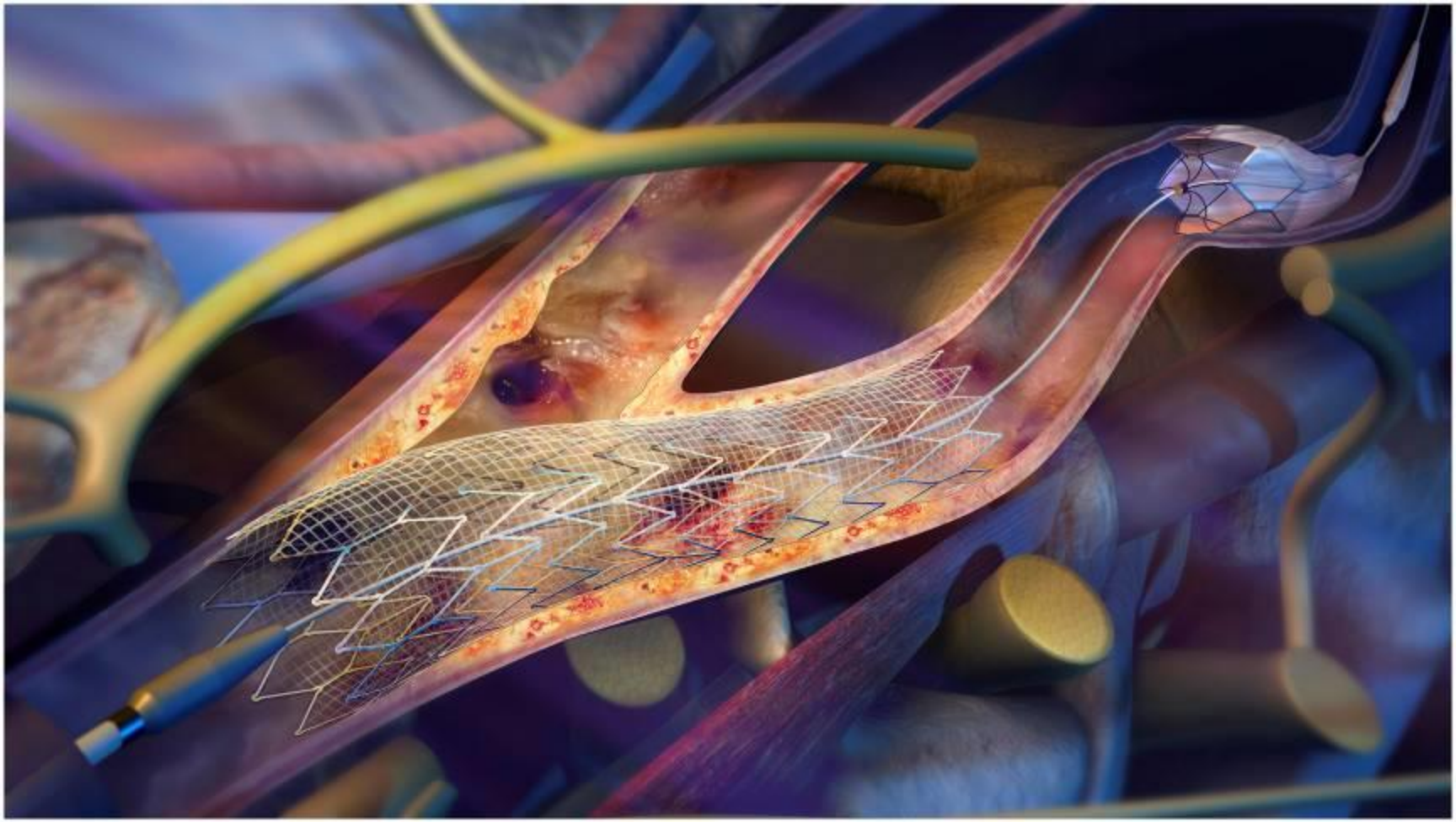
TERUMO

GORE



* Average in lesion at expanded state

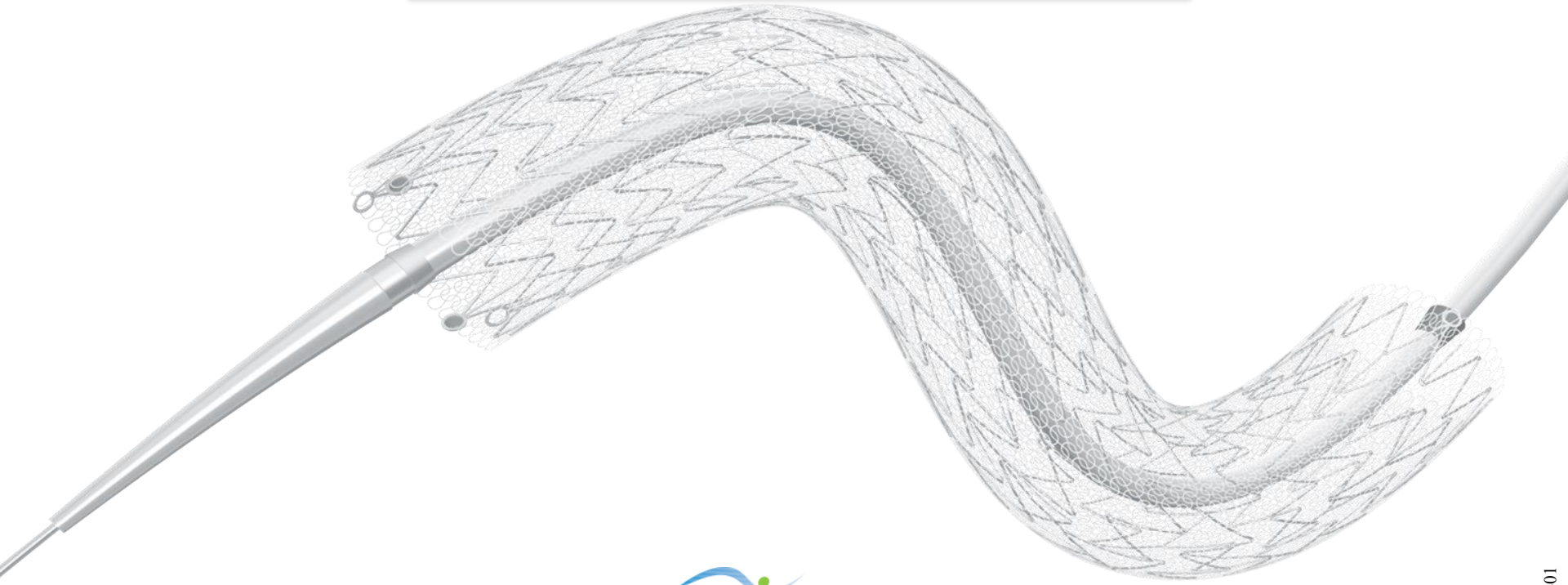
WL Gore SCAFFOLD stent



*CAUTION: Investigational Device. Limited by United States Law to Investigational Use only.

