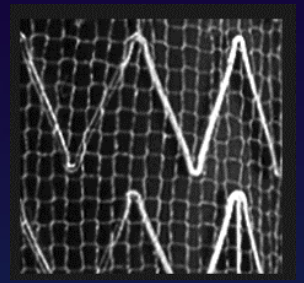
Piotr Musialek
MD DPhil

CRF 2023
TCT



Staying Safe:
Review of Protection in CAS

Jagiellonian University
Dept of Cardiac & Vascular Diseases
John Paul II Hospital, Krakow, Poland

Disclosure of Relevant Financial Relationships

Within the prior 24 months, I have had a relevant financial relationship(s) with an ineligible company(ies) listed below.

Nature of Financial Relationship	Ineligible Company
Grant/Research Support	
Consultant Fees/ Proctoring	Abbott Vascular, InspireMD, Medtronic
Individual Stock(s)/Stock Options	
Royalties/Patent Beneficiary	
Executive Role/Ownership Interest	
Other Financial Benefit	CGUARDIANS IDE (Co-PI)

All relevant financial relationships have been mitigated.
Faculty disclosure information can be found on the app

I will be discussing the MicroNET-Covered Embolic Prevention Stent System (EPS) that is an **Investigational Device** in the U.S.A.

Staying Safe: Protection in CAS

1. **Filters** (Distal Protection)

2. **Flow Reversal** (Proximal Protection)

3. **Stent Protection*** (a novel concept with RCT evidence)

* The MicroNET-Covered Embolic Prevention Stent System (CGuard EPS) is currently an **Investigational Device** in the U.S.A.

CAS (and CEA likewise) ARE Emboligenic

CAS –and CEA– are (and will remain) Emboli-Generating

Effect of the Distal-Balloon Protection System on Microembolization During Carotid Stenting

Nadim Al-Mubarak, MD; Gary S. Roubin, MD, PhD; Jiri J. Vitek, MD, PhD; Sriram S. Iyer, MD; Gishel New, MD; Martin B. Leon, MD

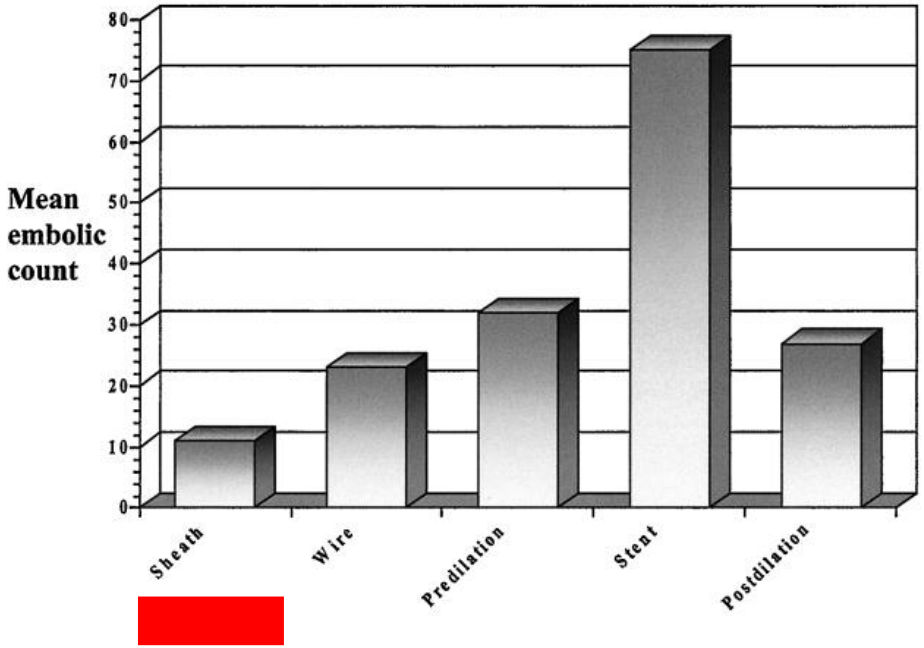


Figure 1. Microembolic profile during unprotected CAS. The mean MES counts during various phases of the procedure are displayed.

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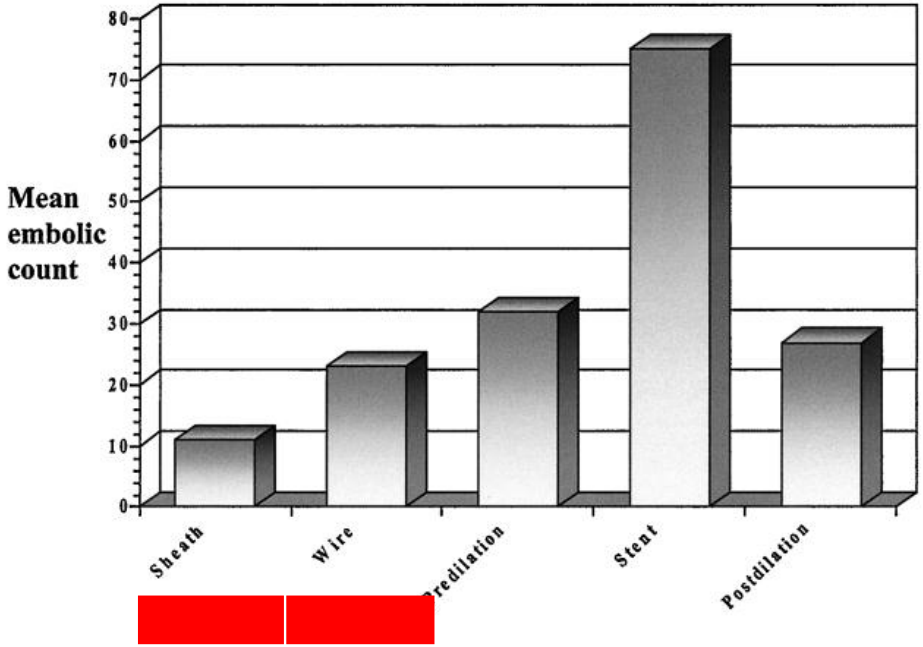

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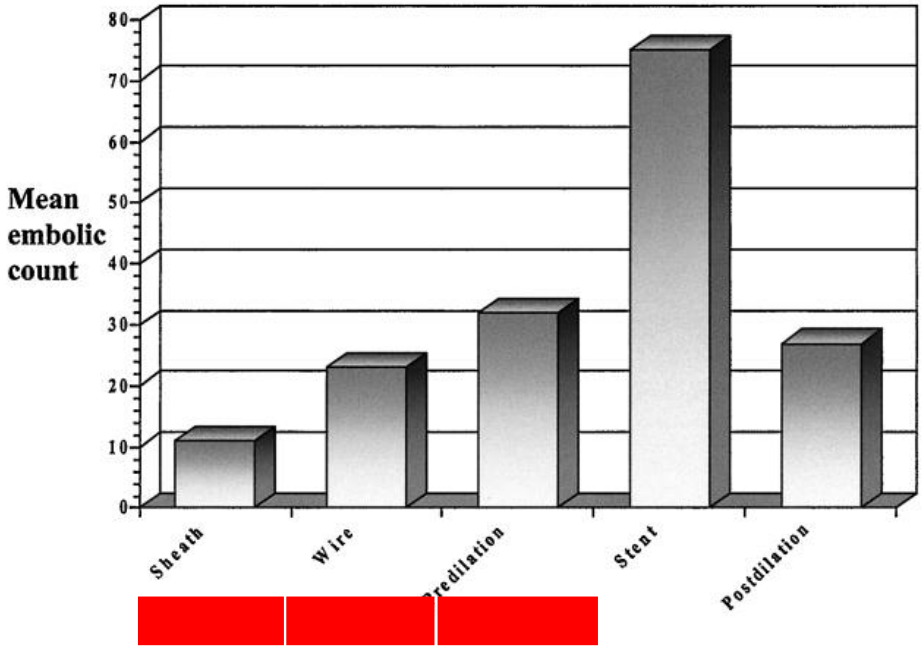

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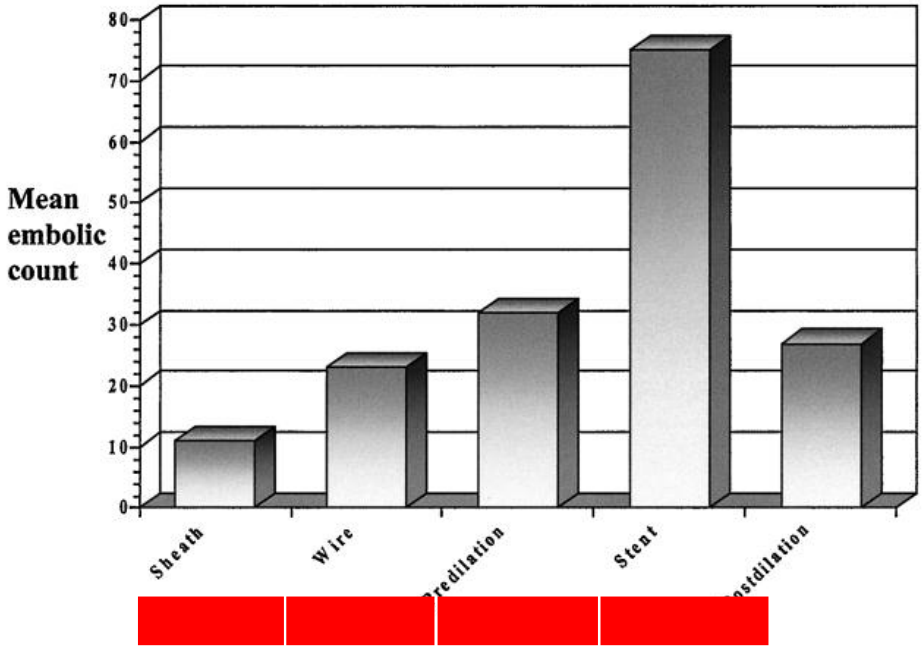

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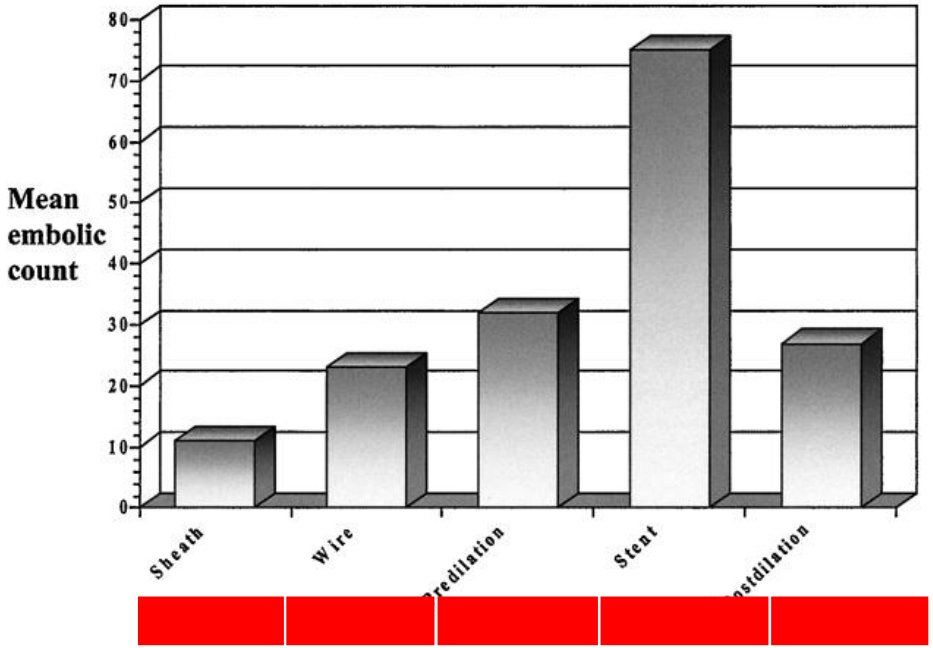

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Cerebral Embolism in CAS

- ’non-linear’

Cerebral Embolism in CAS

- ’non-linear’
- poorely predictable

Cerebral Embolism in CAS

- ’non-linear’
- poorely predictable
- (in part) operator/pocedure strategy/eqipment – dependent

Embolic Protection in CAS – IT WORKS!

Clinical Trial › Stroke. 2004 Jan;35(1):e18-20. doi: 10.1161/01.STR.0000106913.33940.DD.
Epub 2003 Dec 4.

Carotid angioplasty and stenting with and without cerebral protection: clinical alert from the Endarterectomy Versus Angioplasty in Patients With Symptomatic Severe Carotid Stenosis (EVA-3S) trial

J L Mas, G Chatellier, B Beyssen; EVA-3S Investigators

Background and purpose: Whether cerebral protection during carotid angioplasty and stenting (CAS) is associated with a lower risk of periprocedural stroke or death remains to be established. We report on 80 patients randomized in the CAS arm of the Endarterectomy Versus Angioplasty in Patients With Symptomatic Severe Carotid Stenosis trial comparing CAS (with or without cerebral protection) with carotid surgery in patients with recently symptomatic, severe carotid stenosis.

