Carotid artery revascularization using second generation stents versus surgery: A meta-analysis of clinical outcomes

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CARMEN: CArotid **R**evascularization systematic review and **Me**ta - a**N**alysis

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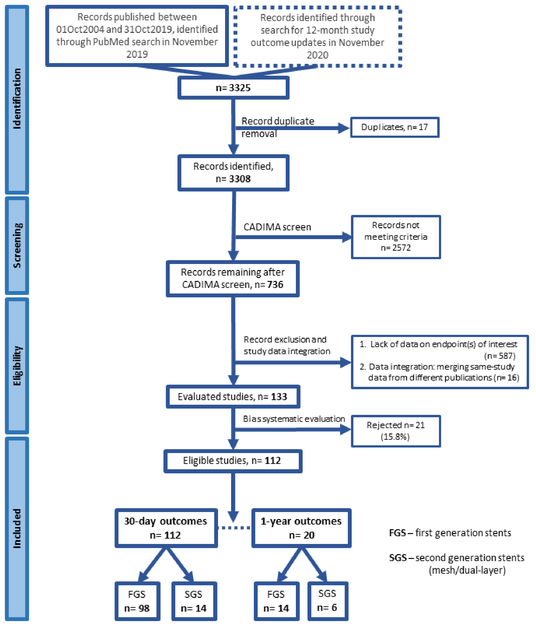
Background

Individual studies suggest that the use of second generation carotid stents (SGS; mesh-covered) may be associated with clinical outcomes that are similar (or superior) to carotid endarterectomy (CEA). Large-scale comparison is lacking.

Methods

PubMed was systematically searched for carotid stenting studies using First-Generation (single-layer) carotid stents and Second-Generation (mesh-covered) stents – SGS. Using the meta-analytical tool, SGS outcomes were compared to surgery in randomized trials (**RCTs**) involving CEA: ***SAPPHIRE, EVA 3S, SPACE-1, ICSS, CREST, ACST-1, ACT-1, Manhaim, SPACE-2,*** and to the CEA in contemporary clinical practice – **Vascular Quality Initiative** (**VQI**) database (PRISMA methodology). SGS and CEA data meta-analysis was performed using a random effect model.

CARMEN Systematic review and meta-analysis flowchart (PRISMA)



Disclosures: PM has served as an Advisory Board member/Consultant for Abbott, Inspire MD and Medtronic, and he is a Proctor for InspireMD and Medtronic

Principal findings in 169,154 meta-analyzed patients

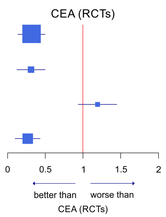
- **CGUARD MicroNET Stent and RoadSaver/ Casper *reduce* 30-day stroke compared to RCT/VQI CEA**
- **12-mo ipsilateral Stroke is *reduced* with RoadSaver and CGUARD**
- **Casper/RoadSaver and Gore Stent *increase* 12 -mo restenosis vs. CEA, wheras restenosis is *reduced* with the CGUARD MicroNET stent**

SGS vs. CEA

30-day Death/Stroke/MI

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	2531 44	100%	0.32 [0.14−0.50]
Casper/RoadSaver	585 10	23.1%	0.33 [0.12−0.54]
Gore Mesh Stent	311 15	12.3%	1.19 [0.94−1.45]
CGuard MicroNET Stent	1635 19	64.6%	0.27 [0.10−0.44]

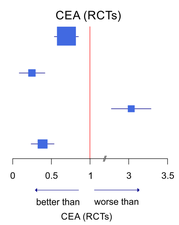
Heterogeneity: I^2=81%, τ^2=0.0003, p<0.01



12-month Ipsilateral Stroke

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	1191 15	100%	0.69 [0.54−0.85]
Casper/RoadSaver	348 3	29.2%	0.25 [0.08−0.42]
Gore Mesh Stent	290 9	24.4%	3.07 [2.85−3.29]
CGuard MicroNET Stent	553 3	46.4%	0.38 [0.23−0.53]

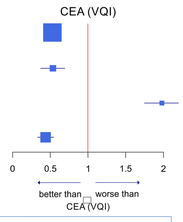
Heterogeneity: I^2=59%, τ^2<0.0001, p<0.01



