Which Station Will be Better?

Proximal Protection vs. Distal Protection

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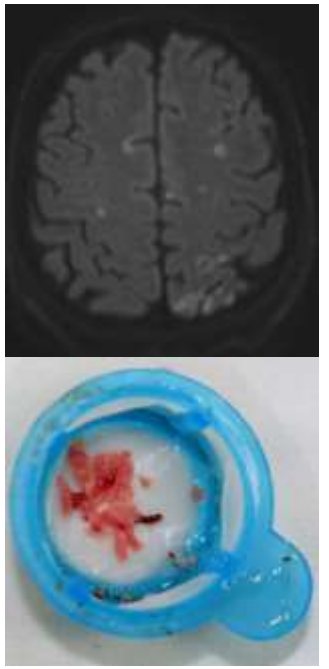
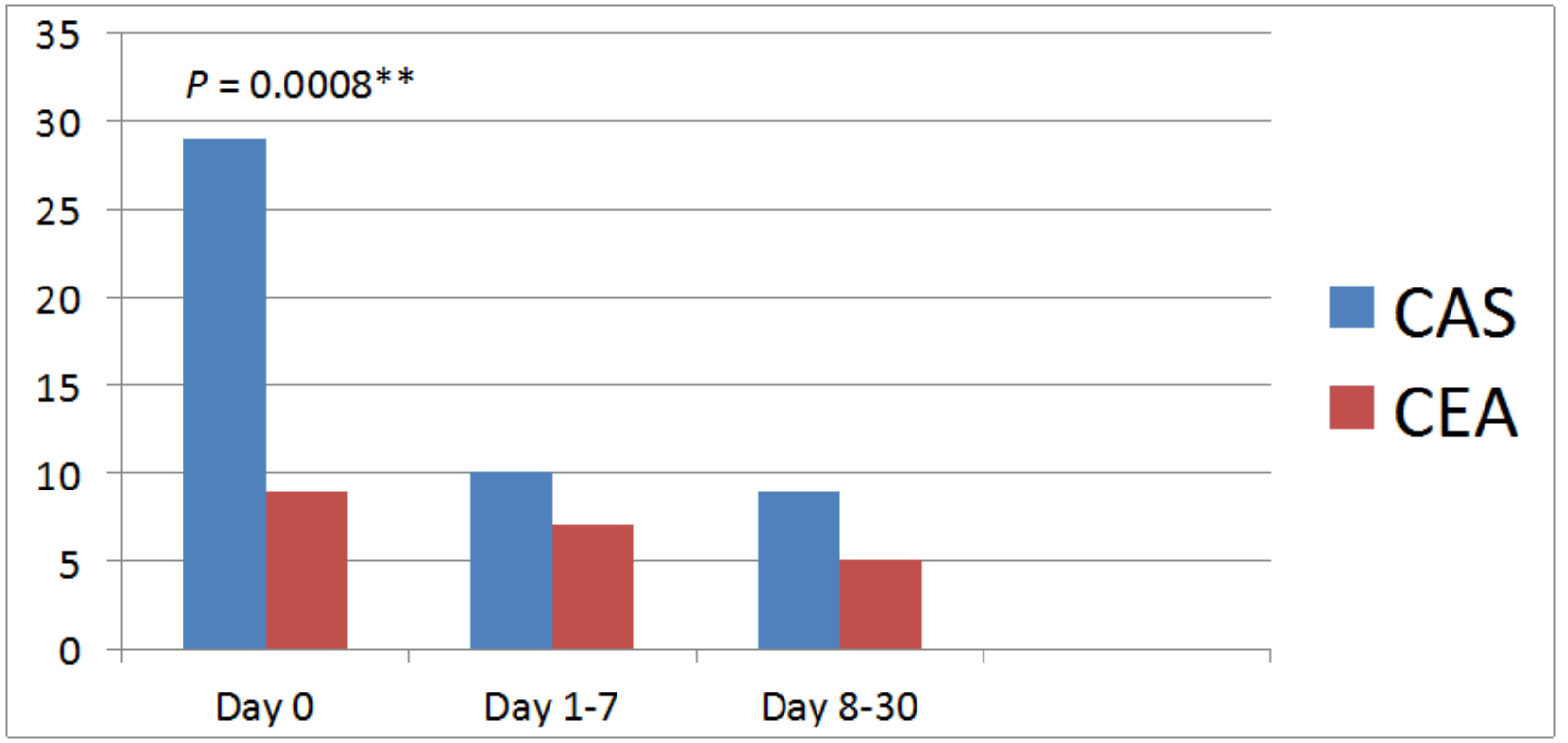
Risk of CAS (carotid artery stenting)

- The greatest risk associated with CAS is peri-procedural stroke or asymptomatic brain infarction due to distal embolization.



- What is the etiology?
- Does use of embolic protection help?
- Does the type of embolic protection matter?
- Does the type of stent used matter ?

Timing of Minor Stroke after CAS



Circulation 2012;126:3054–3061

Should we use embolic protection device (EPD)?