CGUARD™

Carotid Embolic Prevention System



InspireMD

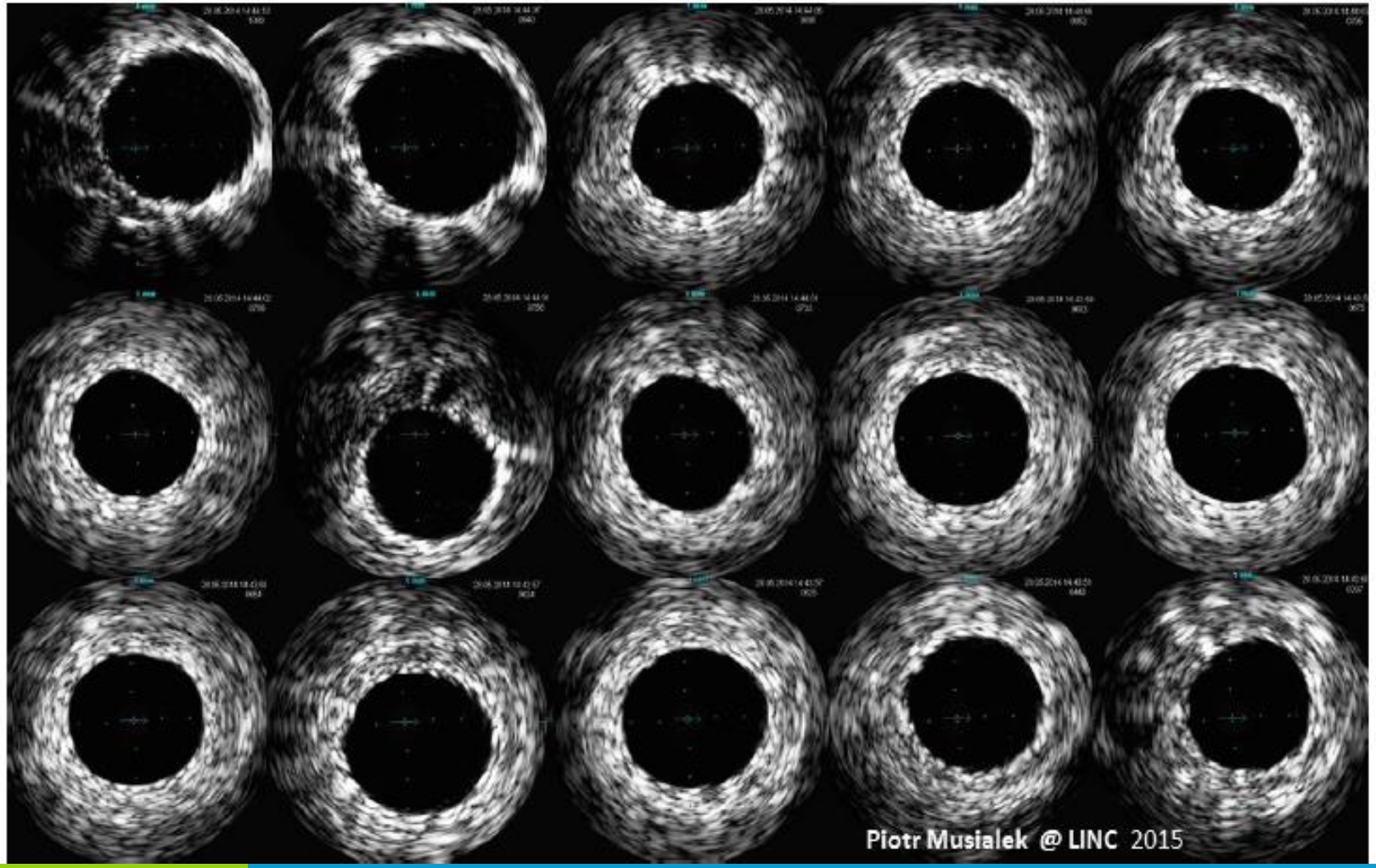
Lankenau Heart Institute
Main Line Health