Summary of report: The Safety Committee recommended stopping unprotected CAS, because the 30-day rate of stroke was 3.9 (0.9 to 16.7) times higher than that of CAS with cerebral protection

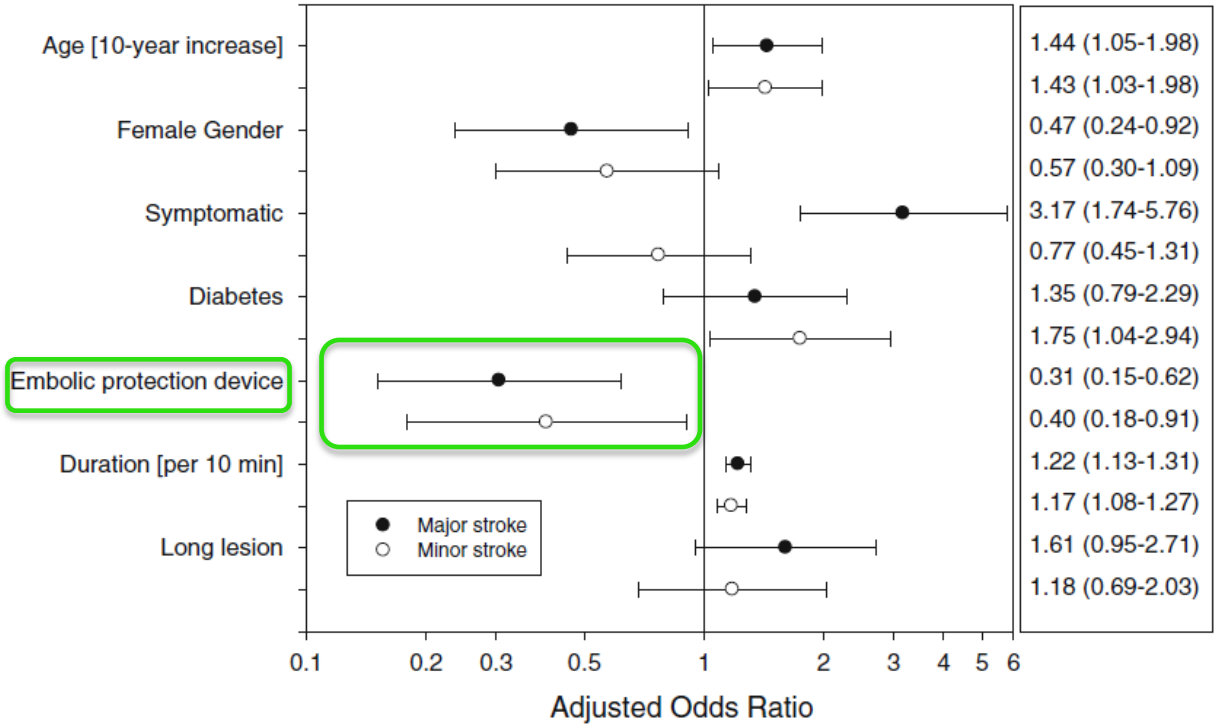
Clin Res Cardiol (2014) 103:345–351
DOI 10.1007/s00392-013-0657-z

ORIGINAL PAPER

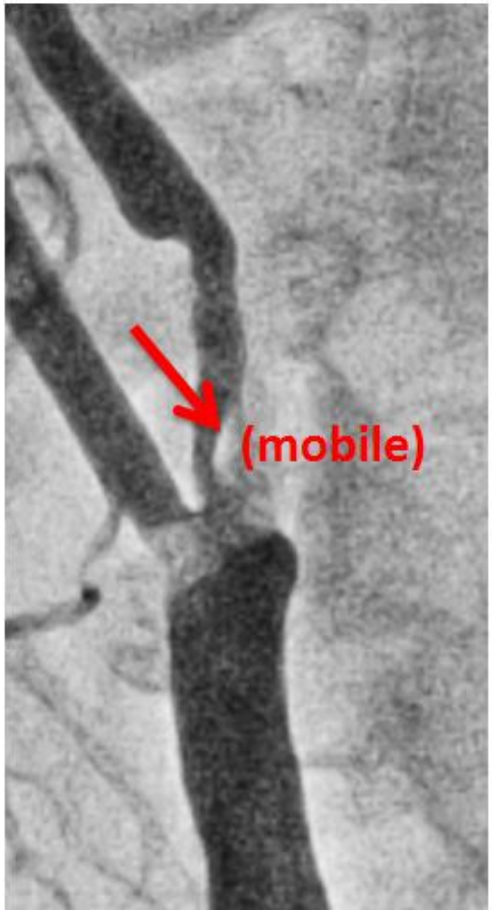
Predictors of minor versus major stroke during carotid artery stenting: results from the carotid artery stenting (CAS) registry of the Arbeitsgemeinschaft Leitende Kardiologische Krankenhausärzte (ALKK)

Stephan Staubach · Ralph Hein-Rothweiler · Matthias Hochadel · Manuela Segerer · Ralf Zahn · Jens Jung · Gotthard Rieß · Hubert Seggewiß · Andre Schneider · Thomas Fürste · Christian Gottkehaskamp · Harald Mudra

n=5,709 CAS



Ideas?



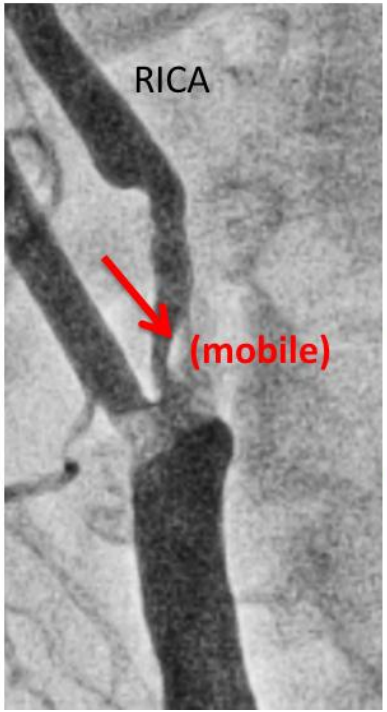
CAS

Protected?/Unprotected?

Filter?

Stent? ANY stent?

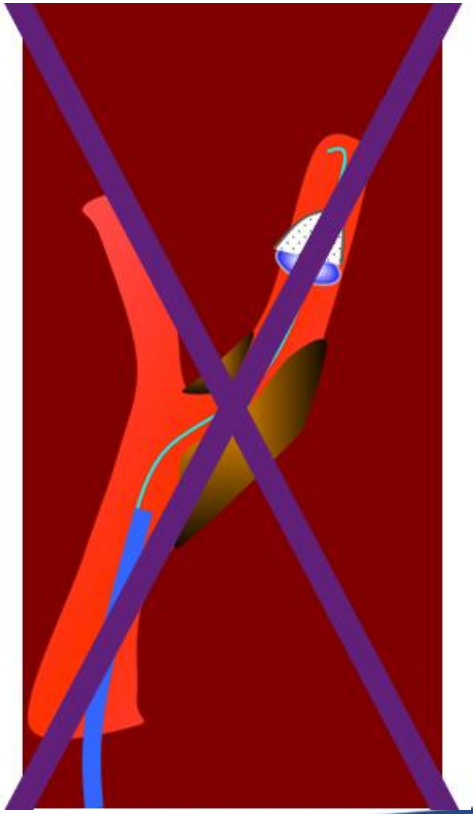
COMPETENT CAS



- (always) Neuro-protected
- NO Filter (in lesion as here)
- plaque-sequestrating stent (permanent protection)

P Musialek, G de Donato. *Carotid artery revascularization using the endovascular route*. In: Peripheral Interventions – Practical Guide. Minerva Medica 2023

COMPETENT CAS



Proximal neuroprotection: A MUST-be-able-to in COMPETENT CAS

The PROFI Study (Prevention of Cerebral Embolization by Proximal Balloon Occlusion Compared to Filter Protection During Carotid Artery Stenting)

A Prospective Randomized Trial

Klaudija Bijuklic, MD, Andreas Wandler, MD, Fadia Hazizi, MD, Joachim Schofer, MD, PHD
Hamburg, Germany

JACC Vol. 59, No. 15, 2012
April 10, 2012:1383–9

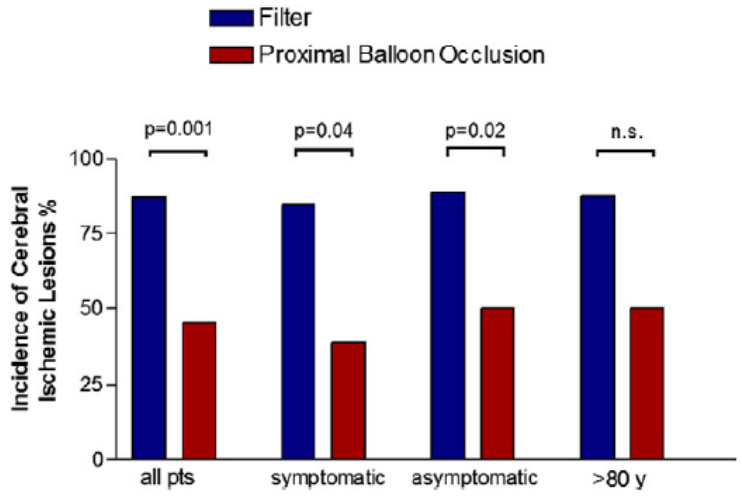
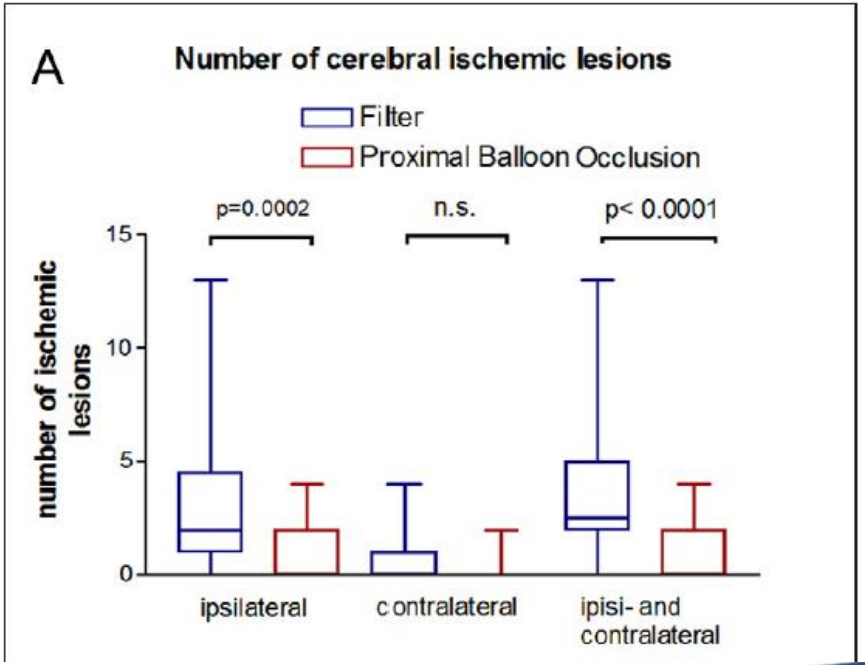
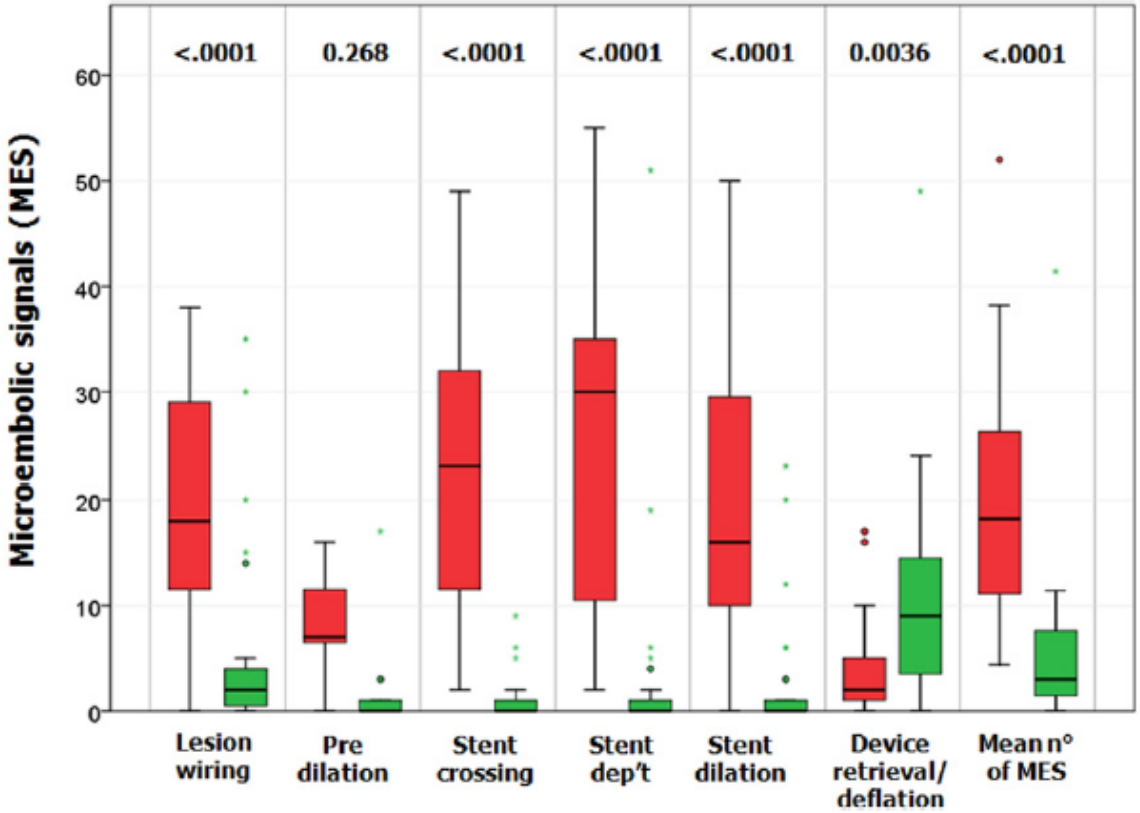


Figure 2 Incidence of New Ischemic Lesions in Patients With Filter Protection Versus Proximal Balloon Occlusion



Proximal neuroprotection: A MUST-be-able-to in COMPETENT CAS



Filter
vs.
MoMa

Montorsi P et al. JACC 2011

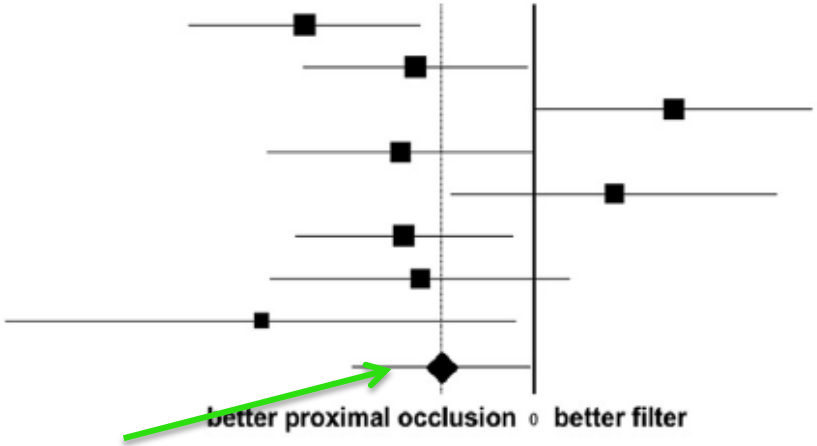
Proximal neuroprotection: A MUST-be-able-to-do in COMPETENT CAS