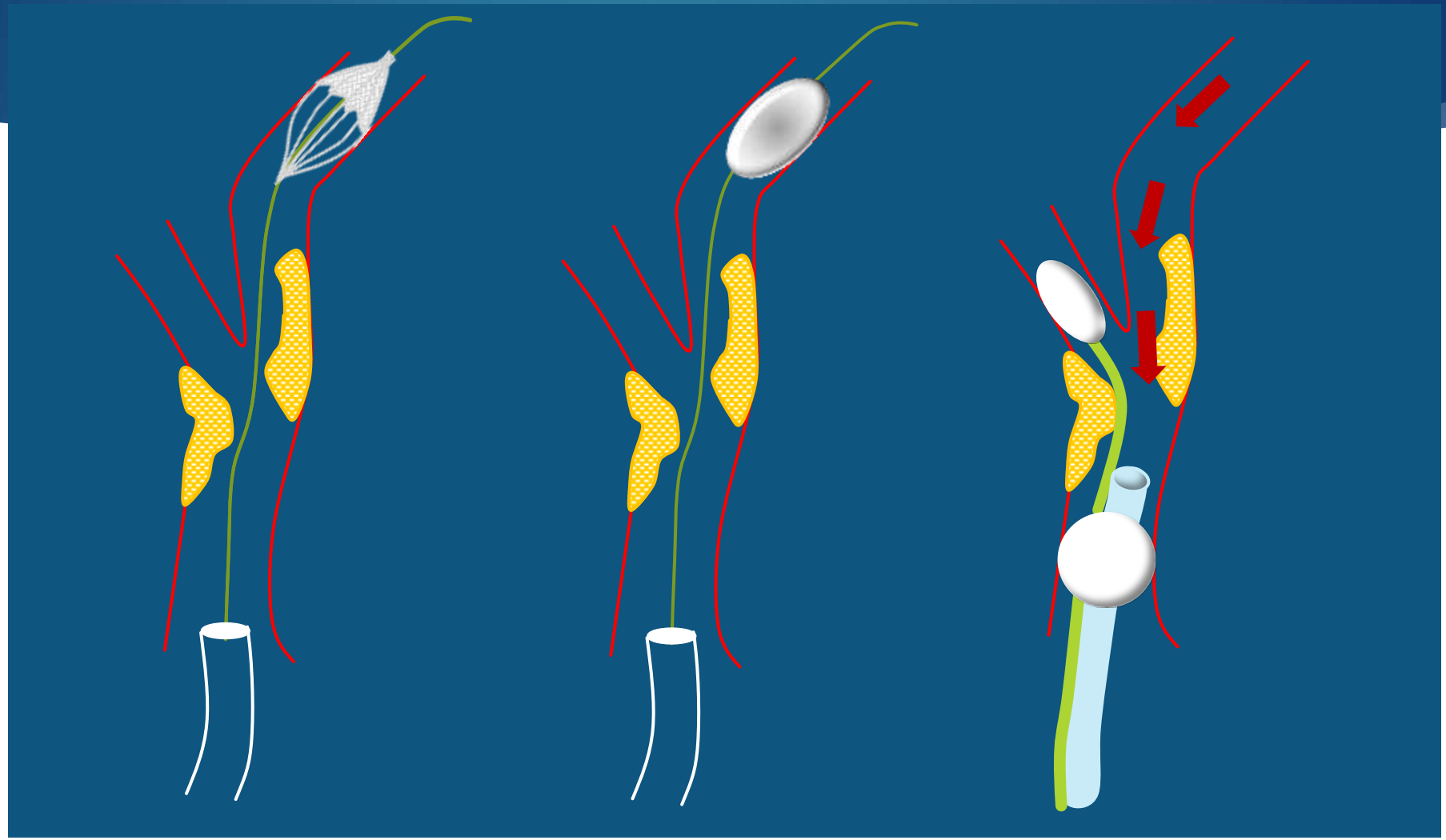
J Endovasc Ther. 2009 Aug;16(4):412-27.

Cerebral protection devices reduce periprocedural strokes during carotid angioplasty and stenting: a systematic review of the current literature.

Garg N, Karagiorgos N, Pisimisis GT, Sohal DP, Longo GM, Johanning JM, Lynch TG, Pipinos II.
Creighton University Medical Center, Omaha, Nebraska, USA.

- Systematic review of published literature the stroke outcomes in protected and unprotected CAS.
- Twenty-four studies included
- Use of cerebral protection devices decreased the risk of perioperative stroke with CAS in both symptomatic and asymptomatic patients.
- RR for stroke was **0.62 (95% CI 0.54 to 0.72**) with embolic protection.