CE Approved | Not available for sale in the USA

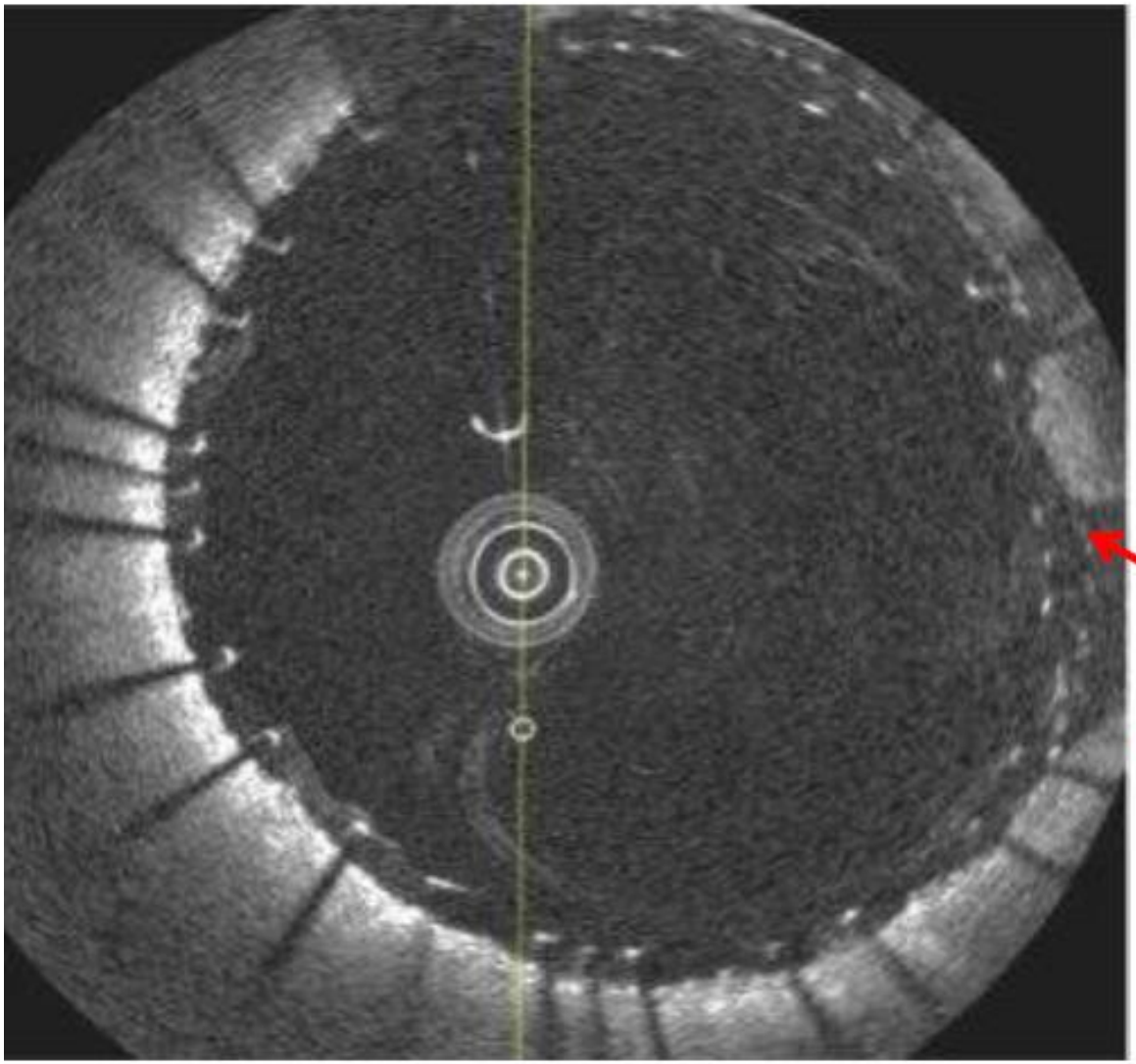
MAL-017-14-01

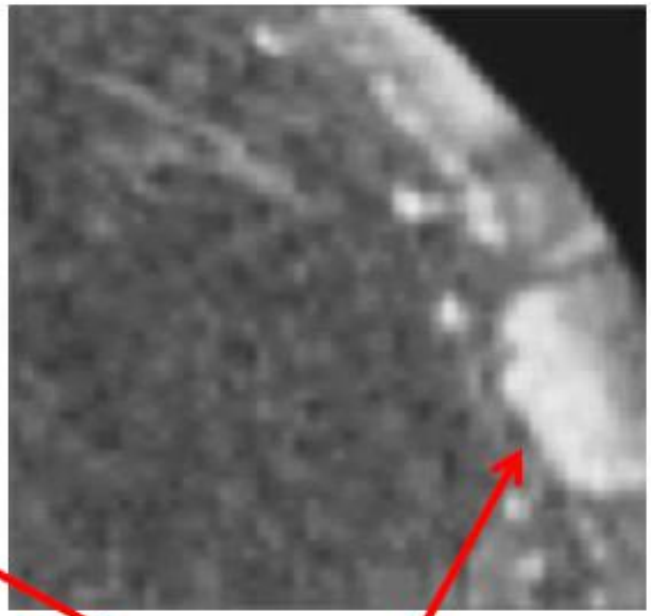
Initial series of CGuard™ IVUS studies indicates...

- Excellent stent expansion and apposition √
- ZERO tissue protrusion though mesh-and-struts √