Cerebral Embolic Lesions Detected With Diffusion-Weighted Magnetic Resonance Imaging Following Carotid Artery Stenting

A Meta-Analysis of 8 Studies Comparing Filter Cerebral Protection and Proximal Balloon Occlusion

Eugenio Stabile, MD, PhD, Anna Sannino, MD, Gabriele Giacomo Schiattarella, MD, Giuseppe Gargiulo, MD, Evelina Toscano, MD, Linda Brevetti, MD, Fernando Scudiero, MD, Giuseppe Giugliano, MD, Cinzia Perrino, MD, PhD, Bruno Trimarco, MD, Giovanni Esposito, MD, PhD

Study ID	ES	95% CI	N
Bijuklic K. et al. 2012	-1.05	-1.58 , -0.52	62
Cano N.M. et al. 2013	-0.54	-1.06 , -0.03	60
Castro-Afonso LH. et al. 2013	0.64	0.00 , 1.28	40
El-Koussy M. et al. 2007	-0.61	-1.22 , -0.00	44
Flach Z.H. et al. 2007	0.37	-0.38 , 1.11	33
Leal I. et al. 2012	-0.60	-1.10 , -0.10	64
Montorsi P. et al. 2011	-0.52	-1.21 , 0.17	35
Taha M.M. et al. 2009	-1.25	-2.42 , -0.08	19
Overall (random-effects model)	-0.43	-0.84 , -0.02	357



A diffusion-weighted magnetic resonance imaging-based study of transcervical carotid stenting with flow reversal versus transfemoral filter protection

Ignacio Leal, MD,[a] Antonio Orgaz, MD,[a] Ángel Flores, MD,[a] Jose Gil, MD,[a] Rubén Rodríguez, MD,[a] Javier Peinado, MD,[a] Enrique Criado, MD,[b] and Manuel Doblas, MD,[a] *Toledo, Spain; and Ann Arbor, Mich*

Transfemoral Filter

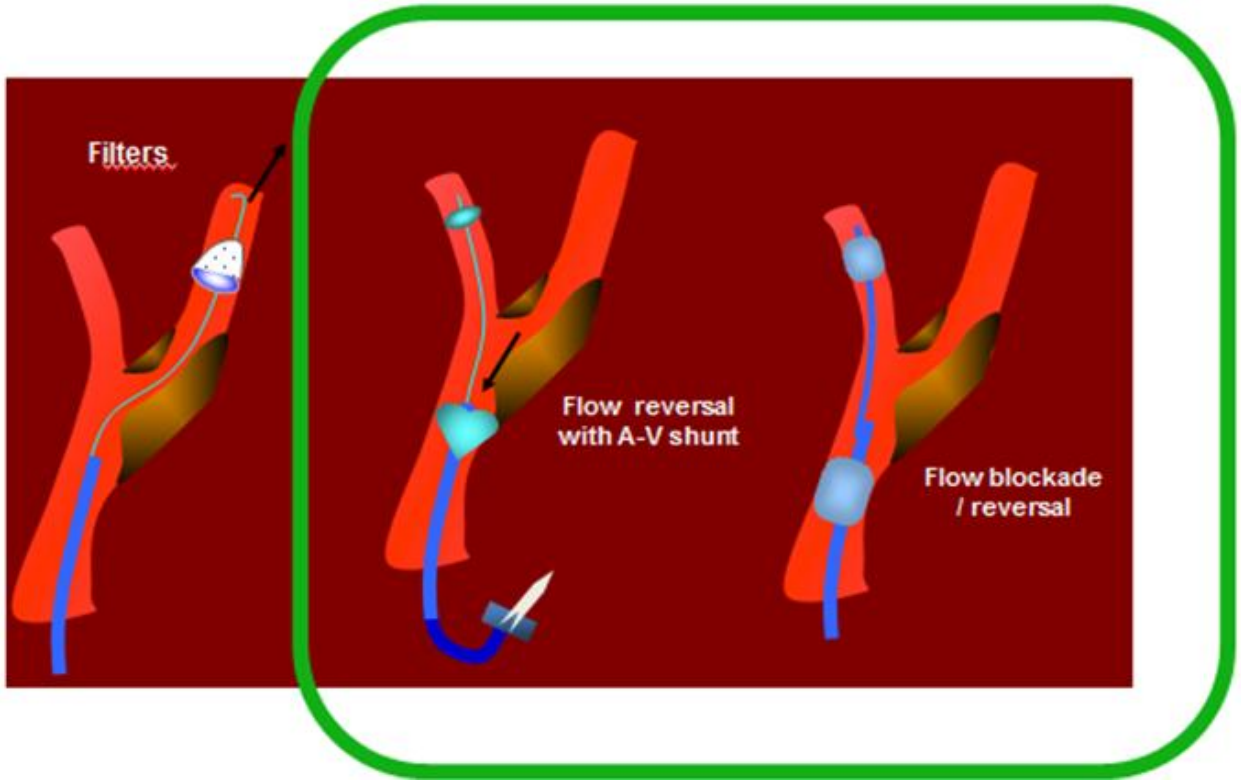
vs.

TCAR "dynamic" Flow Reversal

Table II. Results from diffusion-weighted magnetic resonance imaging (DW-MRI) evaluation

Variable	*Transcervical (n = 31) No. (%)*	*Transfemoral (n = 33) No. (%)*	P
Patients with new lesions	4 (12.90)	11 (33.33)	.03
No. of new lesions	4	13	.02
Localization of new lesions			
Ipsilateral	4	11	.03
Contralateral	0	2	.16

Cerebral Protection in transfemoral/transradial/ transcarotid CAS: PROXIMAL Protection Competence is a MUST



√

Cerebral Embolism in CAS: Fundamental Facts

- Pre-dilatation **REDUCES** embolic load

Cerebral Embolism in CAS: Fundamental Facts

- Pre-dilatation **REDUCES** embolic load

Impact of plaque dilation before carotid artery stent deployment

Antonio Lauricella, MD,[a] Raffaella Berchiolli, MD,[b] Roberto Moratto, MD,[a] Michelangelo Ferri, Andrea Viazzo, MD,[c] *and* Roberto Silingardi, MD,[a] *Modena, Pisa, and Turin, Italy*

Maximum carotid plaque dilation before carotid artery stent deployment

- reduced macroscopic plaque debris (12-fold reduction)
- reduced hemodynamic depression (18- fold reduction)
- reduced microembolic signals ($p < 0.001$)

(J Vasc Surg 2020;71:842-53.)

Cerebral Embolism in CAS: Fundamental Facts

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- Post-dilatation **INCREASES** embolic load

Cerebral Embolism in CAS: Fundamental Facts

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  ONLY WITH 1st GEN (SINGLE-LAYER) STENTS

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In: Peripheral Interventions – Practical Guide. Minerva Medica 2023

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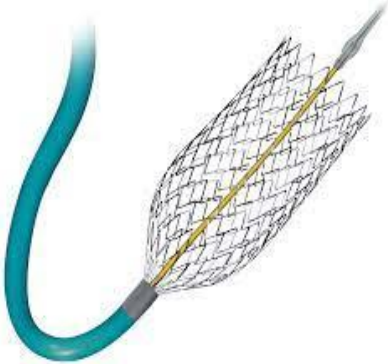

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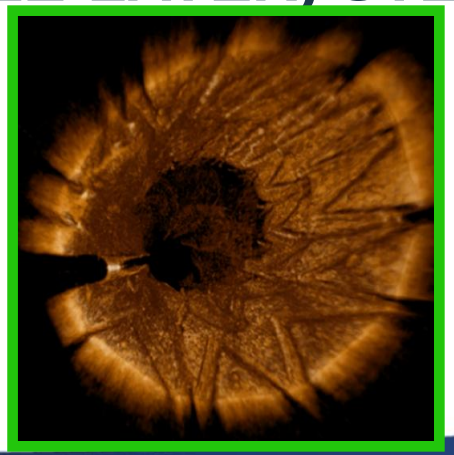

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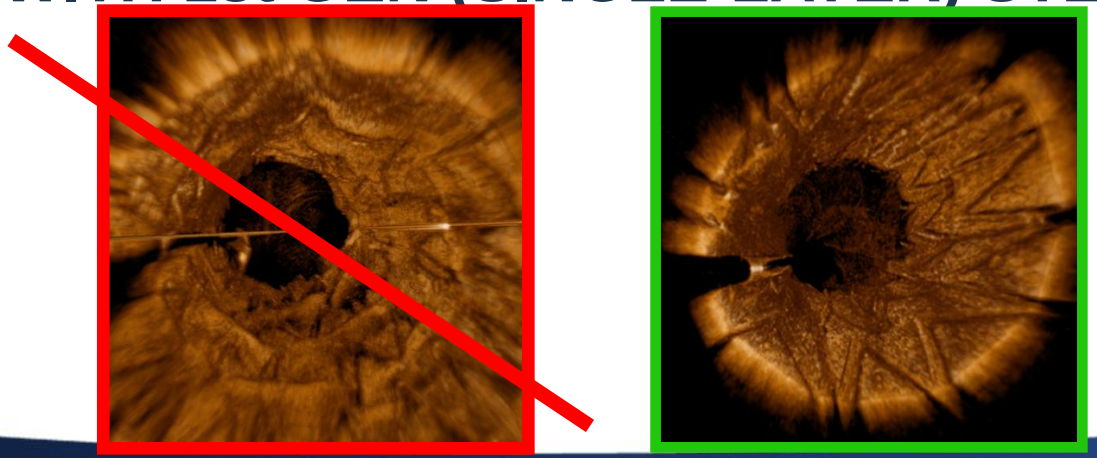

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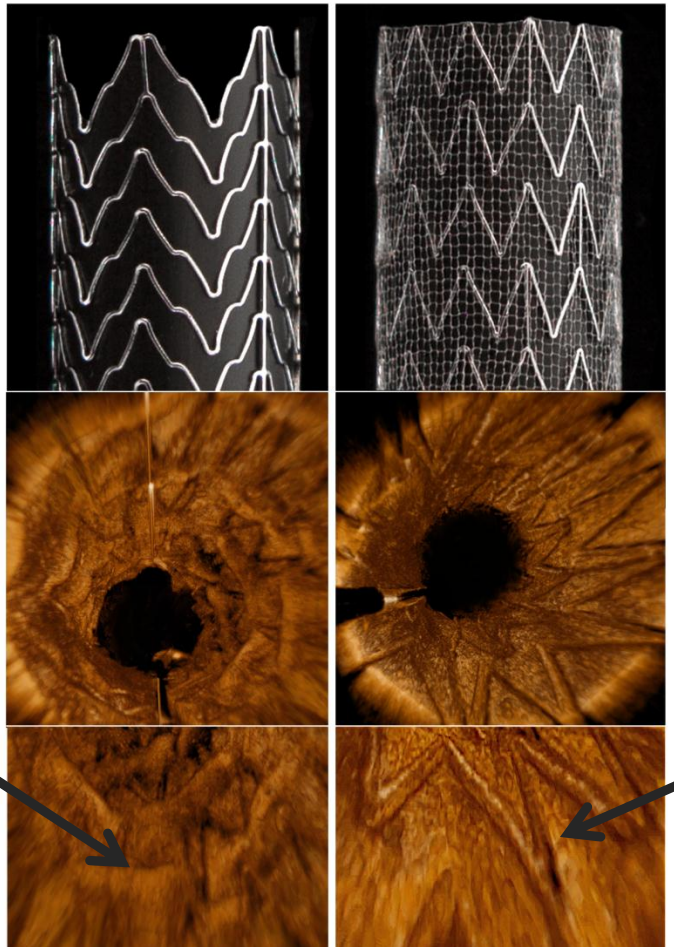
Conventional Carotid Stent

MicroNET--Covered Stent



CREST Study Device

Embolic Prevention Stent (EPS)

P Musialek, G de Donato. *Carotid artery revascularization using the endovascular route*. In: Peripheral Interventions – Practical Guide. Minerva Medica 2023

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but….

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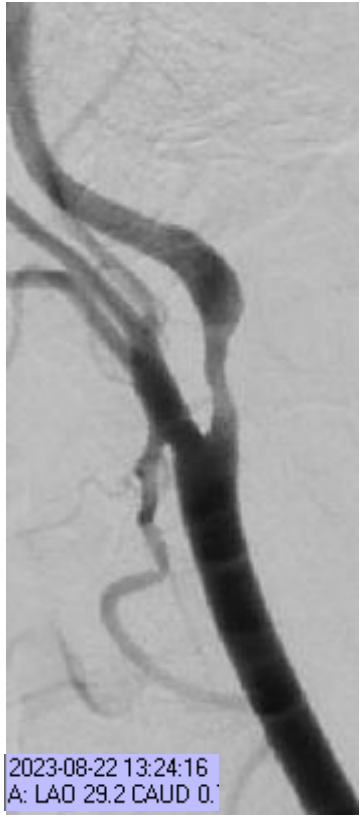
  ONLY WITH 1st GEN (SINGLE-LAYER) STENTS
- FILTERS **PROTECT** against cerebral embolism

LIMITATIONS:
- **Unprotected lesion crossing**
- **Filter Basket CAPACITY**
- **APPOSITION**
- **> 10% need to predilate to Introduce Filter** (Powell JVS)