Embolic Protection Devices



Distal filter

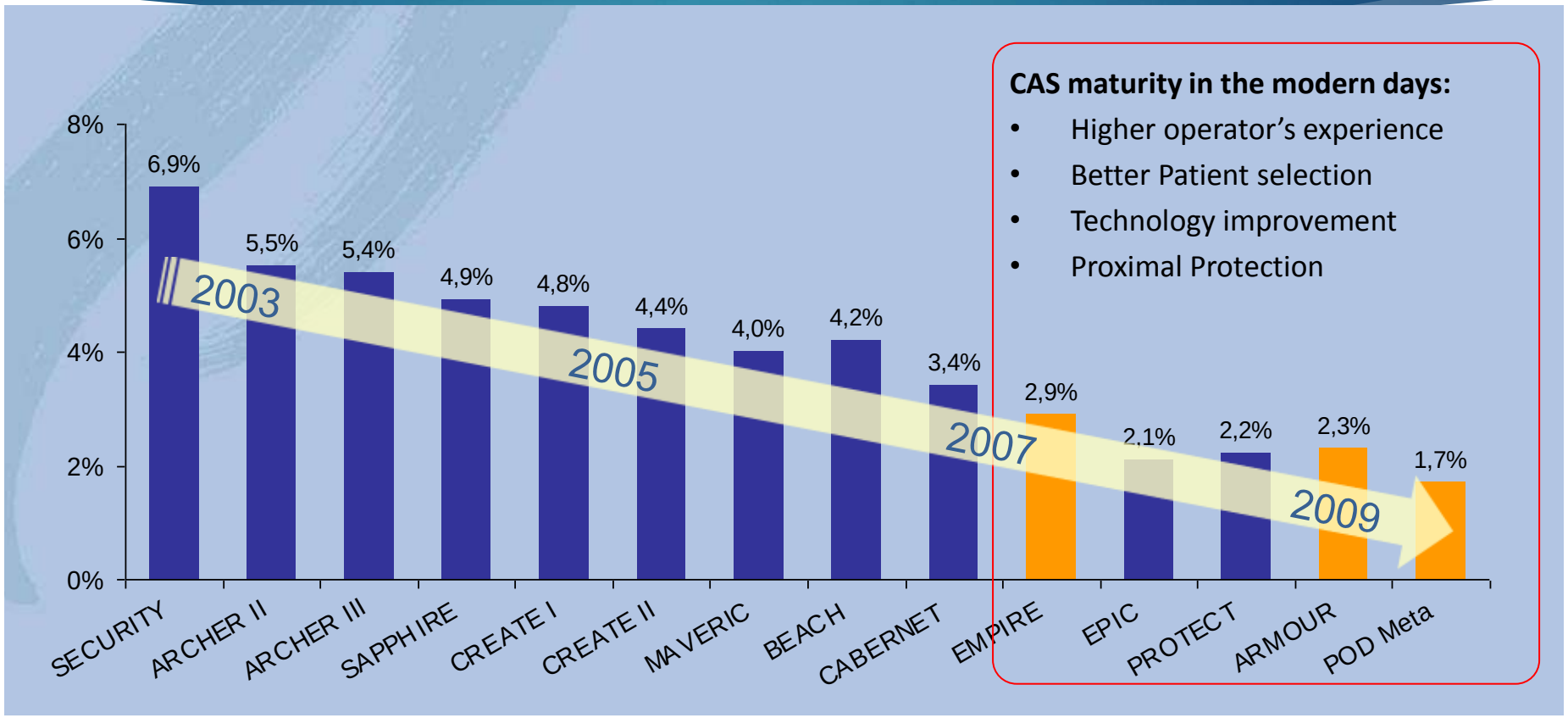
Distal occlusion

Proximal protection

Should All Patients Be Treated with same devices?

Year	Study	Design	EPD	Device	Stroke & Death
2010	EPIC	Single arm IDE	Distal EPD	Fibernet	2.5%
2010	CREST	RCT	Distal EPD	Multiple	4.4%
2012	PROTECT	Single arm IDE	Distal EPD	Emboshield	1.8%
2016	ACT	RCT (Asymp)	Distal EPD	Nav-6, Accunet	2.9%
2010	ARMOUR	Single arm IDE	Proximal occlusion	MoMa	2.7%
2011	EMPIRE	Single arm IDE	Proximal with Flow Reversal	Gore NPS	2.9%
2016	Roadster	Single arm IDE	Proximal with Flow Reversal	EnRoute (Michi)	2.8%

Should All Patients Be Treated with same device?



From Biamino, LINC 2016

Courtesy of Robert Bersin, MD

Are there EPD which perform better than others?

Bottom Line

- Not demonstrated
  - There have been no large scale, randomized trials directly comparing superiority of one EPD over another
  - Surrogate outcomes using proximal protection---new DW-MRI abnormalities---appear better, but lack context, especially for clinical outcomes
  - Both proximal and distal protection have a role and physicians can be educated, when which may best serve the patient's procedure

Proximal vs. Distal Protection: RCT

Effect of two different neuroprotection systems on microembolization during CAS

	MO.MA	FILTER
n =	21	21

Table 4. MES Counts During the Different Phases of CAS

	Filter Group	MO.MA Group	p Value
Sheath placement-protection device placement	20 ± 15	18 ± 10	NS
Wiring of the stenosis	25 ± 22	2 ± 3	< 0.0001
Stent deployment	73 ± 49	11 ± 19	< 0.0001
Balloon dilation	70 ± 31	12 ± 21	< 0.0001
Retrieval of the protection device	14 ± 15	19 ± 15	NS
Total	196 ± 84	57 ± 41	< 0.0001

Table 3. Number of Patients (%) with Detectable MES During he Different Phases of CAS

	Filter Group	MO.MA Group	p Value
heath placement-protection device placement	21 (100%)	21 (100%)	NS
Wiring of the stenosis	20 (95%)	6 (29%)	< 0.0001
tent deployment	21 (100%)	11 (52%)	0.0003
alloon dilation	21 (100%)	15 (71%)	0.008
etrieval of the protection device	21 (100%)	21 (100%)	NS

ata are mean values ± SD or n (%).
CAS = carotid artery stenting; MES = microembolic signals; NS = not significant.