CGuard™ EPS



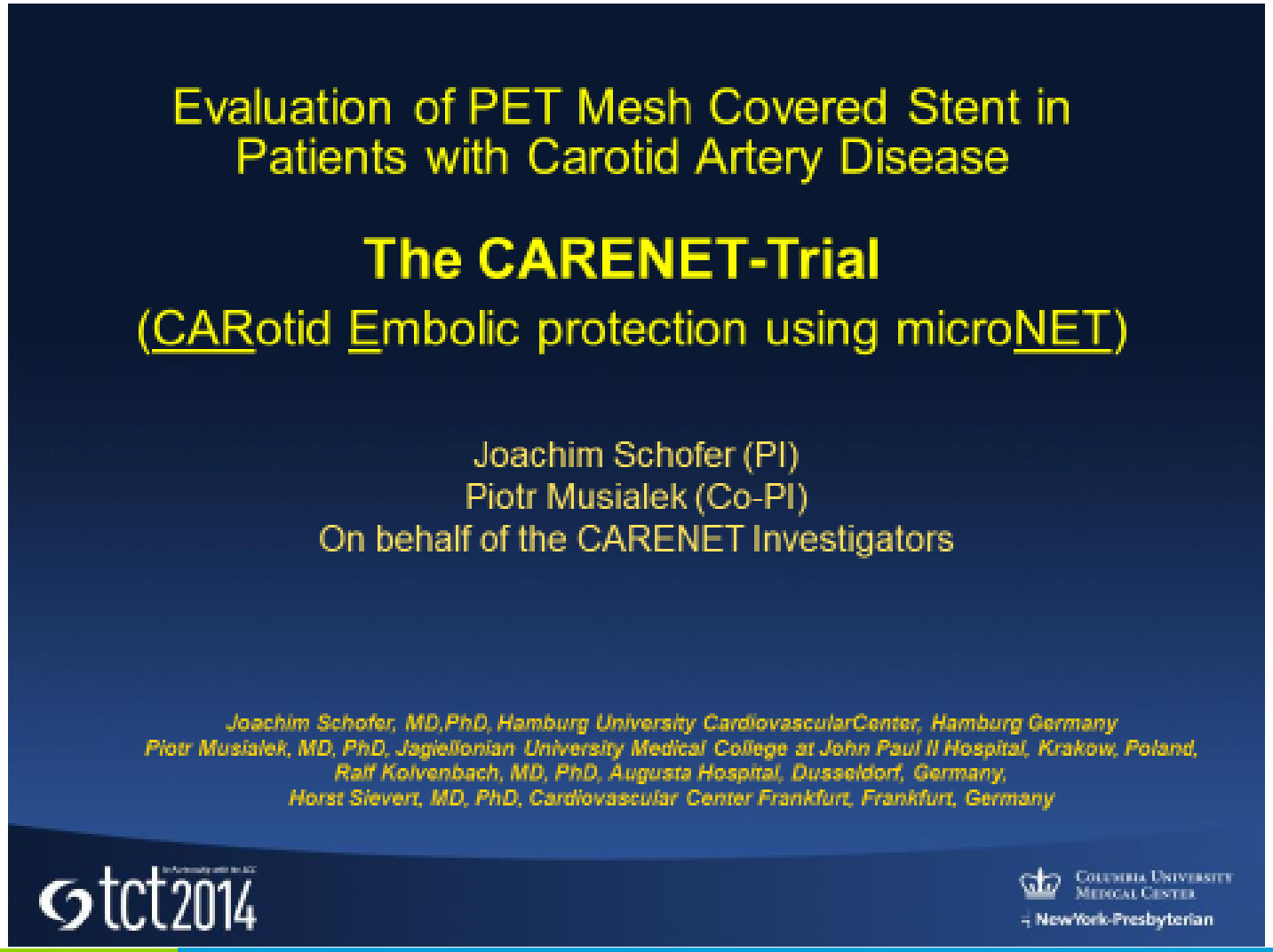


Thrombotic material

TRAPPED

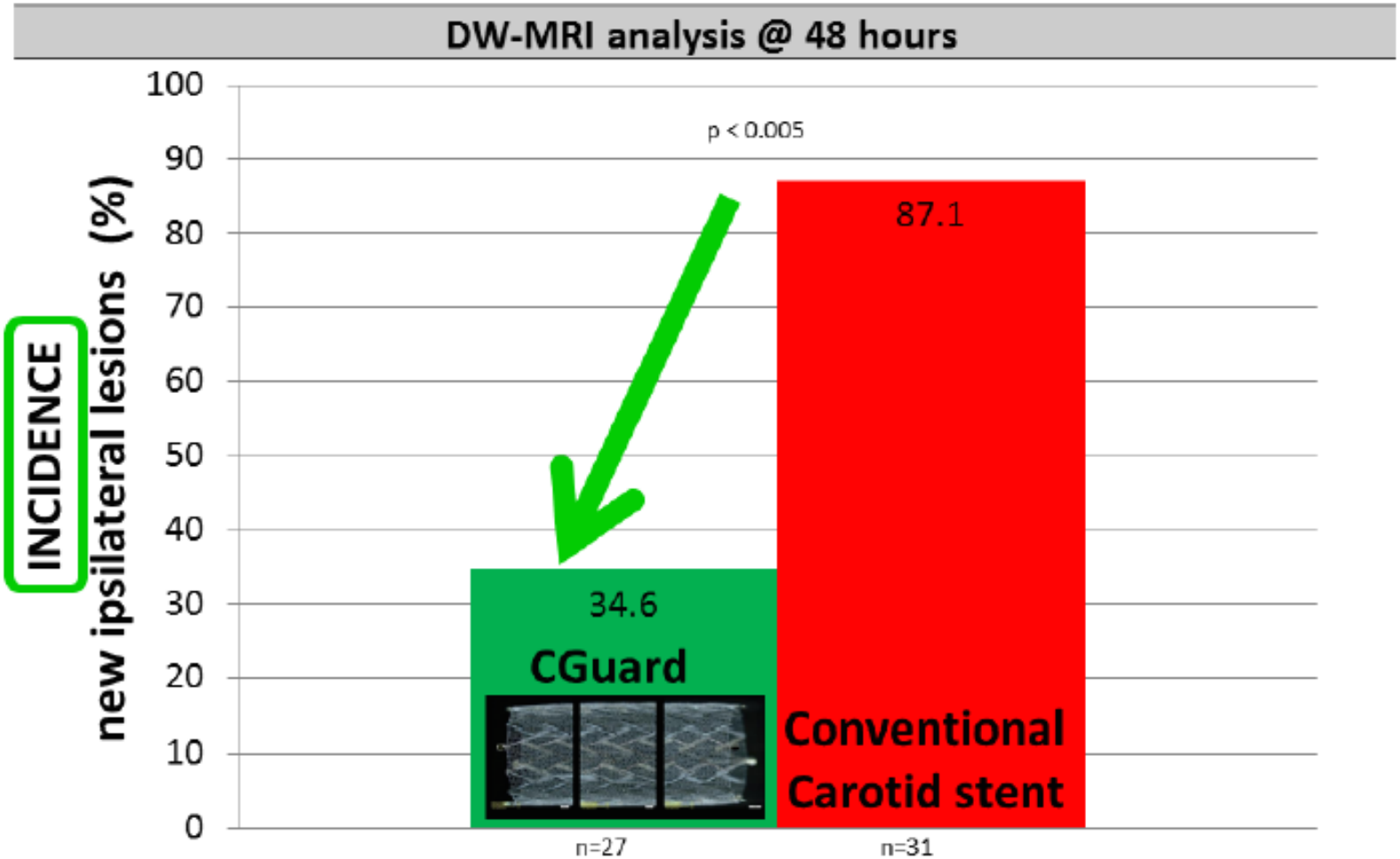
between the stent
MicroNET
and the vessel wall

CARENET I


Evaluation of PET Mesh Covered Stent in Patients with Carotid Artery Disease
The CARENET-Trial
(CARotid Embolic protection using microNET)
Joachim Schofer (PI)
Piotr Musialek (Co-PI)
On behalf of the CARENET Investigators
Joachim Schofer, MD,PhD, Hamburg University CardiovascularCenter, Hamburg Germany
Piotr Musialek, MD, PhD, Jagiellonian University Medical College at John Paul II Hospital, Krakow, Poland,
Ralf Kolvenbach, MD, PhD, Augusta Hospital, Dusseldorf, Germany,
Horst Sievert, MD, PhD, Cardiovascular Center Frankfurt, Frankfurt, Germany
tct2014
Columbia University Medical Center
NewYork-Presbyterian