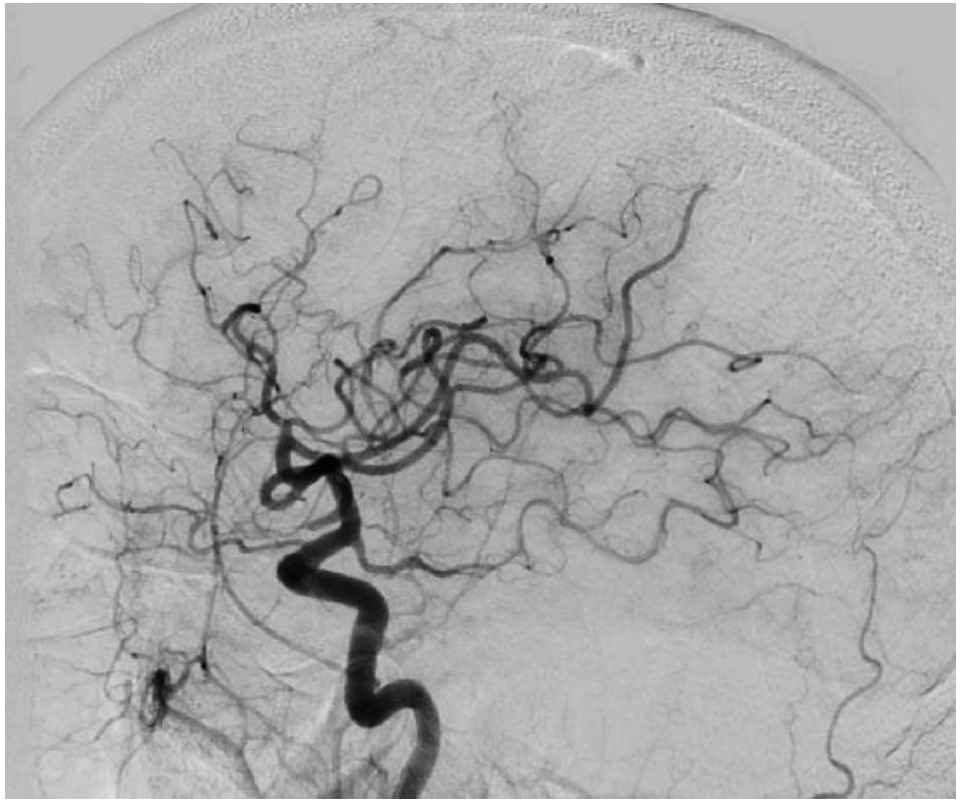
Filters have IMPORTANT LIMITATIONS



Filters have IMPORTANT LIMITATIONS

ACT 267 sec

Filters have IMPORTANT LIMITATIONS



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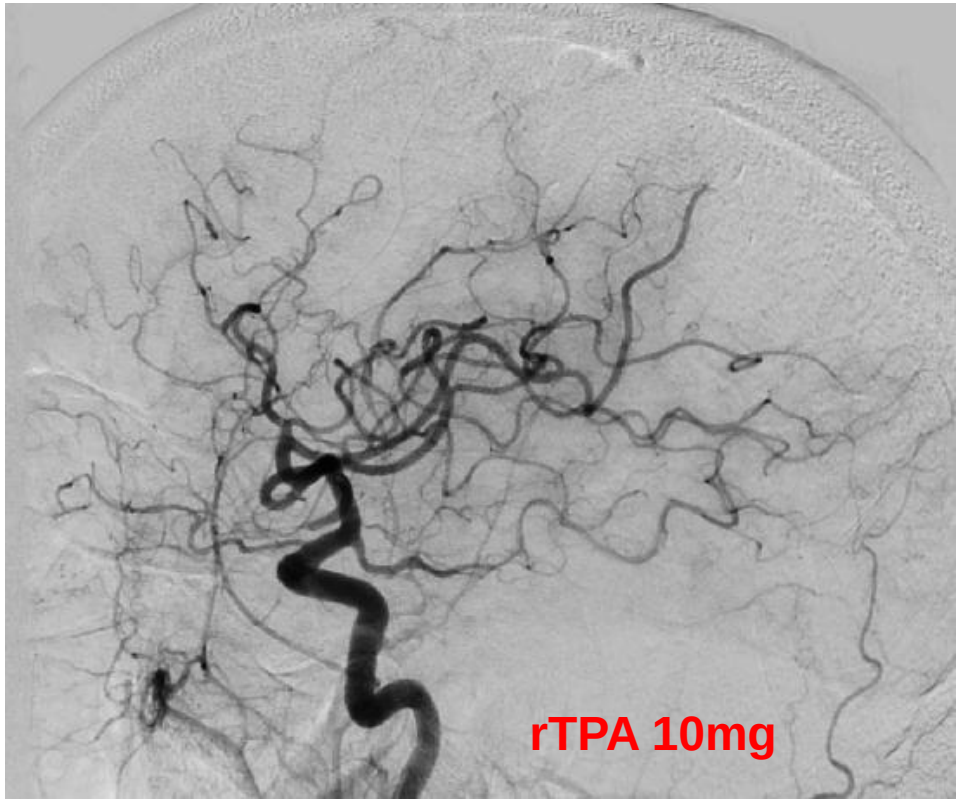

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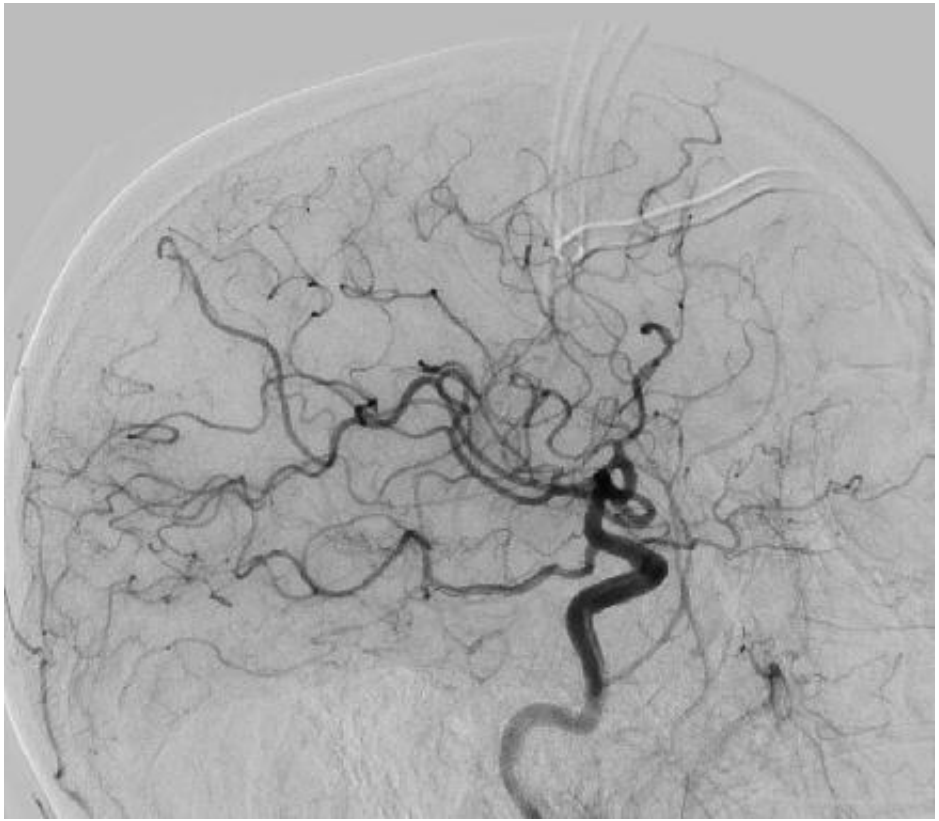
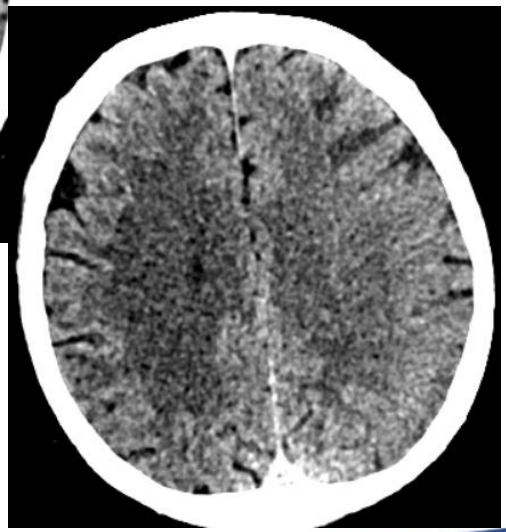
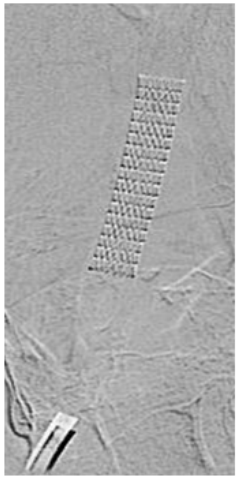


Acute NIHSS 16



Conventional Carotid Stent Design Permits Atherosclerotic Plaque In-Stent Progression

Appropriately sized and implanted Precise stent (2005)



Precise Stent 5.0x30mm (implanted 2005)

increasing " in-stent restenosis" → 2016 SYMPTOMATIC

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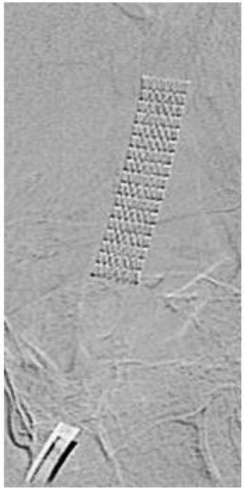

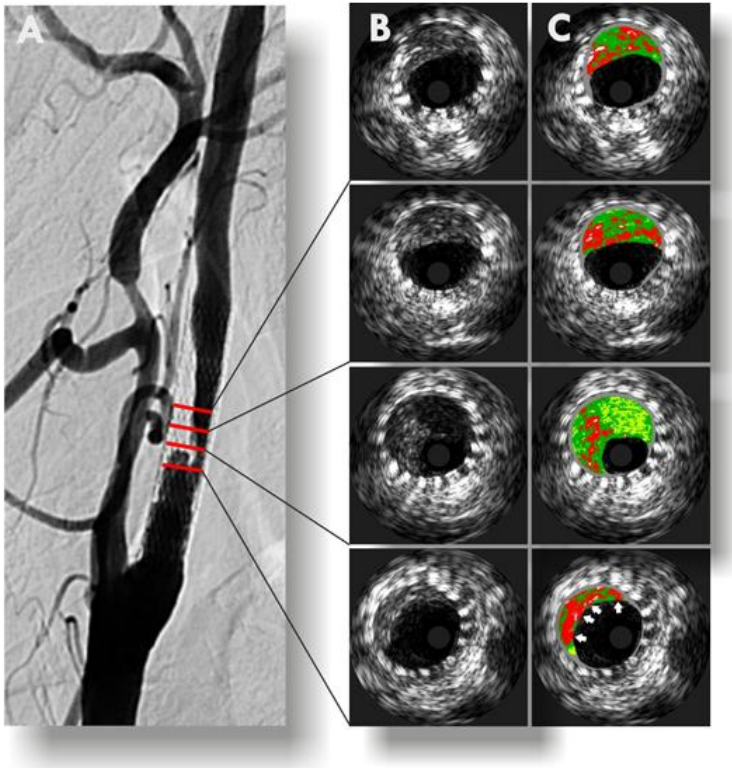

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Tekieli et al. *Eur Heart J* 2021

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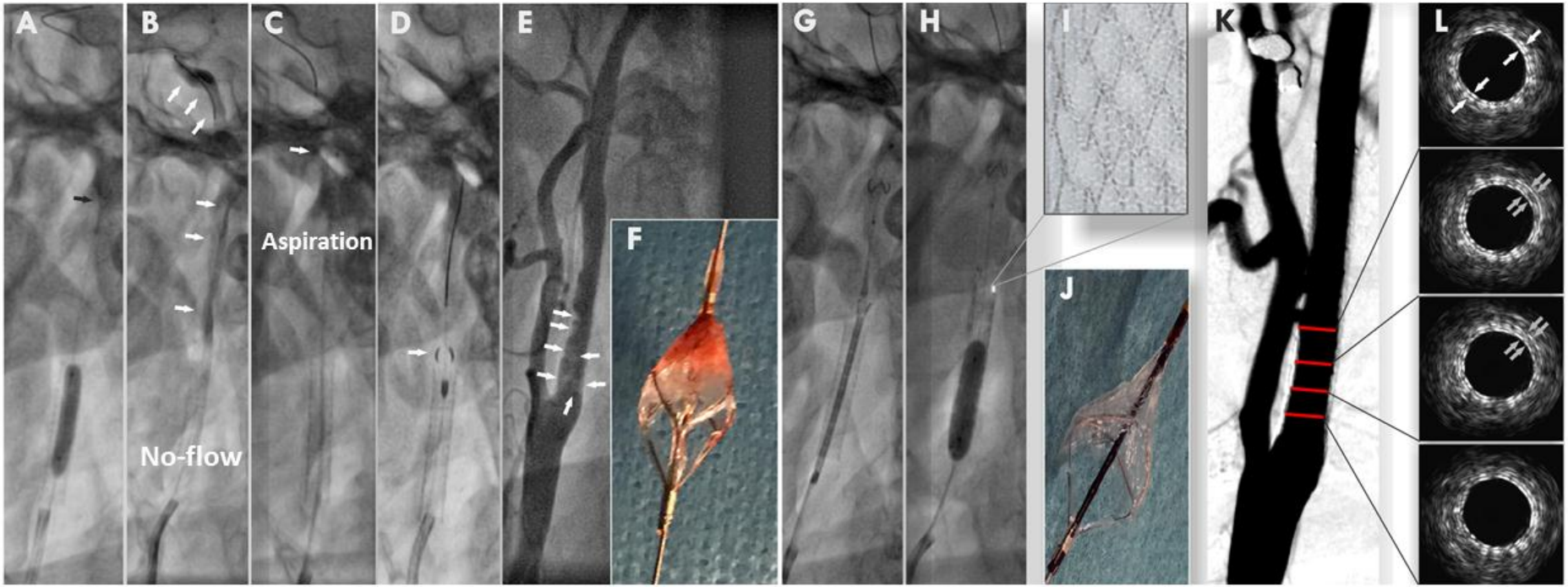

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→ TREATED with MICRONET-COVERED STENT **PLAQUE SEQUESTRATION** (2016)

Conventional Carotid Stent Design Permits Atherosclerotic Plaque In-Stent Progression

→ TREATED with MICRONET-COVERED STENT **PLAQUE SEQUESTRATION** (2016)