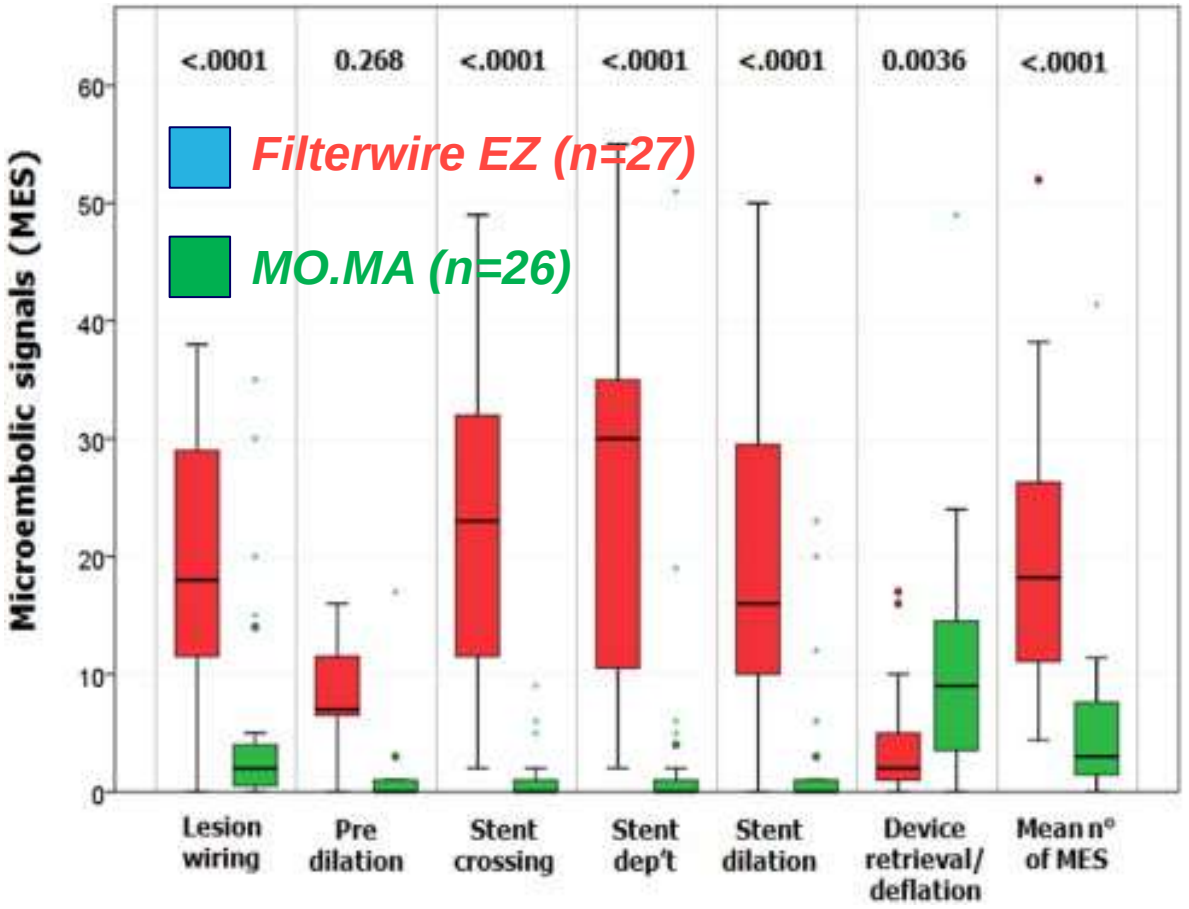
Schmidt A et al. JACC 20004; 44: 1966-1969

Proximal vs. Distal Protection: RCT

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

Table 3 Patients With Detectable MES During the Different Phases of CAS

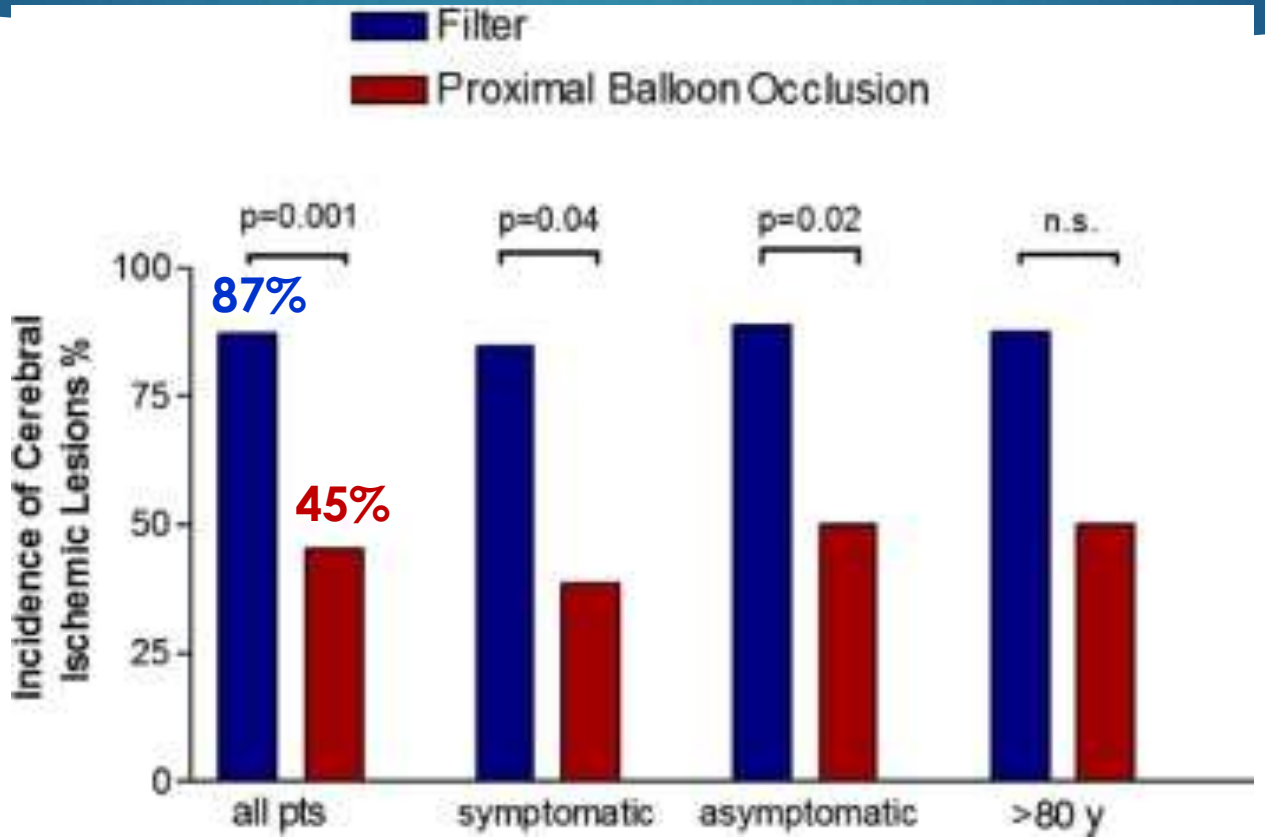
Steps	FilterWire EZ (n = 27)	MO.MA (n = 26)	p Value
Lesion wiring	26 (96%)	19 (73%)	0.145
Pre-dilation*	6/7 (86%)	4/10 (40%)	0.578
Stent crossing of the lesion	27 (100%)	7 (27%)	<0.0001
Stent deployment	27 (100%)	7 (27%)	<0.0001
Stent post-dilation	26 (96%)	7 (27%)	<0.0001
Device retrieval/deflation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