Filter-protected CAS procedures

CARENET vs PROFI: DW-MRI analysis

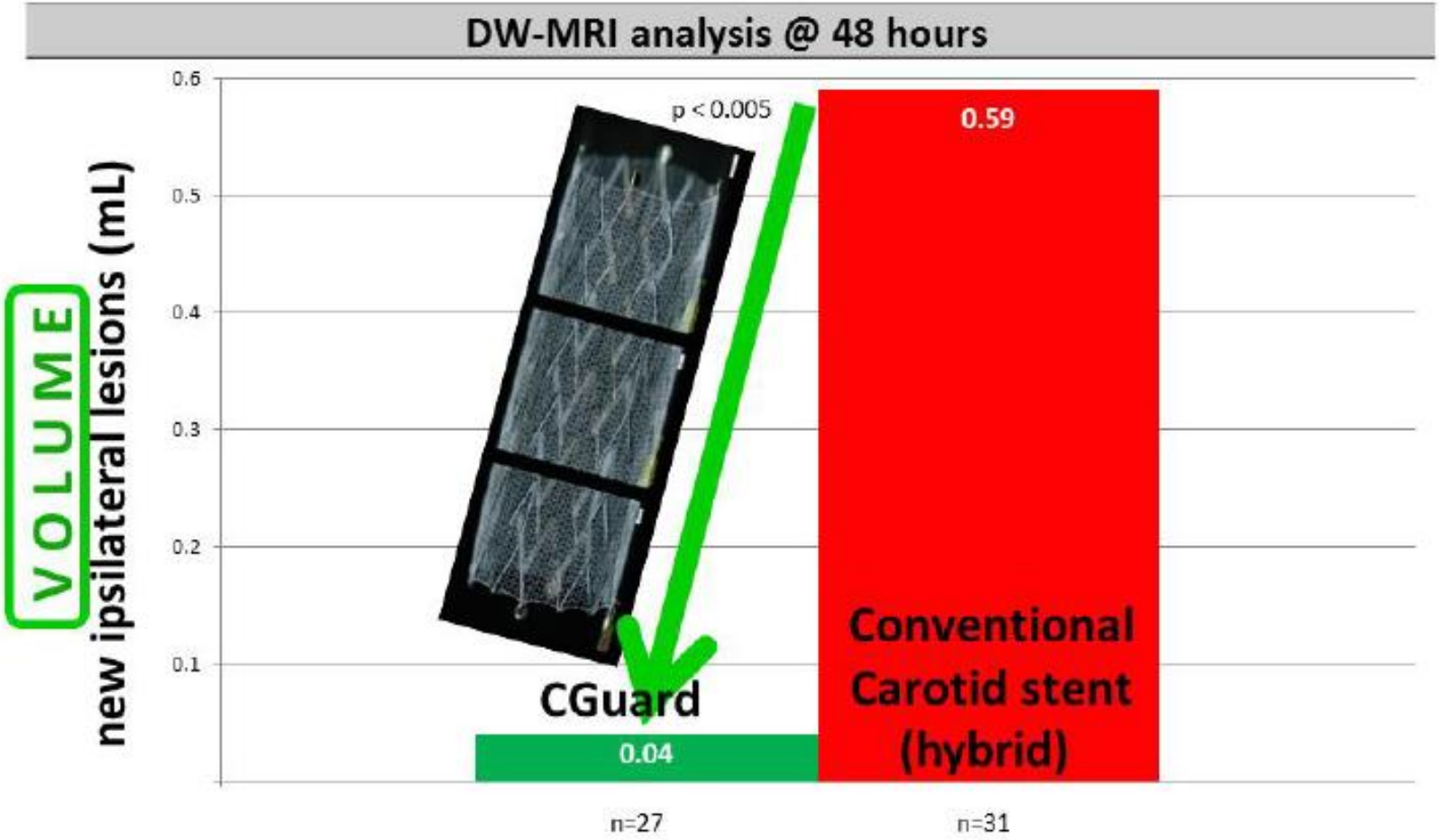


ee patient fluxogram
uklic et al. *JACC*, 2012;59

J. Schofer, P. Musialek et al. ***JACC** Intv* 2015;8:1229-34
Bijuklic et al. (manuscript in preparation)

Filter-protected CAS procedures

CARENET vs PROFI: DW-MRI analysis

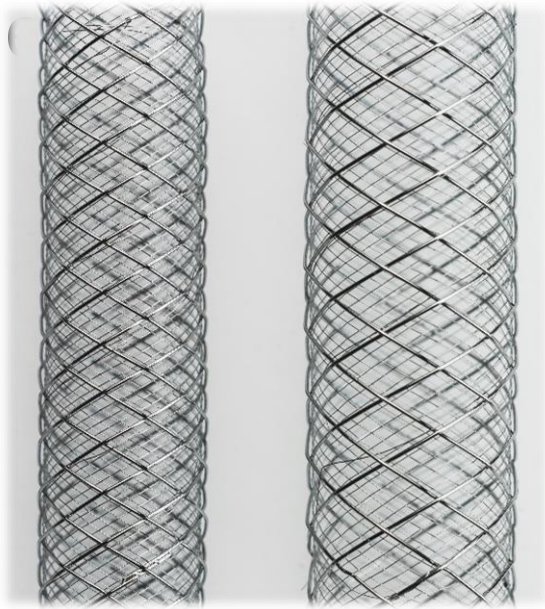


see patient fluxogram
ijuklic et al. *JACC*, 2012;59

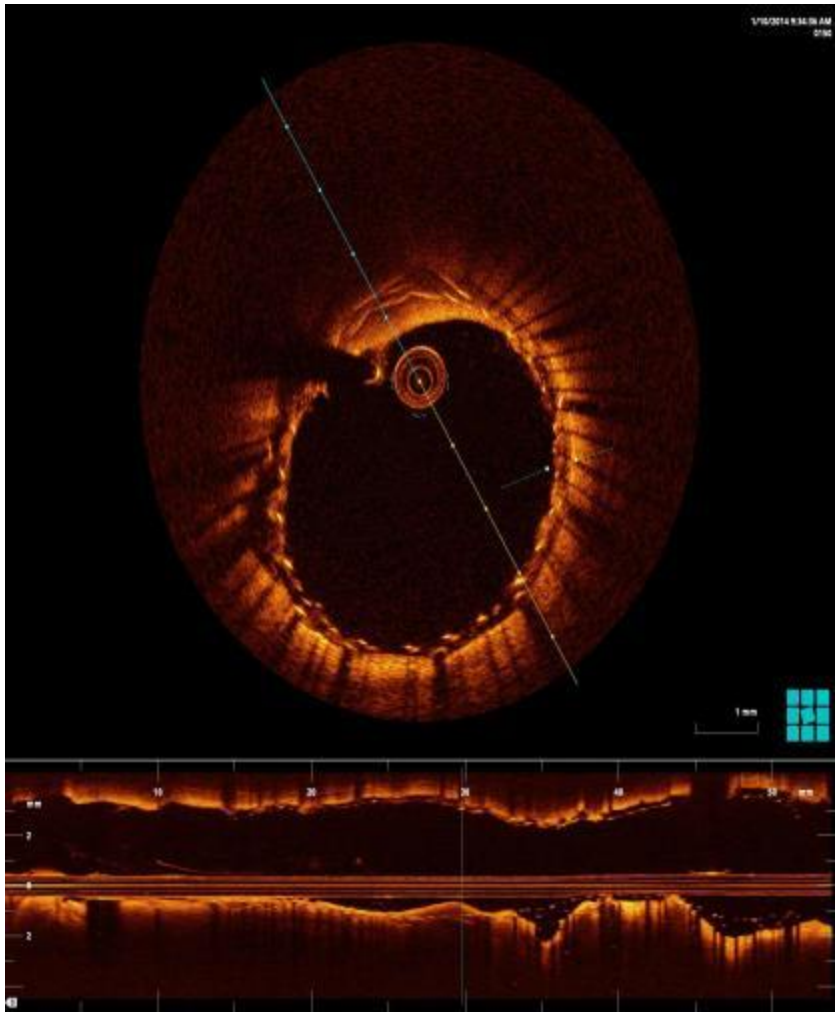
J. Schofer, P. Musialek et al. ***JACC** Intv* 2015;8:1229-34
Bijuklic et al. (manuscript in preparation)

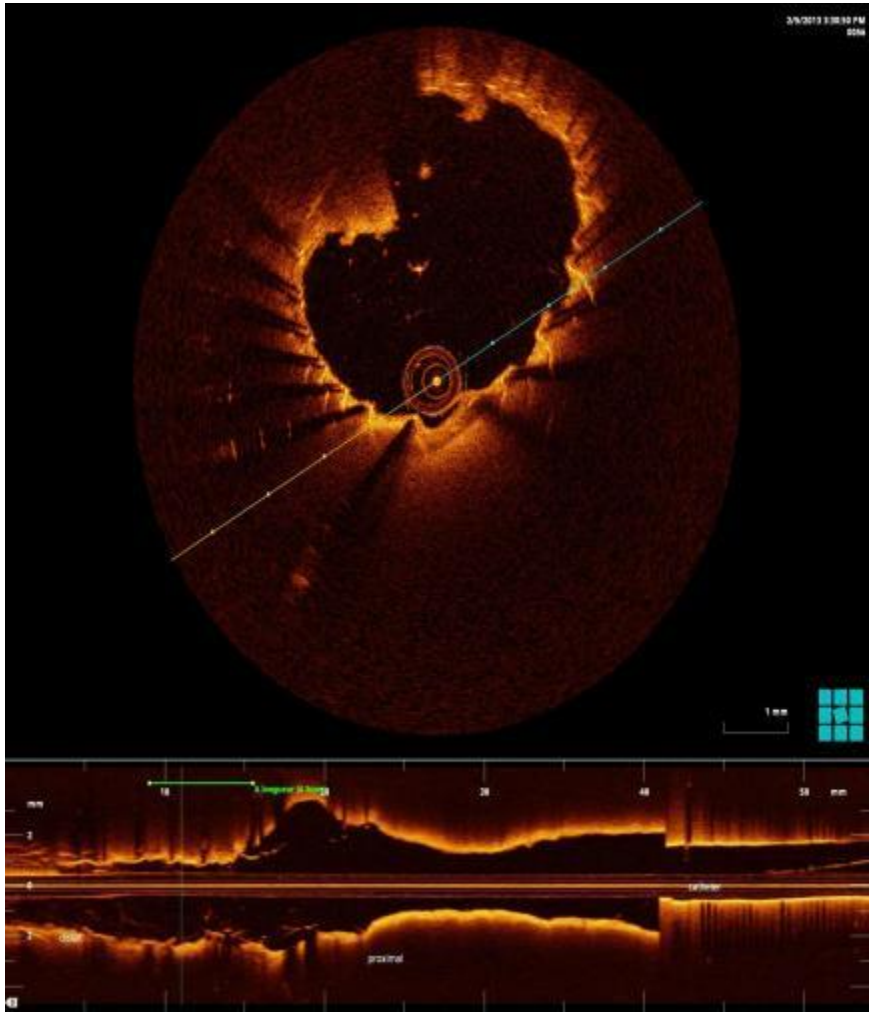
TERUMO: A Novel CAS Design

- Closed cell structure with flexible Nitinol weave
- Dual layer micromesh design for sustained embolic prevention
- Retrievable and repositionable