30-day Death/Stroke/MI

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	2531 44	100%	0.53 [0.41−0.65]
Casper/RoadSaver	585 10	23.1%	0.54 [0.38−0.70]
Gore Mesh Stent	311 15	12.3%	1.98 [1.76−2.20]
CGuard MicroNET Stent	1635 19	64.6%	0.44 [0.33−0.55]

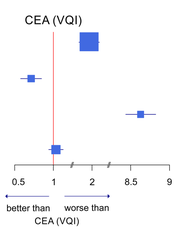
Heterogeneity: I^2=76%, τ^2=0.0001, p<0.01



12-month Ipsilateral Stroke

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	1191 15	100%	1.96 [1.83−2.09]
Casper/RoadSaver	348 3	29.2%	0.71 [0.56−0.85]
Gore Mesh Stent	290 9	24.4%	8.63 [8.43−8.83]
CGuard MicroNET Stent	553 3	46.4%	1.06 [0.96−1.16]

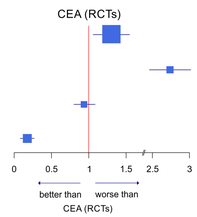
Heterogeneity: I^2=58%, τ^2<0.0001, p=0.08



12-month Restenosis

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	1191 42	100%	1.30 [1.05−1.55]
Casper/RoadSaver	348 26	29.2%	2.75 [2.48−3.02]
Gore Mesh Stent	290 14	24.4%	0.94 [0.80−1.08]
CGuard MicroNET Stent	553 2	46.4%	0.16 [0.08−0.24]

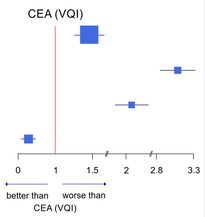
Heterogeneity: I^2=84%, τ^2=0.0002, p<0.01



12-month Ipsilateral Stroke/Restenosis

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	1191 42	100%	1.45 [1.25−1.65]
Casper/RoadSaver	348 26	29.2%	3.08 [2.84−3.32]
Gore Mesh Stent	290 14	24.4%	2.08 [1.85−2.31]
CGuard MicroNET Stent	553 2	46.4%	0.14 [0.04−0.24]

Heterogeneity: I^2=93%, τ^2=0.0002, p<0.01



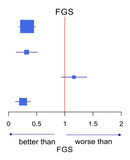
! NO "class" effect of SGS !

Second-generation vs. First-generation stents comparisons

30-day Death/Stroke/MI

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	2531 44	100%	0.32 [0.17−0.46]
Casper/RoadSaver	585 10	23.1%	0.33 [0.14−0.51]
Gore Mesh Stent	311 15	12.3%	1.17 [0.94−1.41]
CGuard MicroNET Stent	1635 19	64.6%	0.26 [0.12−0.40]

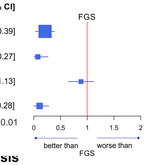
Heterogeneity: I^2=87%, τ^2=0.0004, p<0.01



12-month Ipsilateral Stroke

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	1191 15	100%	0.20 [0.02−0.39]
Casper/RoadSaver	348 3	29.2%	0.07 [0.00−0.27]
Gore Mesh Stent	290 9	24.4%	0.88 [0.64−1.13]
CGuard MicroNET Stent	553 3	46.4%	0.11 [0.00−0.28]

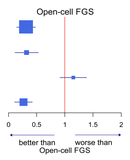
Heterogeneity: I^2=86%, τ^2=0.0002, p<0.01



30-day Death/Stroke/MI

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	2531 44	100%	0.31 [0.14−0.48]
Casper/RoadSaver	585 10	23.1%	0.32 [0.11−0.52]
Gore Mesh Stent	311 15	12.3%	1.15 [0.91−1.40]
CGuard MicroNET Stent	1635 19	64.6%	0.26 [0.10−0.42]

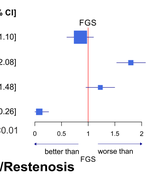
Heterogeneity: I^2=84%, τ^2=0.0003, p<0.01