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

Proximal vs. Distal Protection: RCT (PROFI study)

Randomized DWI MRI Comparison



Reduce embolic load (both number and size of DWI lesions)

No difference in MAE

Bjuklic K et al. JAC(

Meta analysis of Proximal Protection (n=2,397)

TABLE I. Baseline Demographics and Clinical Characteristics by Study

	1	2	3	4	5[a]	Full sample
Study device	MO.MA	MO.MA	MO.MA	MO.MA	Gore FRS	(N = 2,397)
			Age			
Mean ± SD (N)	71.62 ± 8.86 (233)	74.61 ± 8.80 (262)	68.31 ± 8.69 (157)	69.84 ± 7.65 (1,270)	70.21 ± 9.59 (475)	70.51 ± 8.52 (2,397)
Median	71.00	76.64	70.00	70.00	70.00	70.92
Range (min,max)	(42.00,92.22)	(42.38,95.88)	(45.00,85.00)	(40.00,91.00)	(30.00,90.00)	(30.00,95.88)
Age ≥ 80	18.88% (44/233)	29.01% (76/262)	14.65% (23/157)	9.06% (115/1,270)	24.63% (117/475)	15.64% (375/2,397)
Male	72.53% (169/233)	66.79% (175/262)	76.43% (120/157)	71.87% (912/1,269)	66.95% (318/475)	70.70% (1694/2,396)
Hypertension	77.68% (181/233)	87.02% (228/262)	78.98% (124/157)	89.06% (1,131/1,270)	86.32% (410/475)	86.52% (2,074/2,397)
Hyperlipidemia	53.22% (124/233)	84.06% (211/251)	69.43% (109/157)	75.83% (963/1,270)	76.84% (365/475)	74.27% (1,772/2,386)
History of diabetes	37.77% (88/233)	37.69% (98/260)	29.30% (46/157)	38.77% (492/1,269)	34.95% (166/475)	37.18% (890/2,394)
Symptomatic (stroke, TIA, amaurosis fugax ≤ 180 days)	36.91% (86/233)	16.03% (42/262)	71.34% (112/157)	27.75% (351/1,265)	30.32% (144/475)	30.73% (735/2,392)
Current smoking	36.91% (86/233)	14.84% (38/256)	NR[b]	58.04% (498/858)	26.32% (125/475)	41.00% (747/1,822)
Contralateral occlusion of ICA	1.29% (3/233)	NR[b]	NR[b]	4.41% (56/1,270)	6.95% (33/475)	4.65% (92/1,978)