CASPER/Roadsaver vs. Other Closed Cell CAS OCT





Furnished by Dr. M Amor, Polyclinique Louis Pasteur, Nancy, France

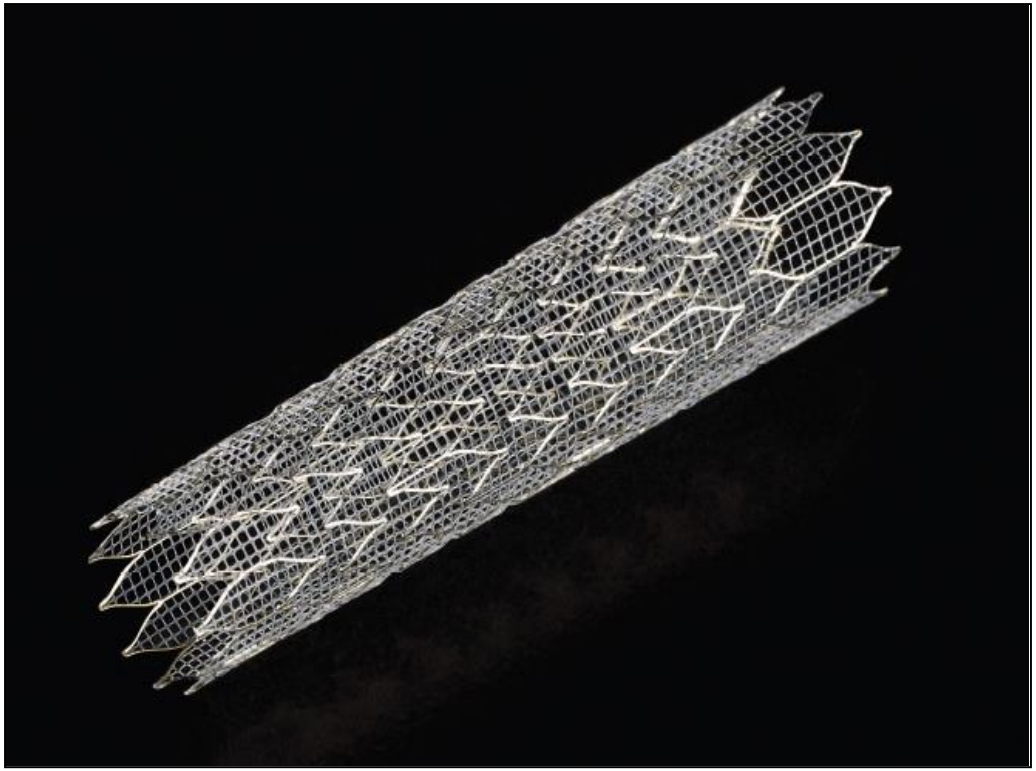
Regulatory status of CASPER

- FDA IDE is in preparation for US investigation
- Initiation planned 2016

Summary

- Mesh-covered carotid stents likely to add benefit in terms of reducing not only clinical events but also surrogate DWI lesions
- As the stent becomes the “protector” and not the “provocateur”, CAS outcomes—already good—should improve further

GORE® Carotid Stent



Attributes

- Stent:
  - Open Cell NiTi Frame
  - Closed Cell 500 µ lattice on outside of NiTi Frame
  - Permanently Bound CBAS Heparin on all device surfaces

*CAUTION: Investigational Device. Limited by United States Law to Investigational Use only.

GORE® Carotid Stent Clinical Study for the treatment of carotid Artery stenosis in patients at increased risk For adverse events From carOtid enDarterectomy

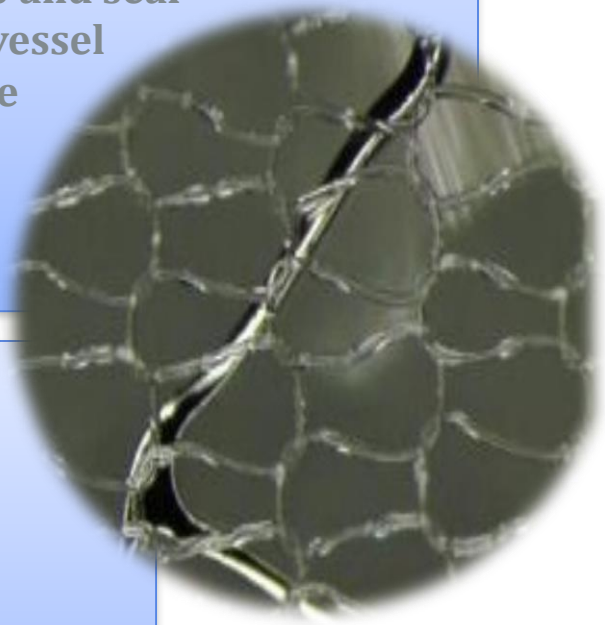
The Gore SCAFFOLD Clinical Study

*CAUTION: Investigational Device. Limited by United States Law to Investigational Use only.

Inspire MD CGuard MicroNet™ Technology

InspireMD's Core Technology

The MicroNet™ is a bio-stable mesh woven from a single strand of 20µm Polyethylene Terephthalate (PET). The MicroNet™ is designed to trap and seal thrombus and plaque against the vessel wall, preventing embolization. The MicroNet™ is sutured to both the distal and proximal crowns of the stent platform.



Advantages of technology:

- Flexible structure
- Does not promote thrombosis
- Minimal foreign body reaction
- Does not alter procedure
- Optimal pore size

CARENET DW-MRI analysis*

DW-MRI analysis @ 48 hours			
	CARENET (n=27)	**PROFI (all)** (n=62)	**ICSS†** (n=56)
Incidence of new ipsilateral lesions	37.0%	66.2%	68.0%
Average lesion volume (cm^3)	**0.039**	**0.375**	-
Maximum lesion volume (cm^3)	0.4[illegible]5		

>10-fold reduction

in cerebral lesion **volume**

see patient fluxogram

***External Core Lab analysis (US)**

Bijuklic et al. *JACC*, 2012; Bonati et. al, *Lancet Neurol* 2010

† bilateral lesions

J. Schofer, P. Musialek et al. ***JACC** Intv* 2015;8:1229-34

CARENET DW-MRI analysis*

DW-MRI analysis @ 48 hours			
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Incidence of new ipsilateral lesions	**37.0%**	**66.2%**	68.0%
Average lesion volume (cm^3)	0.039 ± 0.08	.375	-
Maximum lesion volume (cm^3)	0.445		

