SIVEC 2019: New data in carotid disease

CGuard MicroNET-Covered Embolic Prevention Stent: State of the Art

P. Musialek
on behalf of PARADIGM/PARADIGM-Extend Study Team

Jagiellonian University Dept. of Cardiac & Vascular Diseases
John Paul II Hospital, Kraków, Poland
& Collaborating Vascular Centres

Supported K/ZDS/007819 (Jagiellonian University Medical College)
John Paul II Specialist Hospital in Kraków

21st century medical care
21st century medical care

John Paul II Specialist Hospital in Kraków

Baltic Sea

Busko-Spa

Polska

Busko-Spa

Kraków

SIVEC/Siena
Sienna Vascular and Endovascular Course
September 2019

THE JOHN PAUL II HOSPITAL IN KRAKOW
Busko-Spa
Enrico Marconi  (1792 Roma

Busko-Spa
Enrico Marconi (1792 Roma –)

Busko-Spa
Enrico Marconi  (1792 Roma – 1863 Varsovia)
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Palazo Pac, Varsovia – Ministry of Health
CGuard
Conventional Carotid Stents

Do Have A Problem

Human carotid artery treated using a conventional stent; OCT

Image courtesy Joan Rigla, MD PhD; Perceptual Imaging Lab, University of Barcelona
Conventional Carotid Stents Do Have A Problem

This translates into post-procedural minor strokes during the stent healing (≈30 days)

(CREST, CAPTURE)

≈40% 30d-strokes are post-procedural
• CEA, by excluding the plaque, excludes the post-procedural problem of the plaque.
CEA, by excluding the plaque, excludes the post-procedural problem of the plaque.

In CAS, the stent needs to exclude the plaque too.
• CEA, by excluding the plaque, excludes the post-procedural problem of the plaque.

FUNDAMENTAL

CAROTID PLAQUE SEQUESTRATION

• In CAS, the **stent needs to exclude the plaque too**
## CGuard™—Carotid Embolic Prevention System

### System specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stent type</td>
<td>Nitinol – self expanding</td>
</tr>
<tr>
<td>Micronet aperture size</td>
<td>150-180 μm</td>
</tr>
<tr>
<td>Guidewire</td>
<td>0.014”</td>
</tr>
<tr>
<td>Sizes</td>
<td></td>
</tr>
<tr>
<td>- Diameter</td>
<td>6-10mm</td>
</tr>
<tr>
<td>- Length</td>
<td>20-60mm</td>
</tr>
</tbody>
</table>

- CE Mark – March 2014

- Nitinol frame open-cell area ≈ 21 mm²
- MicroNet closed-cell area ≈ 0.3 mm²

**Carotid-dedicated design**

Musialek @ SIVEC 2019
MicroNet mesh preventing prolapse

Tomyuki Umemoto et al.
*EuroIntervention* 2017

Musialek & Stabile
*EuroIntervention* 2017
MicroNet mesh preventing prolapse

Tomyuki Umemoto et al.
*EuroIntervention* 2017

Musialek & Stabile
*EuroIntervention* 2017
CGuard EPS  90 days/pig
CGuard: Normal Healing Profile
CGuard
clinical
Evidence
$10^+$ studies
Per-Protocol DW-MRI cerebral imaging at B/L, 24-48h after CAS, and at 30 days
The Power of DW-MRI...

48h after LICA-CAS

M. Urbanczyk, P. Banys, Dept. Radiology, JP2 Hospital, Krakow, Poland
Intra-procedural cerebral embolization is minimized.

Post-procedural cerebral embolization is eliminated.
A Prospective, Multicenter Study of a Novel Mesh-Covered Carotid Stent

The CGuard CARENET Trial
(Carotid Embolic Protection Using MicroNet)

Per-Protocol DW-MRI cerebral imaging at B/L, 24-48h after CAS, and at 30 days No stroke(s)/TIA(s)

No ISR

OBJECTIVES This study sought to evaluate the feasibility of the CGuard Carotid Carotid, a novel carotid bifurcation stent combined with a polyethylene terephthalate mesh contrast, in the treatment of carotid artery lesions in consecutive patients undergoing carotid artery stenting.

BACKGROUND The risk of cerebral embolization persists throughout the carotid artery during the stent healing period.