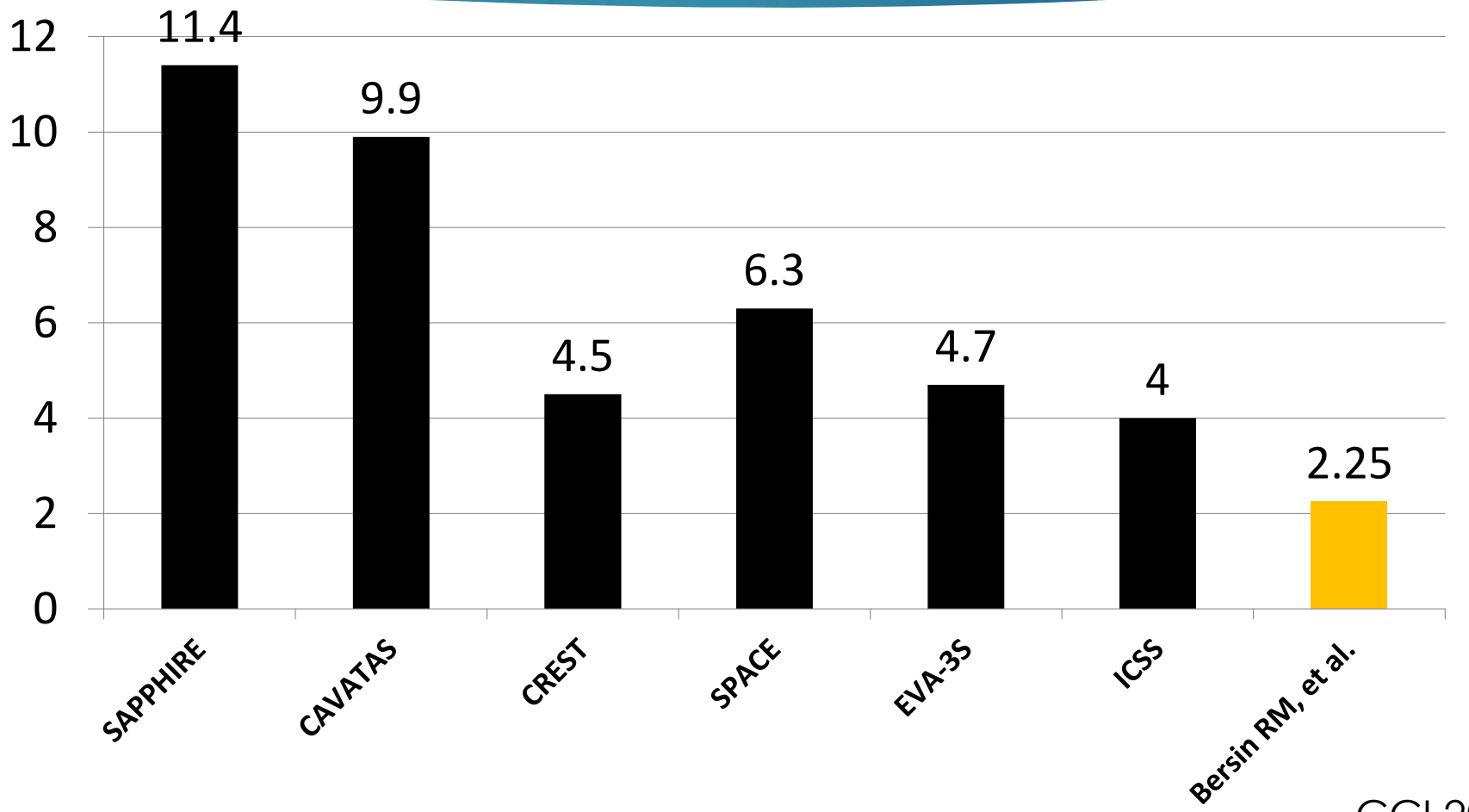
TABLE II. Events by Study

	1	2	3	4	5[a]	
Study device	MO.MA	MO.MA	MO.MA	MO.MA	Gore FRS	Meta-analytic combined rate (%)
Composite rate of MACCE to 30 days postprocedure	0.86% (2/233)	2.29% (6/262)	5.73% (9/157)	1.50% (19/1270)	2.95% (14/475)	2.25
Myocardial infarction	0.00% (0/233)	0.00% (0/262)	0.00% (0/157)	0.00% (0/1270)	0.63% (3/475)	0.02
Death	0.43% (1/233)	0.76% (2/262)	0.64% (1/157)	0.55% (7/1270)	0.63% (3/475)	0.40
Stroke	0.43% (1/233)	1.91% (5/262)	5.10% (8/157)	1.02% (13/1270)	2.32% (11/475)	1.71
Intolerance: device use interruption[b]	NR[c]	0.38% (1/261)	1.91% (3/157)	0.16% (2/1270)	1.47% (7/475)	0.63
Intolerance: alternate device use[d]	NR[c]	0.00% (0/261)	0.64% (1/157)	0.16% (2/1270)	1.26% (6/475)	0.35

Robert Bersin et al. CCI 2012;80:1072–1078

Meta analysis of Proximal Protection (n=2,397)

30-day death/stroke/MI rate in RCT (arm CEA)



CCI 2012;80:1072–1078

Meta analysis of Proximal Protection (n=2,397)

TABLE III. Meta-analytic Odds Ratios for Predictor Variables

	Study-specific OR						
Baseline variables	1	2	3	4	5[a]	Meta-analysis OR	*P* value
Age (per 1-year increase)	1.31	1.00	0.99	1.11	1.03	1.05	0.01
Gender (Male)	NA[b]	0.99	NA[b]	0.85	1.84	1.49	0.32
Hypertension	NA[b]	0.74	0.51	1.05	0.95	0.87	0.84
Hyperlipidemia	0.88	0.28	0.88	1.20	1.11	0.93	0.93
History of diabetes	NA[b]	8.59	3.23	2.75	1.41	2.34	0.01
Current smoking	NA[b]	NA[b]	NR[c]	1.16	1.12	0.90	0.95
Contralateral occlusion of ICA	NA[b]	NR[c]	NR[c]	1.21	2.31	1.72	0.55
Symptomatic	1.71	NA[b]	0.30	3.66	0.92	1.27	0.54

The only independent risk predictors were **age and diabetes**.

Patient gender, **symptomatic status**, and other baseline characteristics were not found to be risk predictors for CAS using proximal occlusion devices.

The presence of a **contralateral occlusion does not predict** an increased risk of MACCE, nor does it predict device/procedure intolerance.

CCI 2012;80:1072–1078

National Cardiovascular Data Registry

TABLE 2 Major Adverse Events Based on Embolic Protection Type

In-Hospital Outcomes (n=10,246)

	Before Propensity Matching			After Propensity Matching		
	F-EPD (n = 9,656)	P-EPD (n = 590)	p Value	F-EPD (n = 2,032)	P-EPD (n = 508)	p Value
Death or stroke	234 (2.4)	9 (1.5)	0.164	40 (2.0)	8 (1.6)	0.560
Mortality	40 (0.4)	1 (0.2)	0.730	9 (0.4)	1 (0.2)	0.697
Stroke	209 (2.2)	9 (1.5)	0.296	33 (1.6)	8 (1.6)	0.937

30-Day Outcomes (n=7,693)

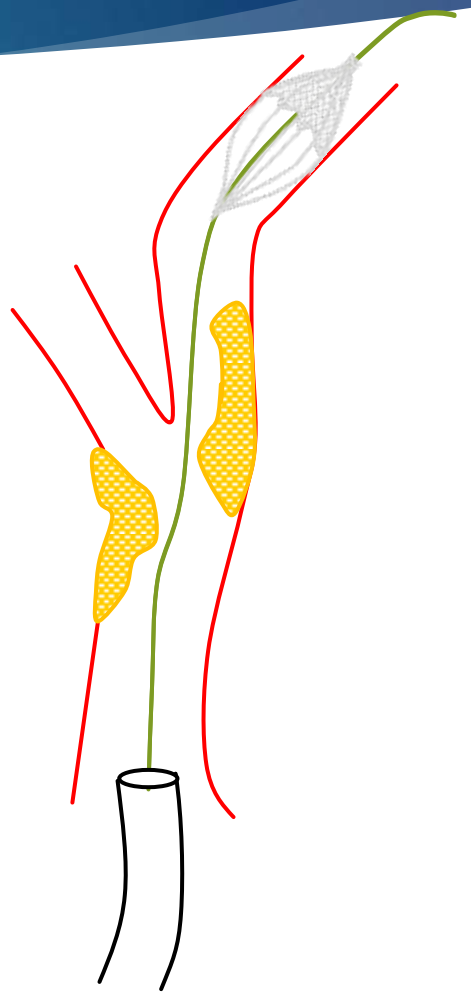
	Before Propensity Matching			After Propensity Matching		
	F-EPD (n = 7,211)	P-EPD (n = 482)	p Value	F-EPD (n = 1,469)	P-EPD (n = 406)	p Value
Death or stroke	300 (4.2)	12 (2.5)	0.072	59 (4.0)	11 (2.7)	0.219
Mortality	53 (0.7)	2 (0.4)	0.582	12 (0.8)	2 (0.5)	0.747
Stroke	264 (3.7)	11 (2.3)	0.114	49 (3.3)	10 (2.5)	0.373