≈50% reduction

in new ipsilateral lesion **incidence**

see patient fluxogram

***External Core Lab analysis (US)**

Bijuklic et al. *JACC*, 2012; Bonati et. al, *Lancet Neurol* 2010

† bilateral lesions

J. Schofer, P. Musialek et al. ***JACC** Intv* 2015;8:1229-34

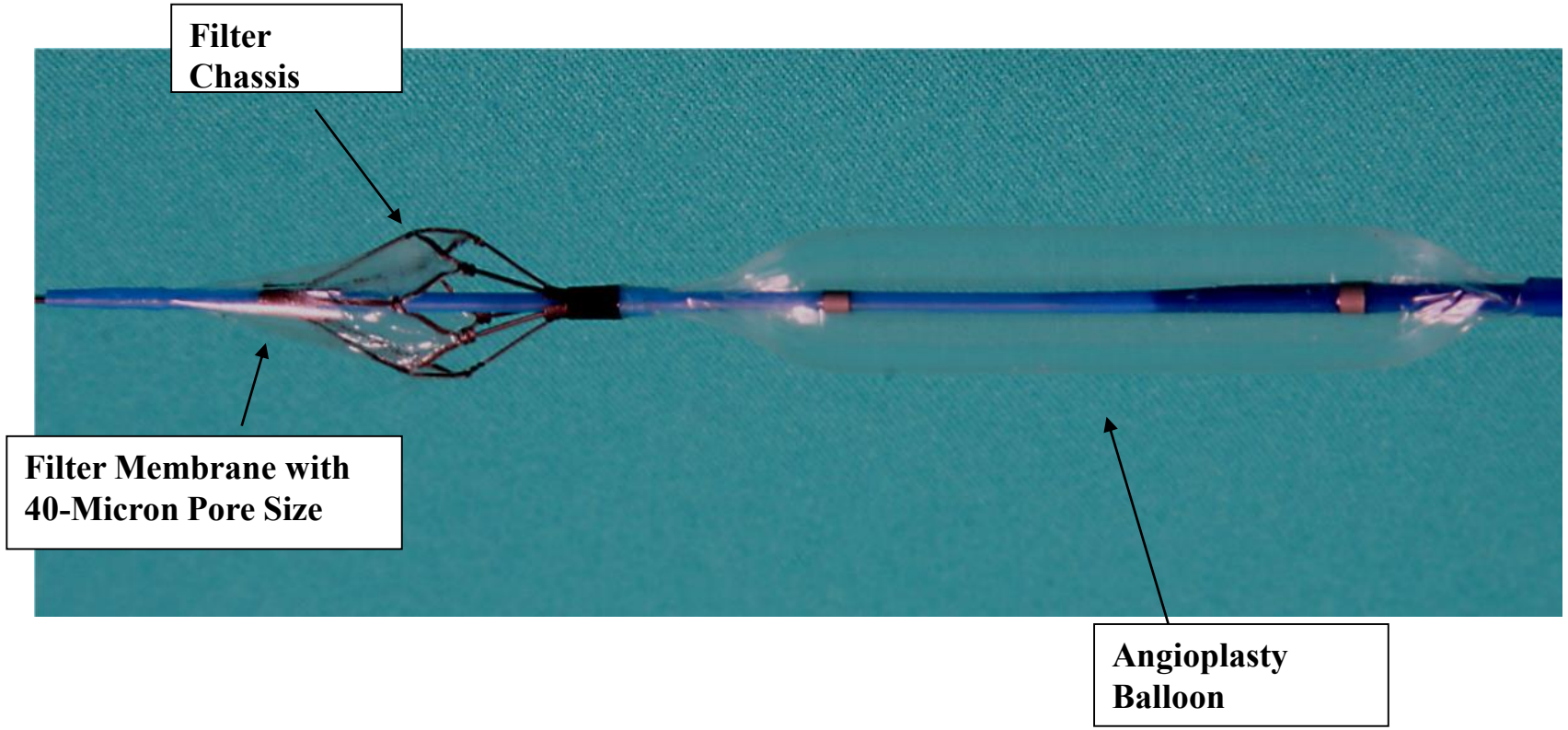
CGuard stent cut new DWI lesions in half c/w historical outcomes

TABLE 3 New Ipsilateral Lesions by DW-MRI Analysis*

	48 H n = 27	30 Days n = 26
Subjects with new AIL	10	1
Incidence of new lesions, %	37.0	4.0
Total number of new AIL	83†	1
Average number of new AIL per patient‡	3.19 ± 10.33	0.04 ± 0.20
Average lesion volume, cm^3	0.039 ± 0.08	0.08 ± 0.00
Maximum lesion volume, cm^3	0.445	0.116
Permanent AIL at 30 days	–	1

PALADIN®

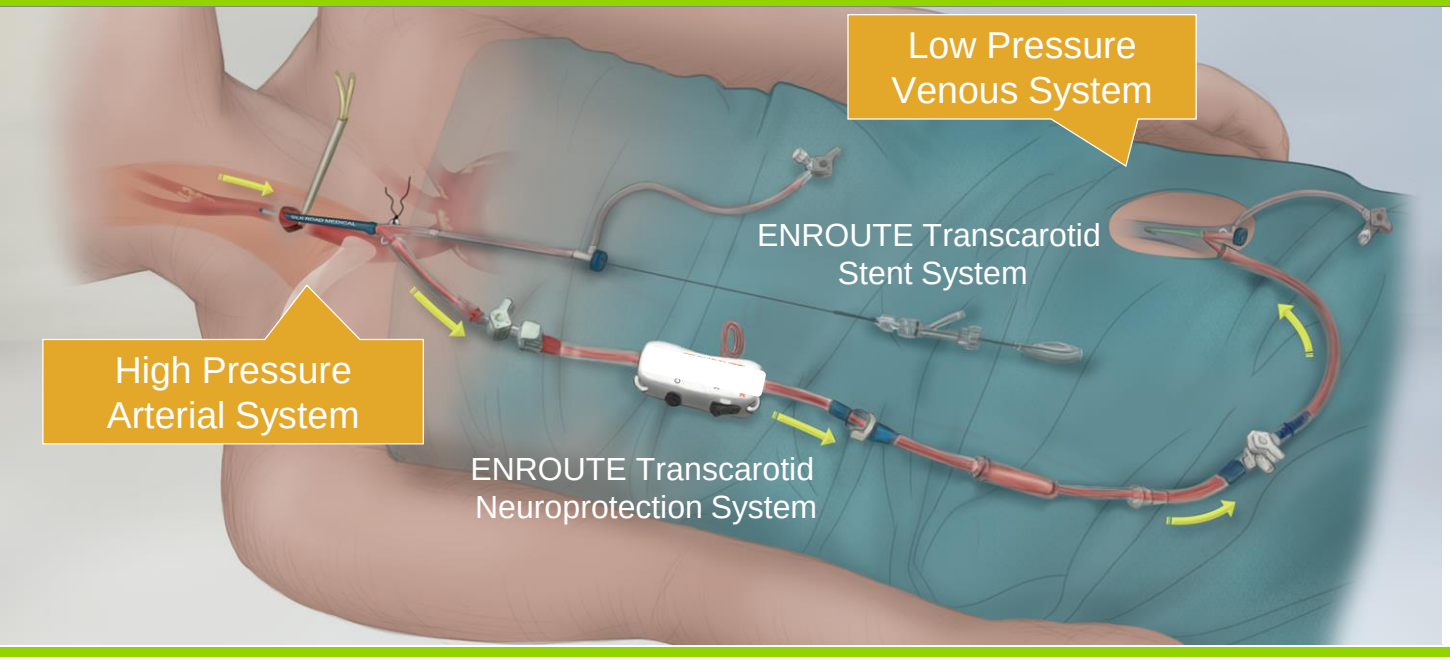
Carotid Post-Dilation Balloon with Integrated Embolic Protection