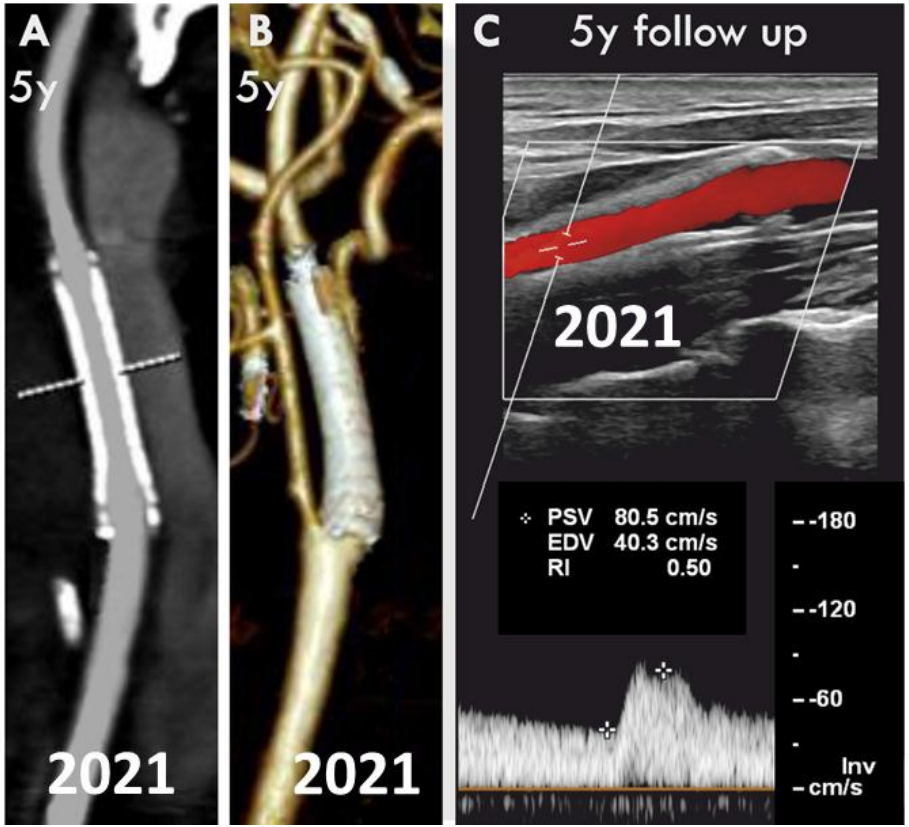
ANATOMIC

& CLINICAL

RESULT

MAINTAINED

LONG-TERM



Tekieli et al. *Eur Heart J* 2021

Conventional Carotid Stent Design Permits Atherosclerotic Plaque In-Stent Progression

→ TREATED with MICRONET-COVERED STENT **PLAQUE SEQUESTRATION** (2016)

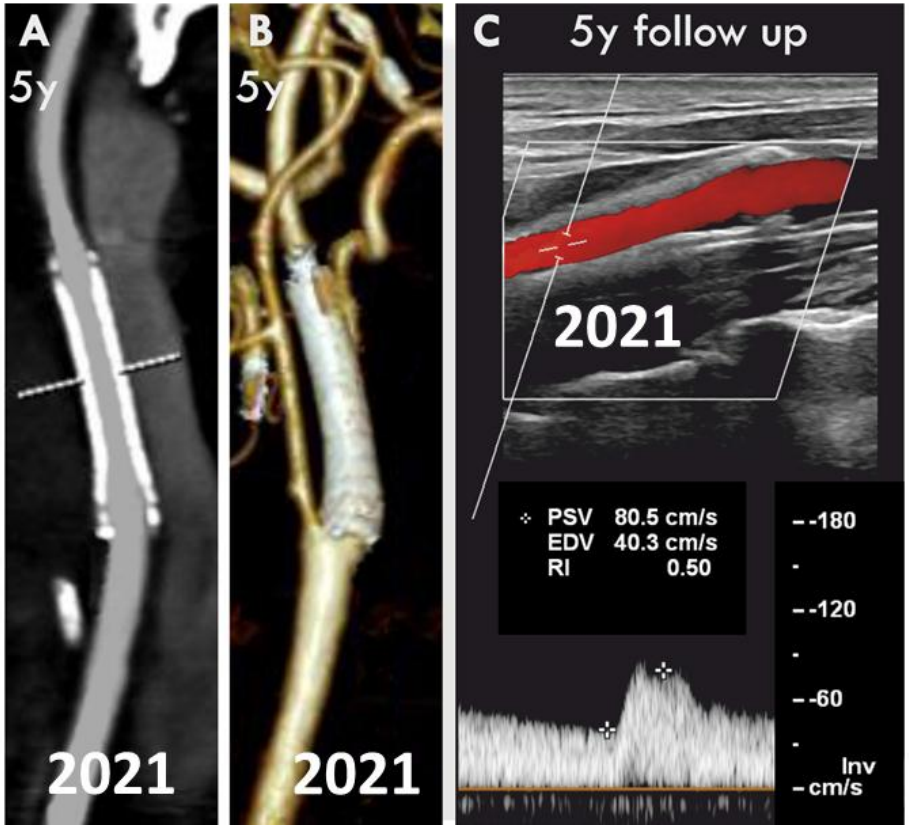
ANATOMIC

& CLINICAL

RESULT

MAINTAINED

LONG-TERM

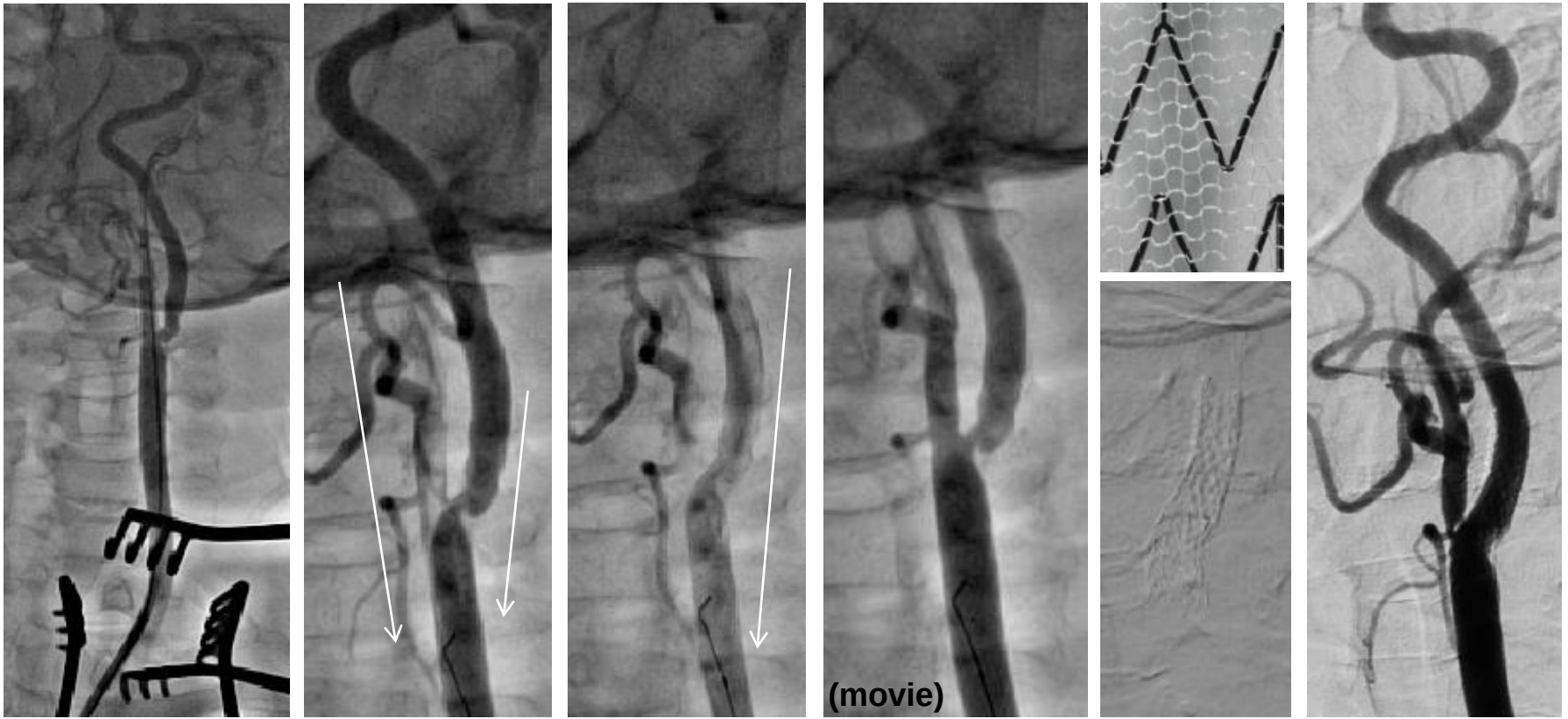


PATIENT

CURED

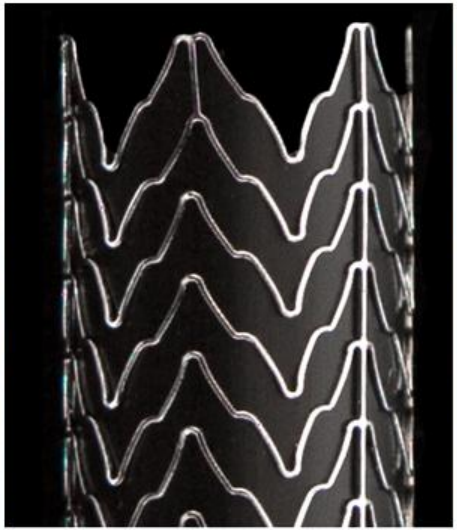
Tekieli et al. *Eur Heart J* 2021

TCAR Dynamic Flow Reversal + Embolic Prevention Stent



The MicroNET-Covered Embolic Prevention Stent System (CGuard EPS) is currently an **Investigational Device** in the U.S.A.

The Problem of conventional (single-layer) carotid stents



P Musialek, G deDonato
Carotid Artery Revascularization Using the Endovascular Route
In: **Peripheral Arterial Interventions - Practical Guide 2023**

The Problem of conventional (single-layer) carotid stents

No only ‘DURING’

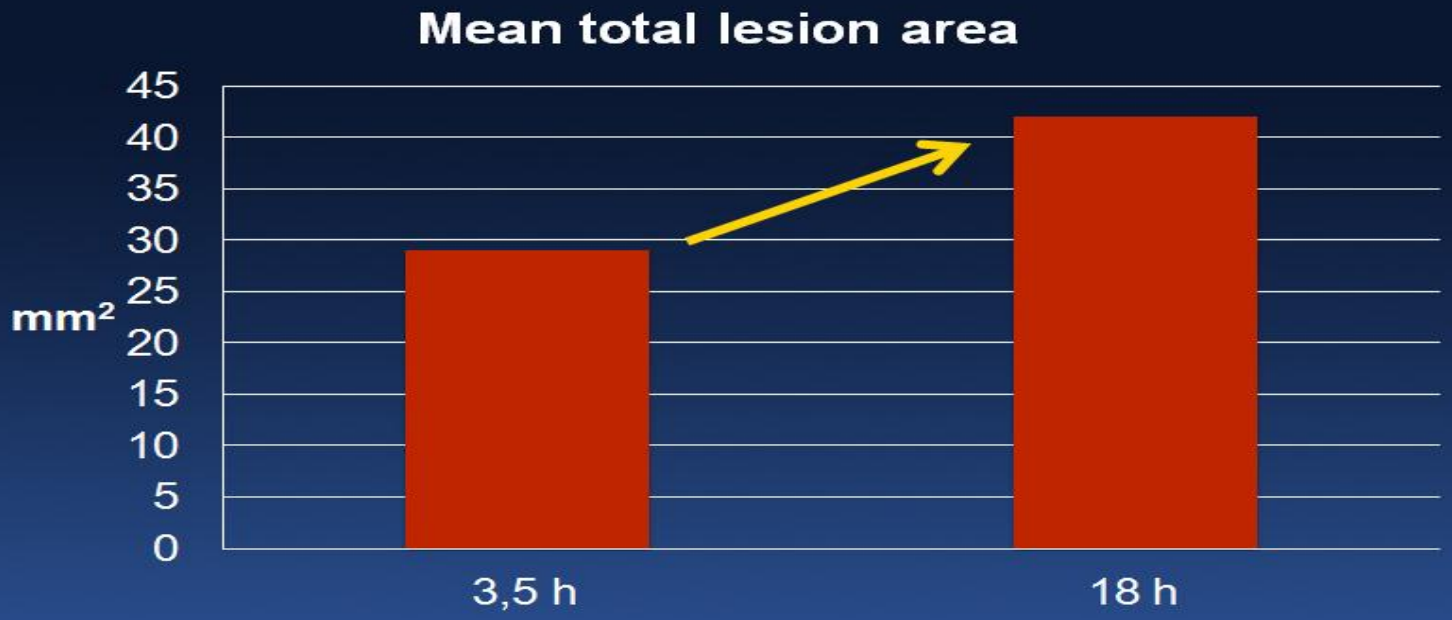
…but ALSO

‘AFTER’

CAS !