terv 2015;8:609–15

Distal Filter Protection

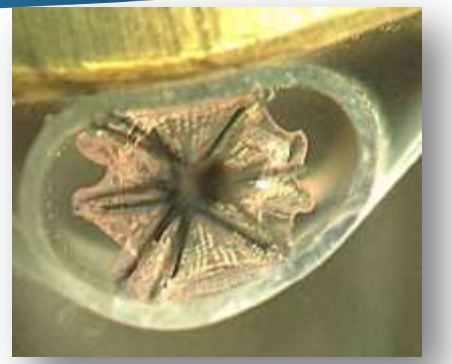
Advantage

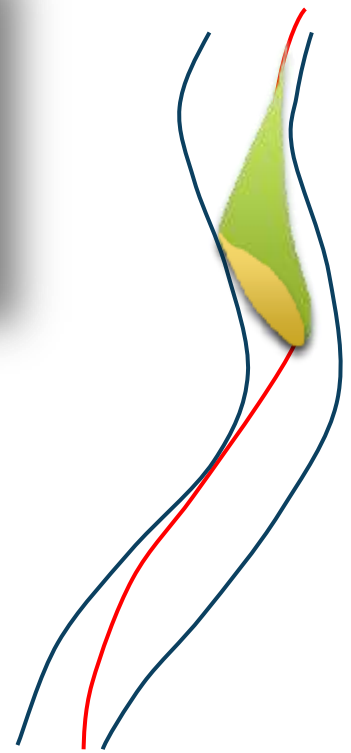
- Continuous carotid artery blood flow
  - Less intolerable (perfusion)
- Intuitive
- Permits visualization of carotid artery during device deployment
- Smaller introducer (6-7 Fr)