METHODS A total of 30 consecutive patients (age 71.6 ± 7.6 years, 63% male) meeting stenting inclusion criteria were enrolled in 4 centers in Germany and Poland.
Novel PARADIGM in carotid revascularisation: Prospective evaluation of All-comer percutaneous carotid revascularization in symptomatic and increased-stroke-risk asymptomatic carotid artery stenosis using CGuard™ Micronet-covered embolic prevention stent system

Piotr Musialek, MD, DPhil; Adam Mazurek, MD; Mariusz Trystula, MD, PhD; Anna Borratyńska, MD, PhD; Agata Lesniak-Sobela, MD, PhD; Małgorzata Urbanczyk, MD; R. Paweł Banys, MSc; Andrzej Brzychczy, MD, PhD; Wojciech Zajdel, MD, PhD; Łukasz Partyka, MD, PhD; Krzysztof Zmudka, MD, PhD; Piotr Podolec, MD, PhD
Prospective evaluation of All-comer percutaneous carotid revascularization in symptomatic and Increased-risk asymptomatic carotid artery stenosis using the CGuard™ Micronet-covered embolic prevention stent system

The PARADIGM Study
Objective

- to evaluate feasibility and outcome of **routine anti-embolic stent system** use in **unselected, consecutive** patients referred for carotid revascularization (**‘all-comer’ study**)
PARADIGM study: referrals flow chart
139 carotid stenosis patient referrals

- Neurologist
- Interventional angiologist
- Vascular surgeon
- Cardiologist

Neuro Vascular Team

for carotid revascularisation
108 patients

NOT for carotid revascularisation
31 patients

n=24: increased stroke risk and/or lesion severity criteria not met
n=2: ICA totally occluded on verification
n=2: ICA functional occluded + h/o prior ipsilateral large cerebral infarct with haemorrhagic transformation
n=1: major post-stroke disability, ICA functionally occluded
n=1: severe circulatory failure (ICA stenosis asympt.)
n=1: malignancy with limited life expectancy (ICA stenosis asympt.)

PARADIGM study: revascularisation flow chart

108 patients for carotid revascularisation

(93%) -> CAS in n=100 patients (bilateral in 5)
(1%) -> CAS+CEA in n=1 patient (LICA-CEA and RICA-CAS) hybrid management
(6%) -> CEA in n=7 patients

106 ICAs treated endovascularly in 101 patients using exclusively the MicroNet-covered embolic prevention stent system

n=1 eGRF 14 → no contrast
n=2 hostile access
n=1 major ICA kink/loop
n=1 severe aortic valve disease + calcific LICA (AVR+CEA)
n=1 floating thrombus in CCA
n=1 ICA diameter <2.0 mm + contralateral ICA occlusion

CGuard™ EPS Carotid PARADIGM Study
12mo Duplex Ultrasound Data

Symptomatic – 54.5%

n=106 arteries in 101 patients

PSV (m/s)

baseline 30 days 12 months

97.0% 97.0% 96.9%
3 ECAs occluded at CAS
97/100 ECAs patent
93/96 ECAs patent

ECA* patency

12month data
PARADIGM – Extend continues as an ALL-Comer Multi-Centre Study

No exclusion criteria other than absence of carotid stenosis that requires revascularization by NVT recommendation.
PARADIGM – Extend continues as an ALL-Comer Multi-Centre Study

31 July 2019

- 402 patients / 436 arteries
  *NeuroVascular Team decision-making on endovascular revascularization*
PARADIGM – Extend continues as an ALL-Comer Multi-Centre Study

31 July 2019

- 402 patients / 436 arteries
  *NeuroVascular Team decision-making on endovascular revascularization*

- Age 48-87 years, 56.4% symptomatic

- Crossed the trial first follow-up window (30d)
PARADIGM – Extend continues as an ALL-Comer Multi-Centre Study

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- Age 48-87 years, 56.4% symptomatic

- Crossed the trial first follow-up window (30d)

- 100% CGuardEPS use, Proximal/distal EPD ≈ 50% : 50%
PARADIGM – Extend
continues as an ALL-Comer Multi-Centre Study

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  *NeuroVascular Team decision-making on endovascular revascularization*

- Age 48-87 years, 56.4% symptomatic

- Crossed the trial first follow-up window (30d)