Post-procedural Embolization with conventional carotid stents

DW-MRI post CAS



Schofer J et al, JACC Cardiovasc interv 2008

MicroNET-Covered Embolic Prevention Stent System (EPS)

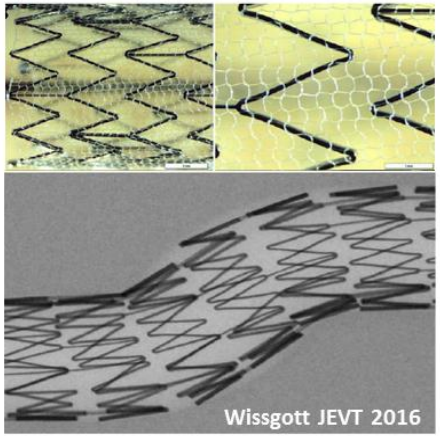
The **MOST 'open'** amongst open-cell stents (metallic FRAME)
& the **MOST 'close'** amongst close-cell stents (MicroNet mesh)

CGuard MicroNET – covered
2nd generation carotid stent

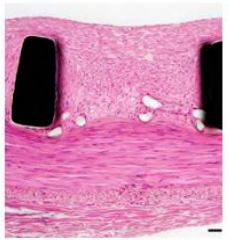
UNIQUE
mechanical
properties

RESPECT
of anatomy

FULL
apposition



NORMAL
healing



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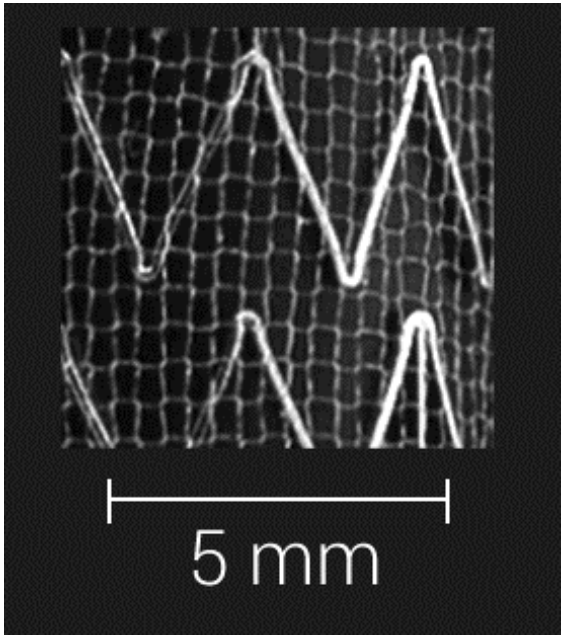
MicroNET-Covered Embolic Prevention Stent System (EPS)

MicroNET Pore Size ≈ CAS Filter Pore Size



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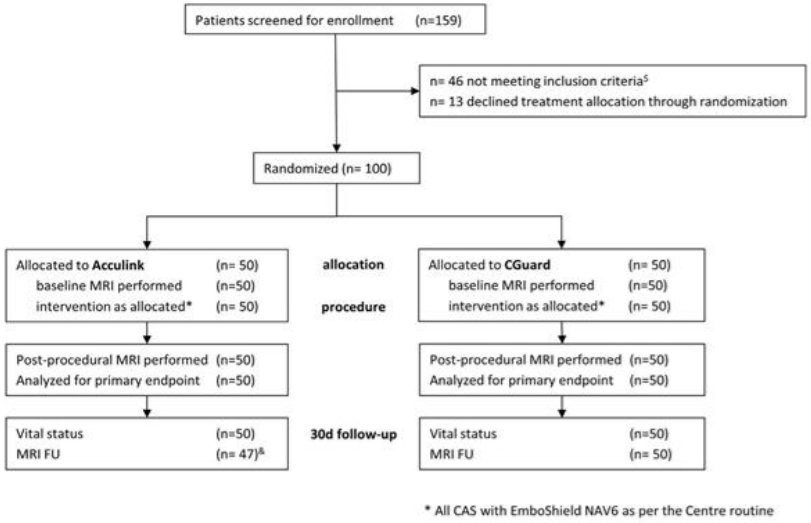
Randomized Controlled Trial of Conventional Versus MicroNet-Covered Stent in Carotid Artery Revascularization

Andrey Karpenko, MD, PhD,[a] Savr Bugurov, MD,[a] Pavel Ignatenko, MD, PhD,[a] Vladimir Starodubtsev, MD, PhD,[a] Irina Popova, MD, PhD,[a] Krzysztof Malinowski, MSc,[b] Piotr Musialek, MD, DPhil[c]

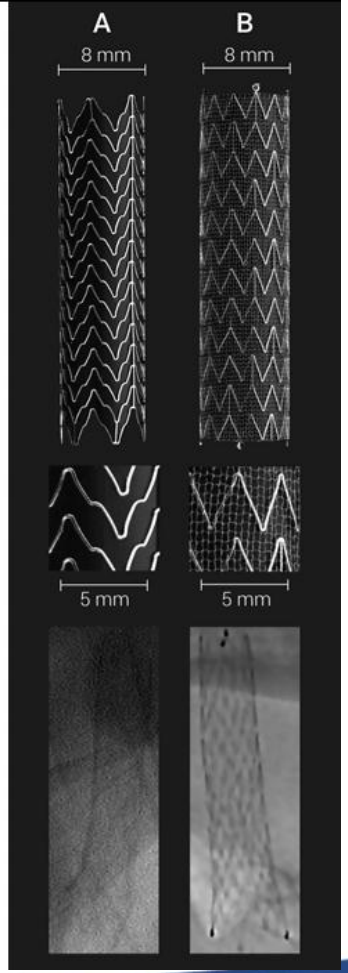


* All CAS with EmboShield NAV6 as per the Centre routine

$ Reasons for not meeting inclusion criteria were: atrial fibrillation (n=14), severe renal failure (n=12), restenotic lesion (n=9), and unsuitability for MRI examination (n=11)

& 2 patients declined on-site follow-up due to travel distance, at the follow up visit the MRI scanner was not functional in 1 (the patient declined re-visit)

JACC: CARDIOVASCULAR INTERVENTIONS VOL. 14, NO. 21, 2021



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RCT: Conventional vs. Micronet-Covered Stent

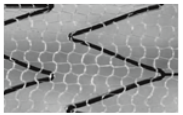
Randomized Controlled Trial of conventional versus Micronet-covered stent use in percutaneous neuroprotected carotid artery revascularization:

Peri-procedural and 30-day **diffusion-weighted magnetic resonance (DWI) imaging** and clinical outcomes

HEAD-TO-HEAD 100 consecutive increased-risk patients (25% symptomatic) **RANDOMIZED 1 : 1**

Distal EPD (Emboshield) in all

MicroNET-Covered
open-cell nitinol frame
2nd generation stent



vs.

Conventional (workhorse)
open-cell nitinol
1st generation stent

JACC Intv 2021

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JACC: CARDIOVASCULAR INTERVENTIONS

Randomized Controlled Trial of Conventional Versus MicroNet-Covered Stent in Carotid Artery Revascularization

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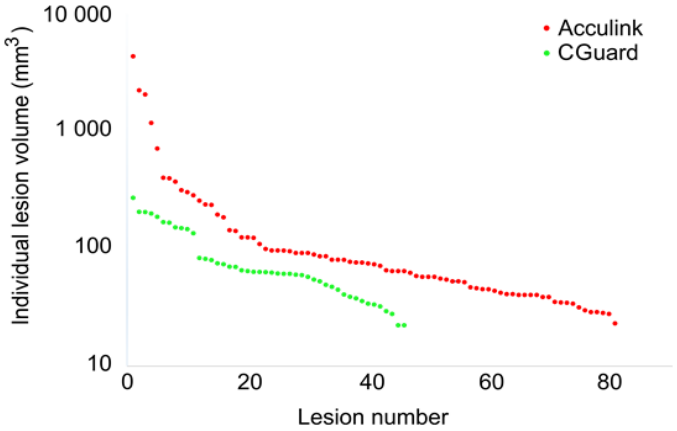
Embolic Load to the Brain

Acculink (CREST study device)

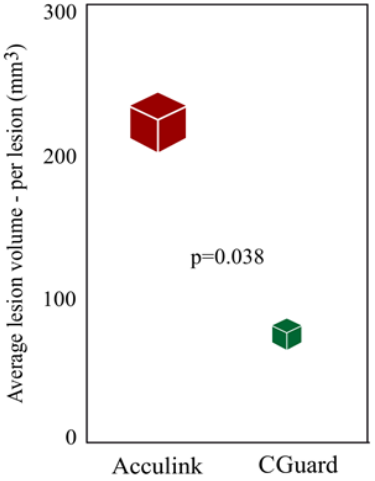
MicroNet-Covered Stent - CGuard

DW-MRI Embolism

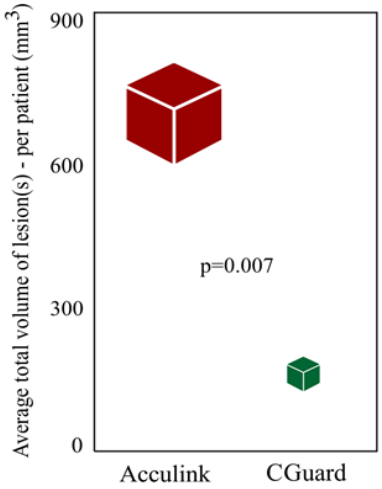
raw data



Per Lesion



Per Ipsil Haemisphere



Emboshield NAV in ALL CAS

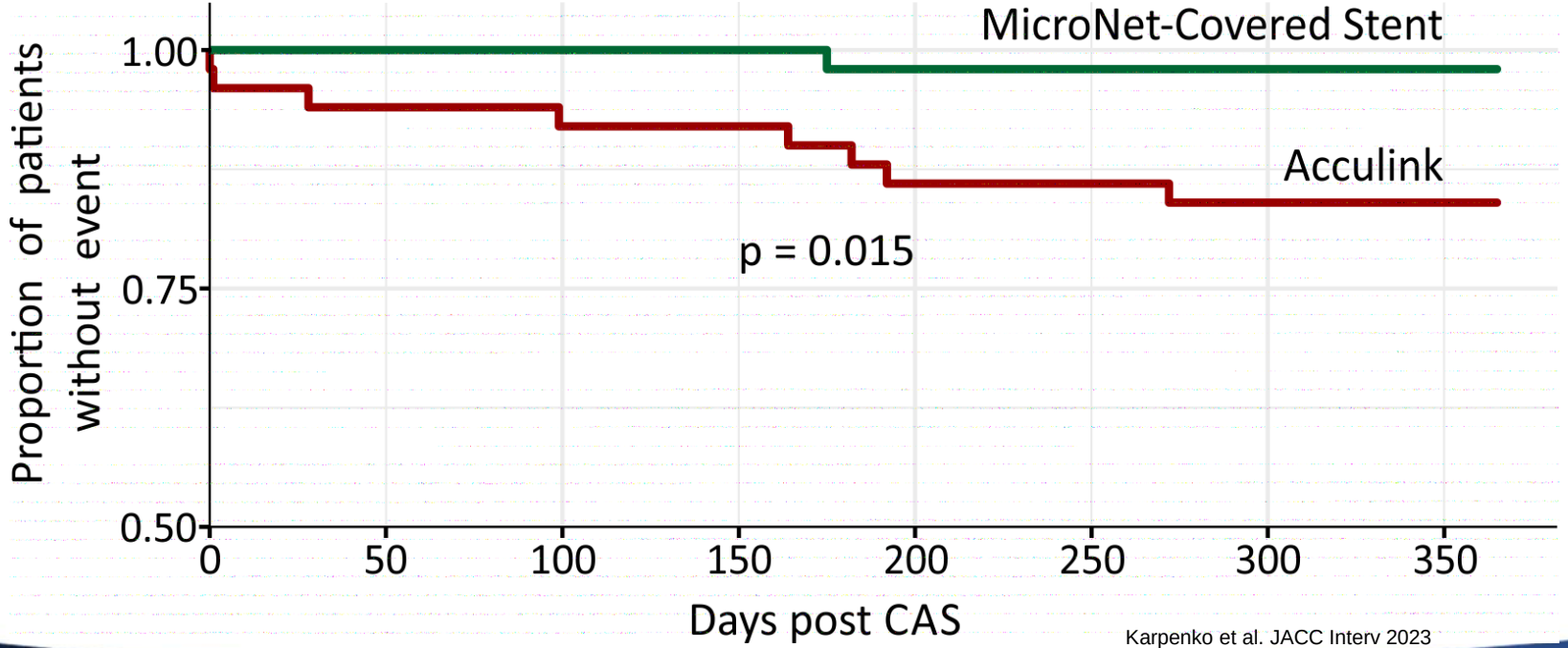
Blinded CoreLab independent anaysis

* The MicroNET-Covered Embolic Prevention Stent System (CGuard EPS) is currently an **Investigational Device** in the U.S.A.

RCT: Conventional vs. Micronet-Covered Stent

Randomized Controlled Trial of Conventional Versus MicroNet-Covered Stent in Carotid Artery Revascularization

12-month data



Karpenko et al. JACC Interv 2023

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MicroNET-Covered Embolic Prevention Stent: 5-year Data

A Prospective, Multicenter Study of a Novel Mesh-Covered Carotid Stent

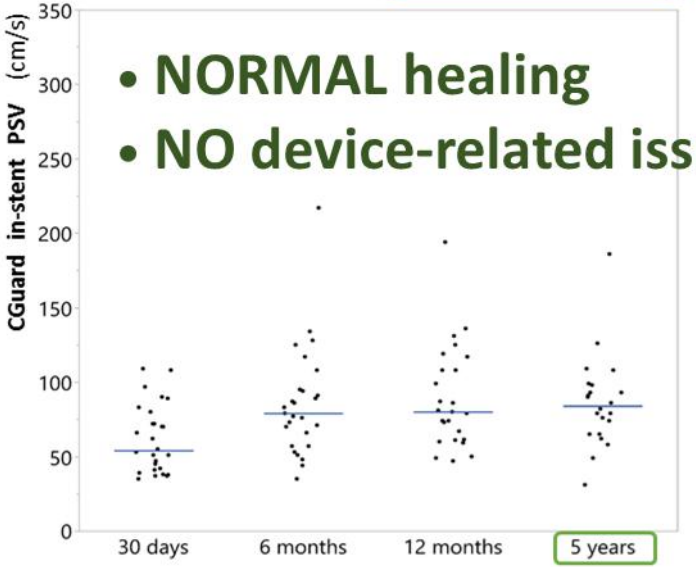
The CGuard CARENET Trial
(Carotid Embolic Protection Using MicroNet)

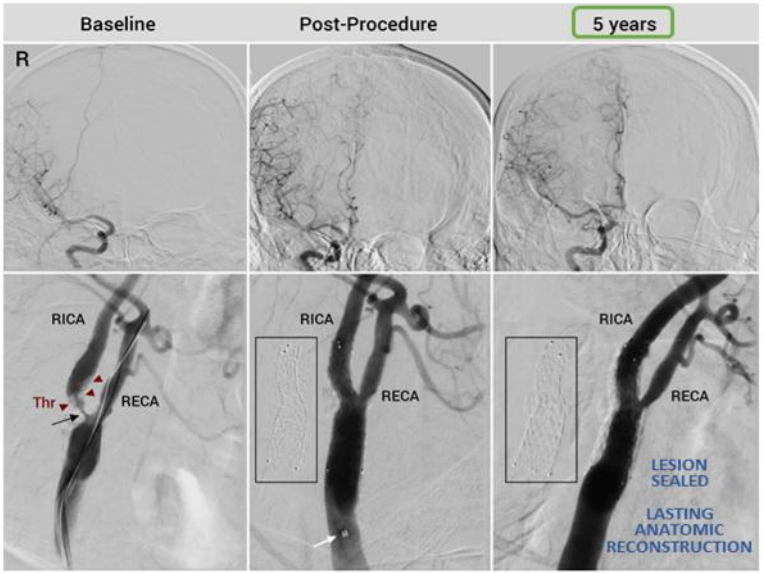
DW-MRI: prior to CAS, 48h post-procedure, and at 30 days