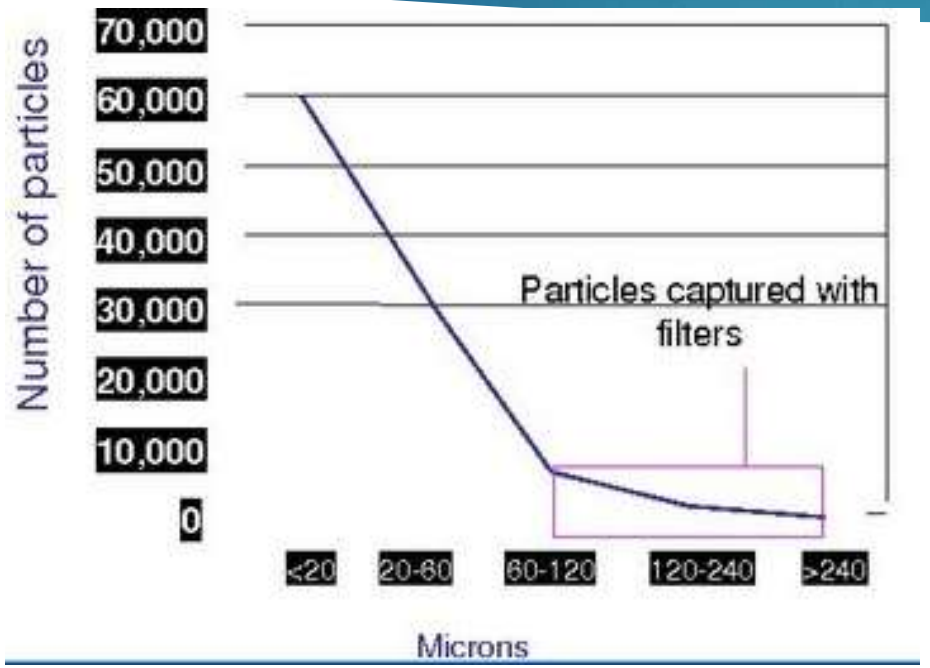
Distal Filters Have Limitations

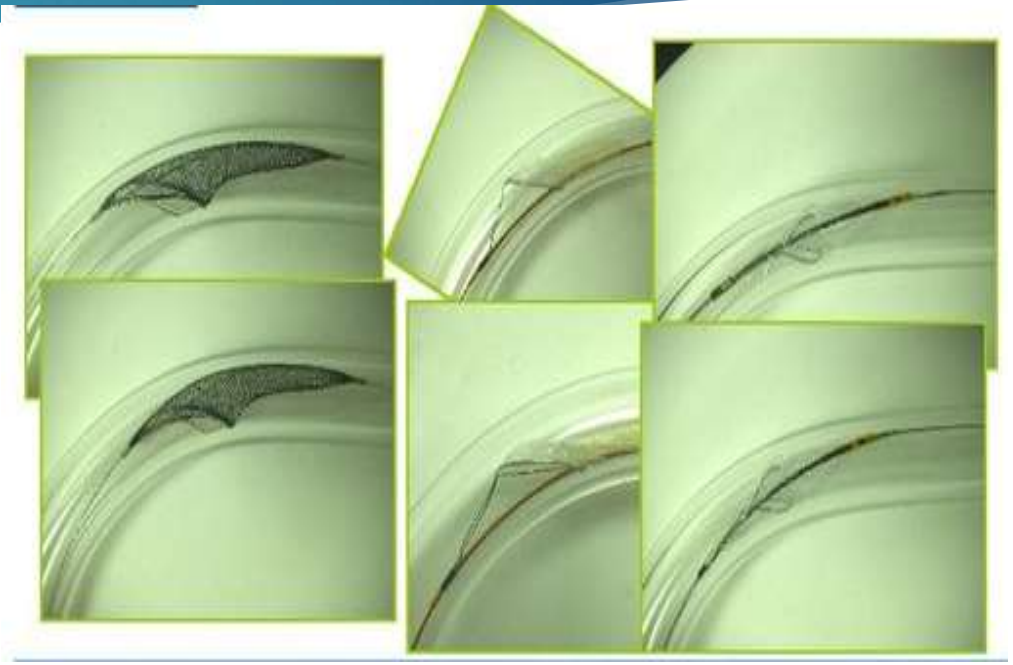
1. No protection during lesion crossing
2. Requires ~ straight landing zone
3. Difficult delivery & use for tortuous ICAs
4. Malapposition allows “peri-flow” emboli
5. Allows passage of particles < 100 microns (“through flow”)
6. “Full basket” affects flow rates
7. Spasm/dissection
8. Difficult retrieval





Filter size and apposition matters in distal EPD…





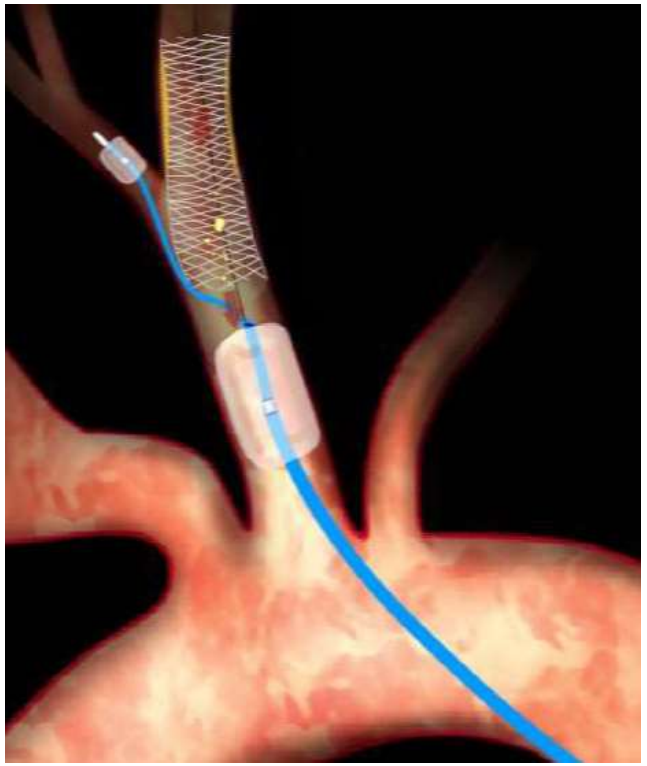
Capture rate proportional to pore size – Stuff gets through

Vessel and guidewire bias apposition -- Allows material around filter (peri-flow)

Proximal Protection

Advantage

- Do not require wire crossing of the stenotic lesion without protection
- Landing zone tortuosity doesn’t matter
- Less emboli get to brain… on TCD & DWI
- Great results especially elderly and symptomatic patients
- Possible to near total lesion



Proximal Protection

Disadvantage

- Transient blockage of cerebral flow

  → Intolerance possible with poor collateral or contralateral occlusion (3~8%)
- Some loss of visualization due to occluded flow
- Larger device (8~9 Fr introducer)
- More manipulation of aortic arch
- May be ECA dependent
- New mechanism to learn
- High pressure during time-dependent procedure

I prefer proximal EPDs, Why?

- Incidence of clinical and surrogate CAS events is higher than the low risk categories, therefore more opportunity for improvement

- Mechanistically sound logic e.g.,
  - Symptomatic →thrombotic lesion → proximal protection

And the low risk CAS patients? Don't they deserve the "best" EPD?

- Low risk defined as:
  - Young
  - Asymptomatic
  - Straightforward access
  - Focal lesions

- Clinical outcomes may not be distinguishable between EPD devices.

For selection of which EPDs

- Physician experience or availability
- Patient selection
  - complete medical history
  - thorough evaluation of anatomy
- Need for more data

A matter of choice and individualization

- Anatomy

  - severe angulation
  - proximal or distal tortuosity
  - aortic arch type
  - stenosis or extension of plaque into external or common
  - ostial disease
  - contralateral stenosis or occlusion

A matter of choice and individualization

- Lesion Characteristics
  - degree of stenosis
  - unstable or high risk plaque characteristics
    - : ulceration or intraluminal thrombus
    - : long smooth lesions
    - : hypoechoic lesions
    - : significant calcification
    - : intraplaque hemorrhage

- Age (Octagenerian)
- Symptomatic state

Conclusions

Proximal EPDs may expand number of safely performed CAS.

- Symptomatic and octagenarians
- Poor ICA landing zones
- Carotid dissections
- Intracranial stenosis or high lesions
- Acute strokes

My default strategy for standard CAS

Conclusions

Distal EPDs may work in majority of daily cases.

- More familiar, More data
- Contrast usage
  → better for difficult GW passage
- Better for contralateral occlusion / poor collateral
- Better for significant CCA or ECA stenosis
- Less manipulation of aortic arch
- Alternative access from radial artery

Thank you for your attention