- 100% CGuardEPS use, Proximal/distal EPD ≈ 50% : 50%

- Angiographic diameter stenosis was reduced from 84±8% to only 6.9±5% (p<0.001, ‘CEA-like’ effect of CAS)
PARADIGM – Extend
402 patients / 436 arteries

31 July 2019

- *Peri-procedural outcome*

  0 death/major stroke – 0%
  1 minor stroke – 0.25%
  1 MI (type 2) – 0.25%
PARADIGM – Extend

402 patients / 436 arteries

31 July 2019

- **Peri-procedural outcome**
  - 0 death/major stroke – 0%
  - 1 minor stroke – 0.25%
  - 1 MI (type2) – 0.25%

- **By 30 days**
  - 1 haemorrhagic transformation of prior ischaemic cerebral infarct leading to death – 0.25%
  - 1 bleeding-related death – 0.25%
PARADIGM – Extend
402 patients / 436 arteries

31 July 2019

- **Total**
  30-day death/MI/any stroke – 0.995% (4/402)

- **no post-proc. ischaemic stroke by 30 days** – 0.0% (0/402)
PARADIGM – Extend

402 patients / 436 arteries

31 July 2019

- **Total**
  - 30-day death/MI/any stroke – 0.995% (4/402)
  - no post-proc. ischaemic stroke by 30 days – 0.0% (0/402)

- Then clinical (inc. Neurology exam) and Duplex follow-up every 12 months
## PARADIGM – Extend

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Stroke Incidence</th>
<th>Any Stroke Incidence</th>
<th>Stroke-Related Death Incidence</th>
<th>MI or Other Non-Cerebral VA Incidence</th>
<th>Any Death Incidence</th>
<th>In-Stent Velocities</th>
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</thead>
<tbody>
<tr>
<td>1-12 mo</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>13</td>
<td>PSV 0.79±0.41 m/s</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EDV 0.21±0.11 m/s</td>
</tr>
<tr>
<td>13-24 mo</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>PSV 0.75±0.36 m/s</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>EDV 0.19±0.09 m/s</td>
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<tr>
<td>25-36 mo</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>PSV 0.75±0.36 m/s</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>EDV 0.20±0.09 m/s</td>
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<tr>
<td>37-48 mo</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>PSV 0.74±0.28 m/s</td>
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<td></td>
<td></td>
<td></td>
<td>EDV 0.20±0.07 m/s</td>
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</tbody>
</table>

### NB. ALL–Comer, Unselected Population

- ipsilateral stroke
- any stroke
- stroke-related death
- MI or other non-cerebral VA
- any death

### In-Stent Velocities
- PSV: 0.79±0.41 m/s
- EDV: 0.21±0.11 m/s

### Stroke Mechanisms
- CHF
- Ca
- MI
- COPD
- urosepsis
- surg

**NB.** ALL–Comer, Unselected Population (eg. AFib 8.9%)
**By 48 months**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Number (n)</th>
<th>ipsilateral stroke</th>
<th>any stroke</th>
<th>stroke-related death</th>
<th>MI or other non-cerebral VA</th>
<th>any death</th>
<th>in-stent velocities</th>
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<tbody>
<tr>
<td>1-12 mo</td>
<td>311</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>PSV 0.79±0.41 m/s</td>
</tr>
<tr>
<td>13-24 mo</td>
<td>205</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>EDV 0.21±0.11 m/s</td>
</tr>
<tr>
<td>25-36 mo</td>
<td>108</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>PSV 0.75±0.36 m/s</td>
</tr>
<tr>
<td>37-48 mo</td>
<td>61</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>PSV 0.74±0.28 m/s</td>
</tr>
</tbody>
</table>

**Normal healing**

- No Stent Thrombosis
- No abnormal ISR signal

(Per-vessel ISR 0.92% - 4/436; DEB-PTA)