- minimized peri-procedural cerebral embolism
- eliminated post-procedural embolism *JACC Intv* 2015

CARENET: 5y data

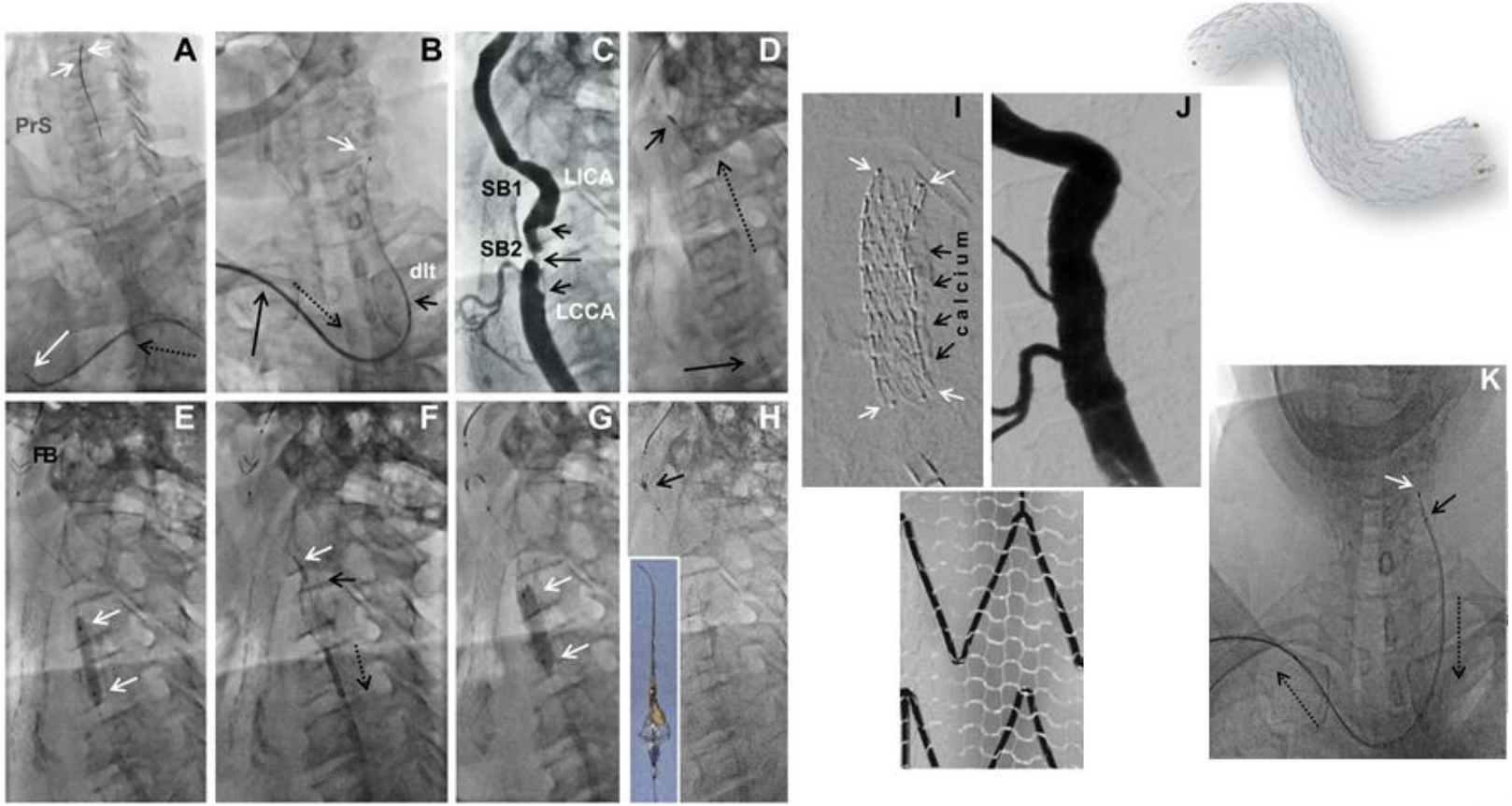
JACC Intv 2022





Musialek et al. *JACC Intv* 2022;15:1889-18912

TransRadial Embolic Prevention Stent CAS



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P Musialek, G deDonato
Carotid Artery Revascularization Using the Endovascular Route
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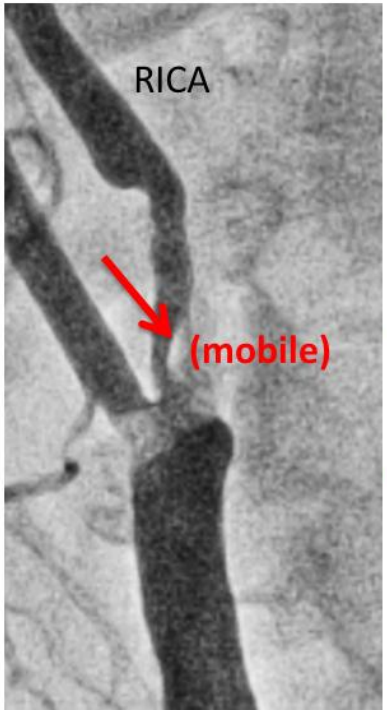
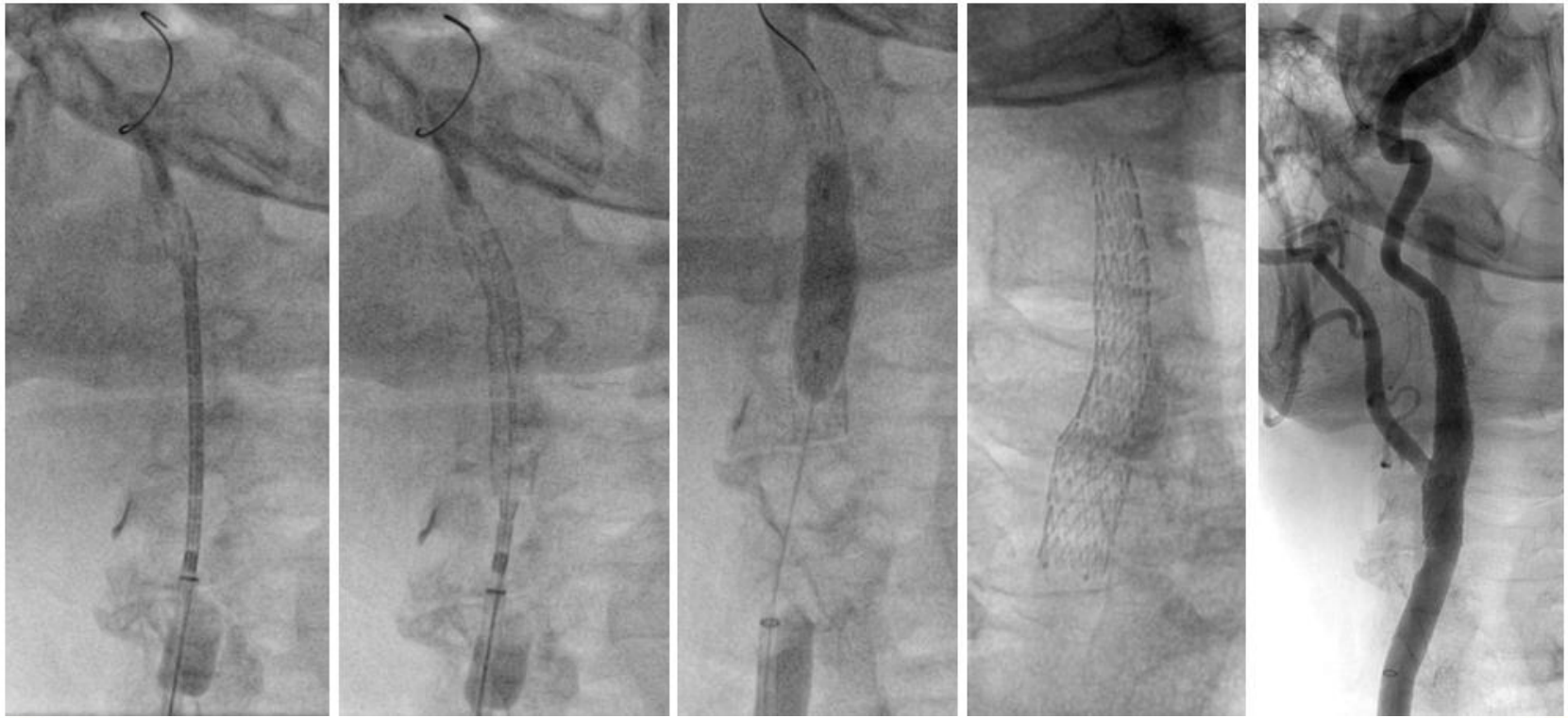
COMPETENT CAS



- (always) Neuro-protected
- NO Filter (in lesion as here)
- plaque-sequestrating stent (permanent protection)

P Musialek, G de Donato. *Carotid artery revascularization using the endovascular route*. In: Peripheral Interventions – Practical Guide. Minerva Medica 2023

Under FR: Predil + MicroNet-Covered EPS + Postdil



* The MicroNET-Covered Embolic Prevention Stent System (CGuard EPS) is currently an **Investigational Device** in the U.S.A.

Final result od PROX-protected CAS with Embolic Prevention Stent:

A COMPETENT CAS

Safe and Effective Procedure

Absence of Residual Stenosis

FULL Anatomic & Functional reconstruction

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Carotid Revascularization For Stroke Prevention in 2023+

”CEA” *”or”* **”TCAR”** *”or”* **”CAS”**

Carotid Revascularization For Stroke Prevention in 2023+

"CEA" ~~"or"~~ "TCAR"* ~~"or"~~ "CAS"

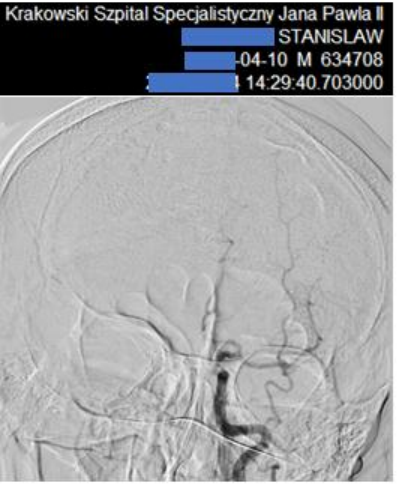


WHAT CEA?

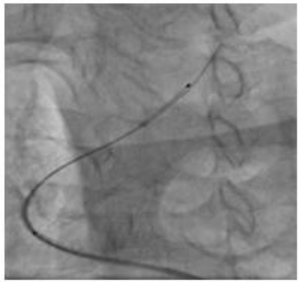
WHAT TCAR?

WHAT CAS?

CGuard MicroNET Stent to treat acute ischaemic stroke

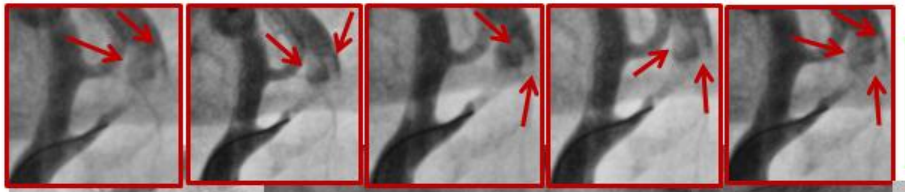


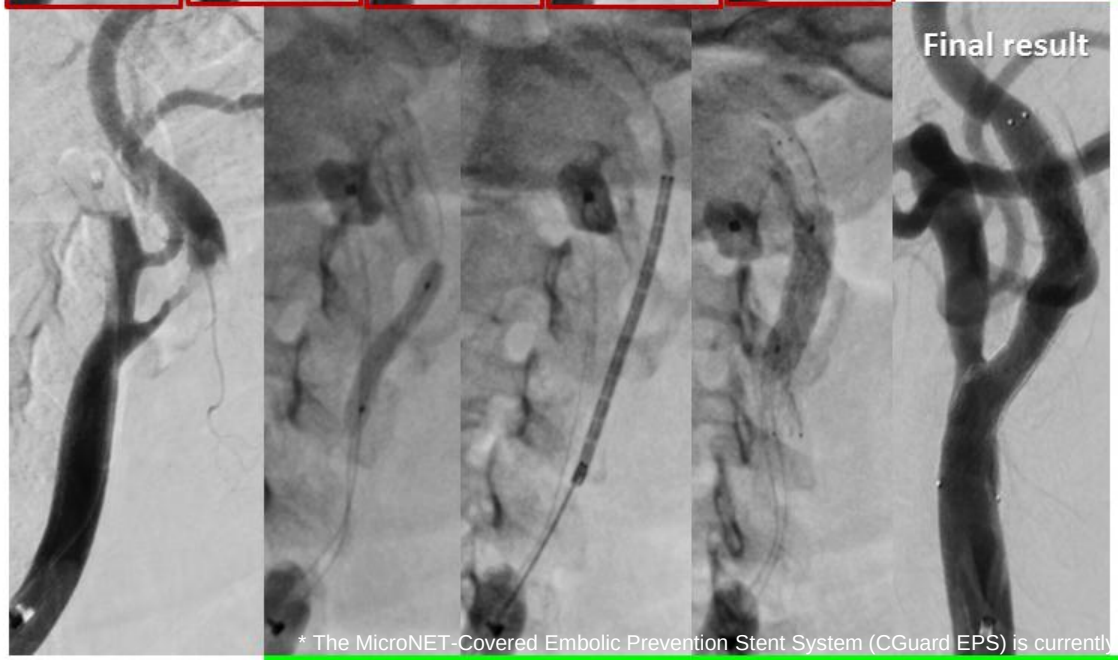
- R-limbs heamiparesis
- TOTAL motoric aphasia
- Severe sensoric aphasia



IFU-heparinization (ACT 261s)

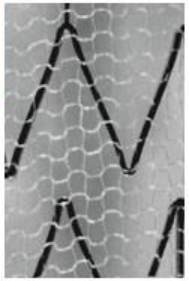
Haemodynamically critical, floating thrombotic lesion



