TCAR Is Safe In Recently Symptomatic Patients And Those With Contralateral Carotid Occlusions: Why It Should Be The Procedure Of Choice In Those Conditions

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Peter A. Schneider Disclosures

Consulting:

Surmodics, Medtronic, Boston Scientific, Phillips, Cagent, Acotec, Abbott, Endologix, Shockwave, Silk Road, Healthcare Inroads, Inari, BD

Carotid Repair in Patients With Contralateral Carotid Artery Occlusion

- Higher burden of atherosclerosis
- More CAD
- Hemodynamic instability is more risky
- Both hemispheres at risk
- Increased in-hospital stroke risk with CEA
  - 4.2% with CCO vs 2.5% without
  - 3.7% with CCO vs 2.2% without (symptomatic)

Menyhei et al. Eur J Vasc Endovasc Surg 2011;41:735
Rockman et al. J Vasc Surg 2002;36:668

TCAR vs CEA in Contralateral Carotid Occlusion

CEA (N=2527) vs TCAR (N=1182)

Outcomes	Univariable analysis					Multivariable analysis			
	CEA		TCAR		p Value	TCAR vs CEA (reference)			Hosmer-Lemeshow
	n	%	n	%		OR (95% CI)	p Value	C-statistic	p Value
Stroke or death*	70	2.8	17	1.5	0.02	0.57 (0.29-1.10)	0.10	0.71	0.51
Stroke, death, or MI	85	3.4	21	1.8	0.01	0.52 (0.28-0.94)	0.03	0.72	0.18
Stroke	60	2.4	17	1.5	0.10	0.65 (0.33-1.28)	0.21	0.70	0.18
Death	19	0.75	6	0.5	0.44	0.78 (0.27-2.27)	0.65	0.81	0.75
MI	18	0.7	5	0.4	0.33	0.45 (0.17-1.18)	0.10	0.86	0.77

Stroke/death
CEA 2.8%
TCAR 1.5%

Dakour-Aridi et al. J Am Coll Surg 2021

TCAR vs CEA in Contralateral Carotid Occlusion

Asymptomatic

Outcomes	CEA (n = 2,063)		TCAR (n = 937)		p Value	TCAR vs CEA	
	n	%	n	%		OR (95% CI)	p Value
Stroke or death	51	2.5	10	1.1	0.01	0.44 (0.21-0.95)	0.04
Stroke, death, or MI	62	3.0	13	1.4	0.01	0.41 (0.21-0.82)	0.01
Stroke	47	2.3	10	1.1	0.02	0.46 (0.21-0.97)	0.04

Symptomatic

Outcomes	CEA (n = 464)		TCAR (n = 207)		p Value	TCAR vs CEA	
	n	%	n	%		OR (95% CI)	p Value
Stroke or death	19	4.1	7	3.4	0.66	0.97 (0.39-2.40)	0.95
Stroke, death, o	23	5.0	8	3.9	0.53	0.87 (0.37-2.03)	0.74
Stroke	13	2.8	7	3.4	0.69	1.30 (0.50-3.39)	0.59

Dakour-Aridi et al. J Am Coll Surg 2021

TCAR in Contralateral Carotid Occlusion

	No CCO (n = 4892 [89.2%]), No. (%)	CCO (n = 593 [10.8%]), No. (%)	P value
In-hospital outcomes			
Ipsilateral stroke	53 (1.1)	6 (1.0)	.87
Contralateral stroke	8 (0.2)	5 (0.8)	.001
Stroke	59 (1.2)	10 (1.7)	.32
TIA	34 (0.70)	6 (1.0)	.39
Death	18 (0.37)	4 (0.67)	.27
MI	24 (0.49)	3 (0.51)	.96
Reperfusion syndrome	20 (0.41)	3 (0.51)	.73
Stroke/TIA	91 (1.9)	16 (2.7)	.17
Stroke/death	71 (1.5)	10 (1.7)	.65
Stroke/death/MI	89 (1.8)	13 (2.2)	.53
30-day outcomes			
Mortality	31 (0.6)	5 (0.8)	.55
Available follow-up*	11,227 (25.1)	132 (22.3)	.13
Stroke	14 (1.5)	2 (2.0)	.66
Stroke/death	16 (1.3)	2 (1.5)	.69
Stroke/death/MI	22 (1.8)	3 (2.3)	.73

Stroke/death rates with TCAR about the same whether contralateral occlusion is present or not.