Pallidin: key features

- Sheathless design
- 40-Micron Pore Size
- 95% capture efficiency with 100 micron particles
- Filter open time of 15-30 seconds ensures minimal risk of thrombin/fibrin deposition
- Ability to adjust size to suit patient anatomy
- Continguous treatment portion and embolic protection portion, with minimal landing zone requirements

Direct Carotid Access with High Rate Flow Reversal: TCAR



- Avoid the arch
- "CEA-like" neuroprotection
- Less manipulation
- Predictable, efficient

Silk Road Medical, Inc.

CAUTION: Investigational device. Limited by federal (USA) law to investigational use. The ENROUTE™ Transcarotid Stent and Neuroprotection Systems bear the CE mark of conformity.

ROADSTER Outcomes
Intention to Treat, Per Protocol

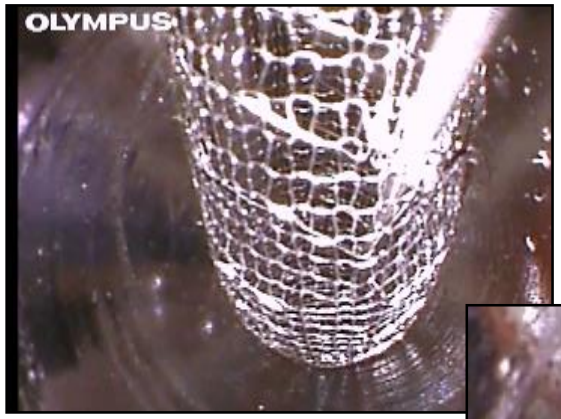
High Surgical Risk	Pivotal Group, ITT (n=141)		Pivotal Group, PP (n=136)	
S/D/MI*	5	3.5%	4	2.9%
Major Stroke	0	0%	0	0%
Minor Stroke	2	1.4%	1	0.7%
Death	2	1.4%	2	1.5%
MI	1	0.7%	1	0.7%
Stroke & Death	4	2.8%	3	2.2%
Cranial Nerve Injury (CNI)	1	0.7%	1	0.7%
CNI Unresolved at 6 Mos	0	0%	0	0%

*Hierarchical

Per Protocol excludes major protocol deviations

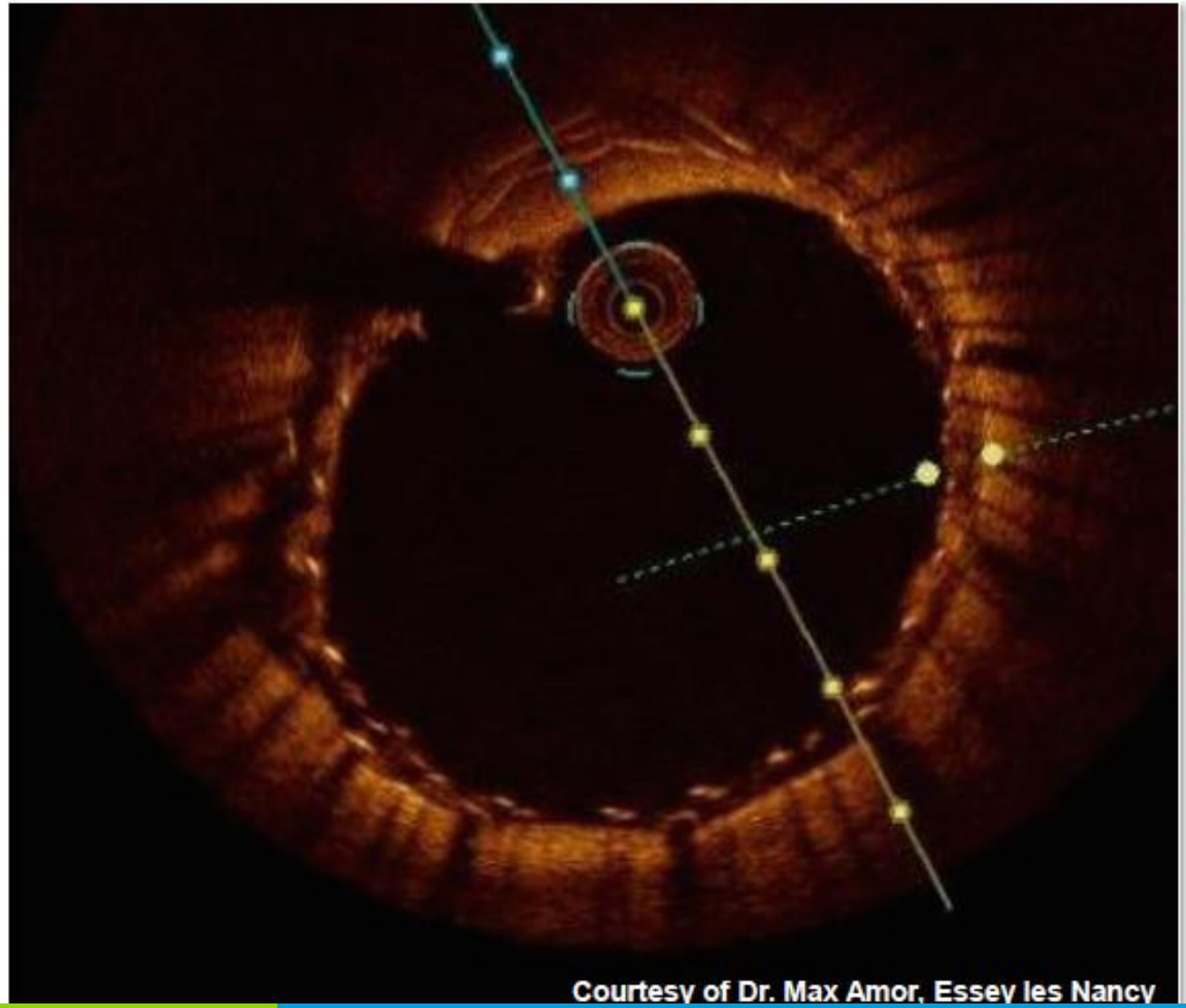
All FDA-approved carotid stent systems were used per site preference (Acculink, Xact, Precise, Protégé, Wallstent)

Unique Benefit of CGuard



Ability to dilate MicroNet with balloon to optimize blood flow into carotid side branches without any net rupture

RoadSaver



Courtesy of Dr. Max Amor, Essey les Nancy