**NB. ALL-Comer Unselected Population**

(eg, AFib 8.9%)
PARADIGM–EXTEND

@ 48 months
Favourable Cerebral Outcome

• NO device-related adverse events
• NO procedure-related events

s u s t a i n e d stroke prevention
Endovascular Solution for All-Comers

Endovascular Reconstruction of the Carotid Bifurcation

Prevention of embolism, High radial force, Conformability
systematic

CEA-like effect of CAS
<table>
<thead>
<tr>
<th>Study</th>
<th>2200 pts</th>
<th>Specialist</th>
<th>Status</th>
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<tbody>
<tr>
<td>CARENET</td>
<td>30 pts</td>
<td>DW-MRI</td>
<td>Multi</td>
</tr>
<tr>
<td>PARADIGM</td>
<td>100 pts</td>
<td>All comer</td>
<td>Multi</td>
</tr>
<tr>
<td>IRON-Guard</td>
<td>200 pts</td>
<td>Real World</td>
<td>Vasc Surgery</td>
</tr>
<tr>
<td>TORIN (MRI)</td>
<td>30 pts</td>
<td>DW-MRI</td>
<td>INR</td>
</tr>
<tr>
<td>Wissgott</td>
<td>30 pts</td>
<td>Mechanics</td>
<td>Angiology</td>
</tr>
<tr>
<td>Casana</td>
<td>80 pts</td>
<td>Real World</td>
<td>Vasc Surgery</td>
</tr>
<tr>
<td>Wissgott NG</td>
<td>20 pts</td>
<td>New Gen</td>
<td></td>
</tr>
<tr>
<td>IRON-Guard 2</td>
<td>500 pts</td>
<td>Real World</td>
<td>Vasc Surgery</td>
</tr>
<tr>
<td>PARADIGM-Extend</td>
<td>300 pts</td>
<td>All comer</td>
<td>Multi</td>
</tr>
<tr>
<td>CGuard Vasc Surg (Poland)</td>
<td>500 pts</td>
<td>Real World</td>
<td>Vasc Surgery</td>
</tr>
<tr>
<td>CGuard vs. Acculink RCT</td>
<td>100 pts</td>
<td>(DW-MRI)</td>
<td>Vasc Surgery</td>
</tr>
<tr>
<td>CGuard PRO</td>
<td>500 pts</td>
<td>Real World</td>
<td>Vasc Surgery</td>
</tr>
<tr>
<td>CGuard OPTIMAL</td>
<td>100 pts</td>
<td>with IVUS</td>
<td>EU KOL</td>
</tr>
<tr>
<td>TBQ: FDA</td>
<td>300 pts</td>
<td></td>
<td>Multi</td>
</tr>
</tbody>
</table>
Ostial CCA lesions
(note adequate radial force and placement precision)

OPTIMAL angiographic + clinical + duplex result @ 12mo
(and LECA patent)
High-ICA Aneurysm recurrent TIAs
High-ICA Aneurysm
recurrent TIAs

Normal CT-angio result @ 6 mo
excellent healing & no more symptoms

CONFIRMED
C U R E D 😊
44-year-old woman hairdress model
minor stroke then cresc. TIAs...

LICA

C1/C2

CGuard™ 6.0x20mm 'Smart-FIT'

Direct stenting
44-year-old woman hairdress model
minor stroke, then TIAs

Totally SEALED @ 24h

Patient CUR ED 😊 😊
This concept has been desired.  
And it works.
This concept has been desired.
And it works.

This is the future of Carotid Artery Stenting
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 and Gary S. Roubin, MD, PhD

Keywords
carotid artery stenosis, carotid artery stenting, carotid endarterectomy, closed-cell stent, MicroNET, open-cell stent, plaque protrusion, stent-graft, restenosis, double-layer stent, unstable plaque

Both surgical and endovascular routes of carotid revascularization are associated with the risk of symptomatic and asymptomatic cerebral embolism. Optimized pharmacotherapy, the mainstay of atherosclerosis management, can reduce or delay but not abolish the risk of stroke from atherosclerotic carotid artery stenosis. Interventional elimination or sequestration of the thromboembolic carotid plaque remains an important consideration in a significant proportion of patients if carotid stenosis-related strokes are to be prevented rather than experienced. This is the focus and the stent free-cell area also affect the risk of embolism after stent placement. Thus, while optimized neuroprotection during CAS may minimize intraprocedural cerebral embolism, the problem of early or delayed post-procedural embolism remains. With optimal patient selection technique and antiplatelet therapy, post-stent embolic phenomena are largely related to intrastent plaque prolapse, balloon trauma, and subsequent embolism. This may occur after the period of intraprocedural cerebral protection using flow reversal techniques and/or filters.
This concept has been desired.

And it works.

This is the future of Carotid Artery Stenting.
This concept has been desired.
And it works.

This is the future of Carotid Artery Stenting.