12-month Restenosis

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	1191 42	100%	0.85 [0.60−1.10]
Casper/RoadSaver	348 26	29.2%	1.80 [1.53−2.08]
Gore Mesh Stent	290 14	24.4%	1.22 [0.95−1.48]
CGuard MicroNET Stent	553 2	46.4%	0.09 [0.00−0.26]

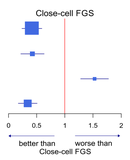
Heterogeneity: I^2=88%, τ^2=0.0003, p<0.01



30-day Death/Stroke/MI

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	2531 44	100%	0.41 [0.23−0.59]
Casper/RoadSaver	585 10	23.1%	0.42 [0.21−0.63]
Gore Mesh Stent	311 15	12.3%	1.53 [1.28−1.79]
CGuard MicroNET Stent	1635 19	64.6%	0.34 [0.17−0.51]

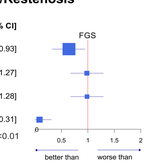
Heterogeneity: I^2=73%, τ^2=0.0002, p<0.01



12-month Ipsilateral Stroke/Restenosis

Study	Patients Events	Weight	Risk Ratio [95% CI]
SGS	1191 57	100%	0.63 [0.32−0.93]
Casper/RoadSaver	348 29	29.2%	0.97 [0.66−1.27]
Gore Mesh Stent	290 23	24.4%	0.97 [0.66−1.28]
CGuard MicroNET Stent	553 5	46.4%	0.09 [0.00−0.31]

Heterogeneity: I^2=92%, τ^2=0.0012, p<0.01



FGS = First-Generation (single-layer) carotid Stents
SGS = Second-Generation (dual-layer)carotid Stents
- Metallic (Nitinol) Mesh Inside - **Casper/RoadSaver**
- PTFE Membane Cover outs' - **Gore Carotid Stent**
- PET MicroNET-Cover outside - **CGuard**

CEA = Carotid Endarterectomy (surgery)

Meta-Analyzed Populations Clinical Characteristics

(SGS vs CEA)	RCTs CEA	VQI CEA	SGS	p RCTs-CEA vs SGS	p VQI-CEA vs SGS
No of studies	9	2	14	-	-
No of patients	5,335*	95,776*	2,152*	-	-
Age	69.4 (1.5)	71	71.9 (2.5)	0.03	-
Male [%]	69%	61%	73%	0.71	0.29
Symptomatic [	37%	23%	41%	0.75	0.83
Diabetic	29%	35%	32%	0.44	0.99
CAD	41%	27%	47%	0.75	0.35
AFib	3%	nd	3%	1.0	-
Contralateral occlusion [%]	7%	nd	16%	0.56	-

* as per published (Public Domain) data

Results

30-day Death/Stroke/MI (DSM) was 3.76% for CEA and 1.34% for SGS taken as a group (p<0.001). Both Casper/Roadsaver (CR) and CGuard (CG) showed a significant reduction in DSM by an absolute –2.45% and –2.70% (p=0.002 and p<0.001) whereas the Gore stent (GS) showed a non-significant increase in the event rate (+1.11%, p=0.48). For pooled SGS's, there was no difference between SGS and CEA in 12-month combined ipsilateral stroke (IS) and restenosis (R) (4.1% vs. 4.8%; p=0.85). However, there was a significant difference in the combined 12-month endpoint (IS+R) for the individual SGS (increase to 7.9% with CR, reduction to 0.6% with CG, increase to 6.6% with GS), translating into their different effect against the CEA 12-mo IS+R (CEA - 4.1%).

Conclusions

- **SGS reduce 30-day stroke rate against CEA; an effect driven by MicroNET-covered CGUARD and by the RoadSaver/Casper stent.**
- **12-month adverse outcomes are *reduced* with CGUARD, *increased* with RoadSaver/Casper, and are not significantly affected by the Gore Stent.**

Findings from this meta-analysis may impact clinical decision-making in carotid revascularization.

References
1. Mazurek A et al. 2021 (at review); 2. Dakour-Aridi H et al. *Ann Vasc Surg.* 2020;65:1-9; 3. Columbo JA, et al. *J Vasc Surg.* 2019;69:104-109; 4. Karpenko A. et al. *J Am Coll Cardiol Intv*. 2021 (Nov 8);14: 2377-2387.

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