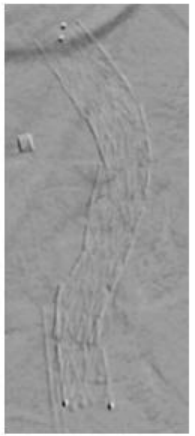


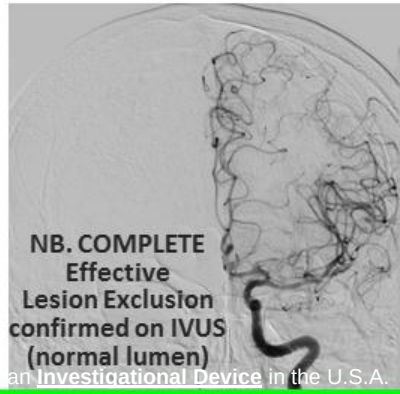
IMMEDIATE Regression of symptoms

CGuard*



MicroNET





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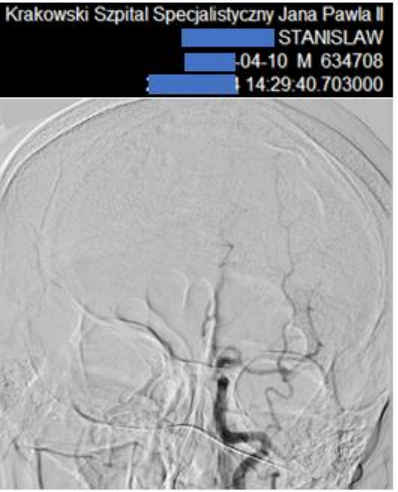
SAFE & uncomplicated, with optimal angiographic and clinical outcome

CGuard MicroNET Stent to treat acute ischaemic stroke



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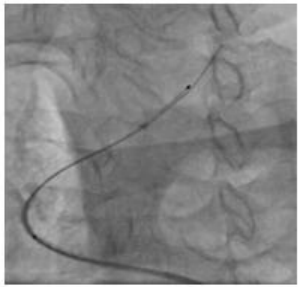
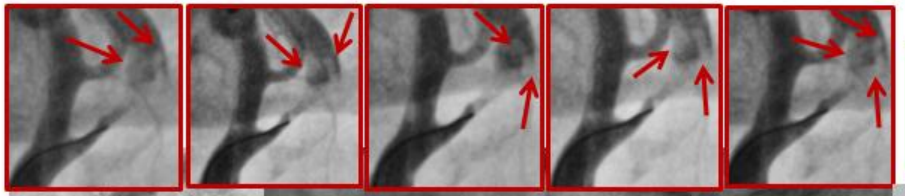
- TOTAL motoric aphasia
- Severe sensoric aphasia



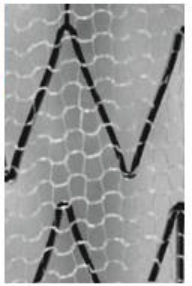
IFU-heparinization (ACT 261s)

Haemodynamically critical, floating thrombotic lesion

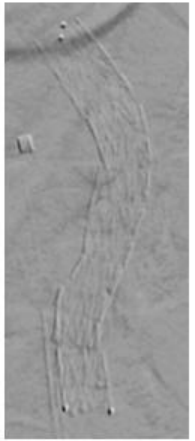


IMMEDIATE regression of symptoms

CGuard*



MicroNET



Final result

FLOW REVERSAL!

is a MUST in ENDO Tx of these lesions!

NB. COMPLETE Effective Lesion Exclusion confirmed on IVUS (normal lumen)

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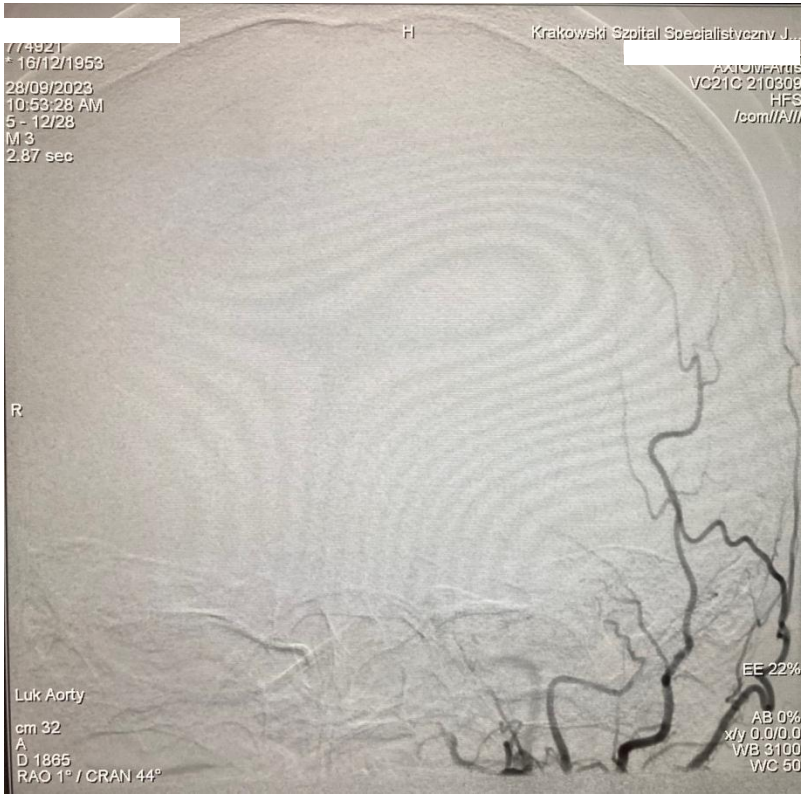
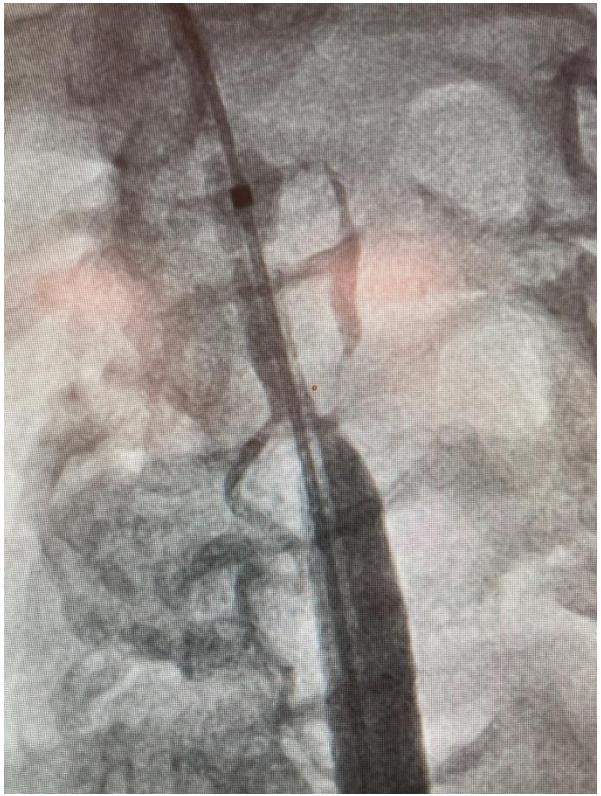
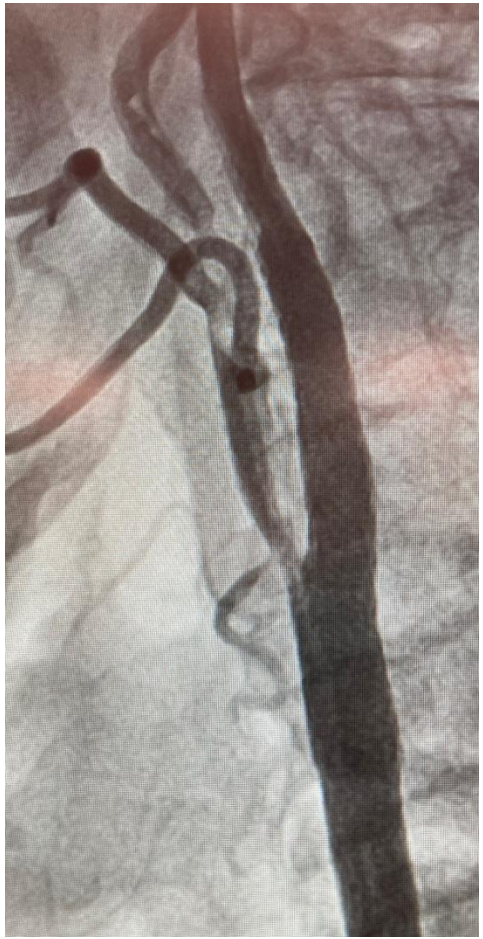
SAFE & uncomplicated, with optimal angiographic and clinical outcome

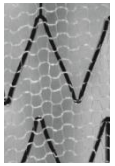
Lady, 69 yo L-haemispheric Stroke-in-evolution (September 28, 2023)







Mo.Ma Flow Reversal + MicroNET-Covered EPS (Embolic Prevention Stent)



with CGuard ’FULL’ optimization

The MicroNET-Covered Embolic Prevention Stent System (CGuard EPS) is currently an **Investigational Device** in the U.S.A.

A/S Carotid Stenosis
Decision-making

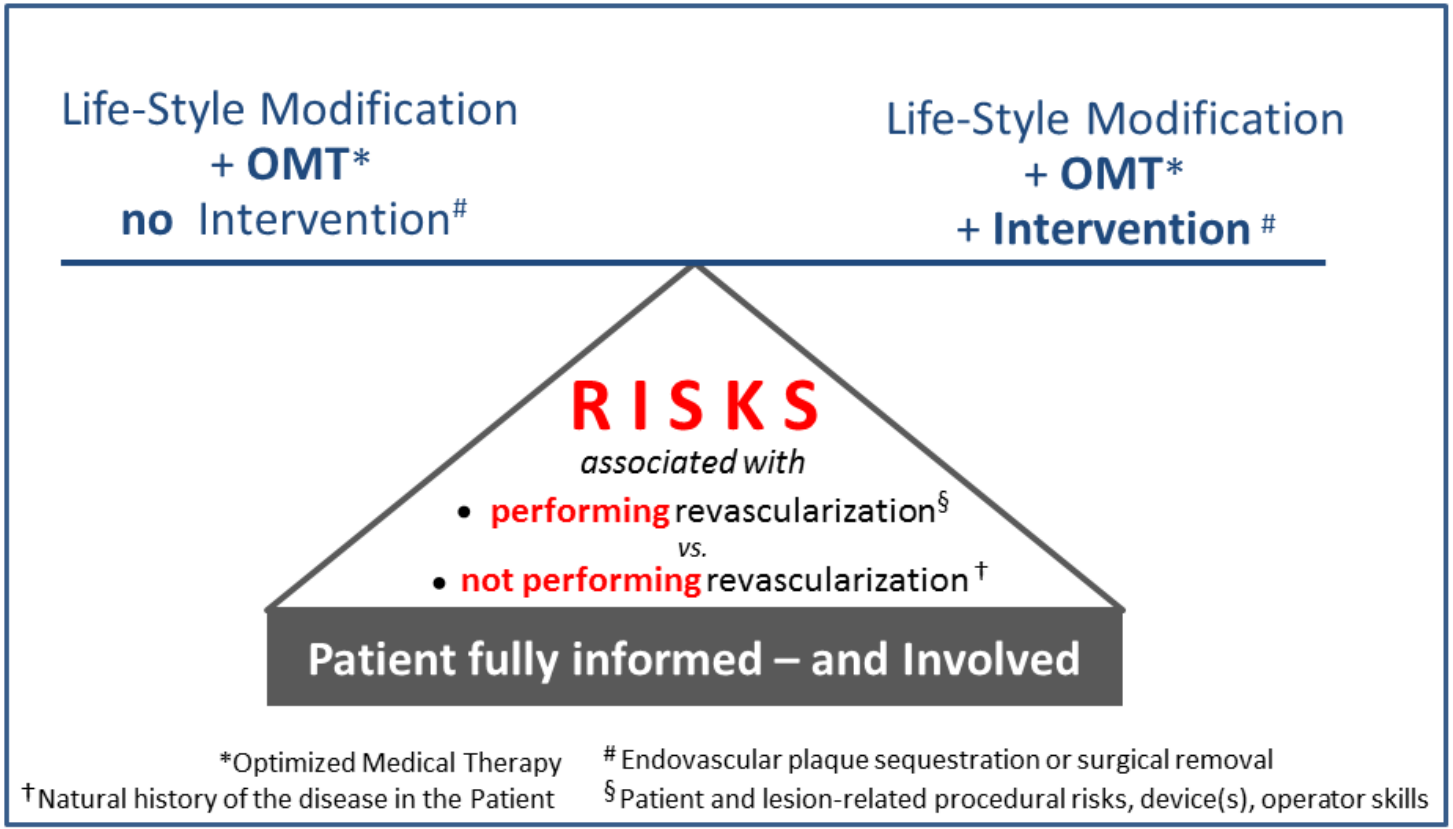
Maximized Prevention

"Waiting - for - stroke"

PHARMACOTHERAPY
+ INTERVENTION

ISOLATED
PHARMACOTHERAPY

Fig 14.6 Contemporary Prevention of Carotid-Related Stroke: Fundamental factors



P Musialek, G de Donato. *Carotid artery revascularization using the endovascular route*. In: Peripheral Interventions – Practical Guide. Minerva Medica 2023

Double-Layer Carotid Stents: From the Clinical Need, through a Stent-in-Stent Strategy, to Effective Plaque Isolation… the Journey Toward Safe Carotid Revascularization Using the Endovascular Route

Piotr Musiałek, MD, DPhil[1] and Gary S. Roubin, MD, PhD[2]

Journal of Endovascular Therapy
2019, Vol. 26(4) 572–577

DOI: 10.1177/1526602819861546
www.jevt.org
SAGE

Conclusions

- CAS Operators should have a working knowledge of both Proximal (Mo.Ma; FlowGate; Walrus, etc) and Distal (filters) Embolic Protection Systems (to ”tailor” their use)

  and

  should have access to the Embolic Prevention Stent System (EPS)*

- In 2023, >99% ALL-COMER carotid Patients that require revascularization can be treated SAFELY/EFFECTIVELY (PARADIGM 500/533) using the fully endovascular/percutaneous route (or TCAR) + EPS

  (…. *i.e., the Patient Preference!*)

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