Dakour-Aridi et al. J Vasc Surg 2021;73:524

Carotid Repair: Recently Symptomatic Patients

- Unstable plaque
- Early CEA appears to be relatively safe
  - Very early CEA may have higher risk of perioperative stroke and death.
  - Swedevasc: <2d=11.5%, 3-14d=3.6-4.0%, >15d=5.4%

CLINICAL PRACTICE GUIDELINES

Society for Vascular Surgery clinical practice guidelines for management of extracranial cerebrovascular disease

3.1. In patients with recent stable stroke (modified Rankin scale score 0-2), we recommend carotid revascularization for symptomatic patients with >50% stenosis to be performed as soon as the patient is neurologically stable after 48 hours but definitely before 14 days after the onset of symptoms. **Level of recommendation: grade 1 (strong); quality of evidence: B (moderate).**

Savardekar et al. Neurosurgery 2019;85:E214
Stromberg et al. Stroke 2012;43:1331.
AbuRahma et al. J Vasc Surg 2022;75:4S

TCAR in Recently Symptomatic

	<2days		3-14 days		15-180 days
	N=144 (5.2%)		N=928 (35.6%)		N=1536 (58.9%)
		P value vs >15d		P value vs >15d	
Stroke	5.6%	0.01	2.5%	0.40	2.0%
Death	1.4%	0.17	1.0%	0.27	0.5%
Stroke/death	6.5%	0.01	2.9%	0.48	2.3%

In-hospital outcomes

Acceptable risk of stroke/death at 3-14 days after stroke presentation

Cui et al. J Vasc Surg 2021;73:1649

TCAR in Recently Symptomatic

Cui et al. J Vasc Surg 2021;73:1649

Variable	Interval to surgery: 0-2 Days (n = 144; 5.52%)	3-14 Days (n = 928; 35.58%)	15-180 Days (n = 1536; 58.9%)	*P* value
Demographics				
Female sex	54 (37.5)	351 (37.8)	544 (35.4)	.47
Age, years	72.6 ± 10.1	73.2 ± 10.4	72.8 ± 9.8	.62
Nonwhite race	12 (8.3)	128 (13.8)	142 (9.3)	**<.01**
Hispanic ethnicity	4 (2.8)	35 (3.8)	62 (4.1)	.74
BMI, kg/m^2	29.9 ± 6.0	28.3 ± 6.0	28.7 ± 8.1	.63
Comorbidities				
Diabetes	57 (39.6)	362 (39.0)	612 (39.8)	.92
Hypertension	128 (88.9)	838 (90.3)	1397 (91.0)	.64
Congestive heart failure	25 (17.4)	168 (18.1)	258 (16.8)	.71
Coronary artery disease	56 (38.9)	388 (41.8)	713 (46.4)	**.03**
History of CABG or PCI	44 (30.8)	302 (32.5)	543 (35.4)	.25
COPD	22 (17.2)	222 (26.9)	456 (32.8)	**<.001**
Current smoker	65 (45.1)	397 (42.8)	794 (51.8)	**<.001**
GFR <60 mL/min/1.73 m^2	82 (57.8)	508 (55.8)	910 (60.6)	.07
Dialysis	2 (1.4)	15 (1.6)	26 (1.7)	.96
Previous ipsilateral CAS/CEA	12 (8.3)	84 (9.1)	160 (10.4)	.45
Preoperative hemoglobin, g/dL	13.0 ± 2.1	13.0 ± 2.1	13.1 ± 1.9	.05
Preoperative medication				
Aspirin	127 (88.2)	833 (89.9)	1417 (92.3)	.06
β-Blocker	76 (52.8)	498 (53.7)	856 (55.7)	.53
Statin	118 (81.9)	833 (89.8)	1402 (91.3)	**<.01**
P2Y12 inhibitor	107 (74.3)	780 (84.1)	1386 (90.2)	**<.001**
ACE inhibitor	68 (47.2)	445 (48.0)	791 (51.5)	.18
Stroke presentation	71 (49.3)	528 (56.9)	779 (50.7)	**.01**
Stenosis >80%	63 (45.0)	391 (42.4)	679 (44.6)	.55
General anesthesia	117 (81.2)	709 (76.5)	1254 (81.6)	**<.01**

Recently symptomatic: less likely to be on DUAP and statin.

TCAR vs CEA in Recently Symptomatic Patients

Stroke and Death

	CEA	TCAR	Adjusted OR	
<2d	4.0	6.5	1.9 (0.9-4.0)	NS
3-14d	2.5	2.9	1.1 (0.7-1.7)	NS
>14d	1.6	2.3	1.5 (0.9-2.3)	NS

Cui et al. Stroke 2022;53:100

Odds Ratio >1.0 Favors CEA	Symptomatic	
	OR (95% CI)	P-value
Death	0.75 (0.37-1.53)	0.43
Stroke	0.96 (0.66-1.39)	0.84
MI	0.39 (0.20-0.76)	0.01
Stroke/Death	0.86 (0.60-1.23)	0.42
Stroke/Death/MI	0.70 (0.50-0.98)	0.04

TCAR (n=5716) vs CEA (n=44,442)

Malas et al. Ann Vasc Surg 2020

Adjusted for symptomatic status, age, CAD, CHF, COPD, CKD, prior ipsilateral CEA, prior ipsilateral CAS, Contralateral occlusion, ASA Class and statin use

TCAR and CEA produce similar results in recently symptomatic patients.

ROADSTER 2 Trial:

692 TCAR patients-Post Market Study

	Asymptomatic n=467		Symptomatic n=165		Age ≥ 80 n=134	
Stroke/Death/MI	9	1.9%	2	1.2%	4	3.0%
Stroke	3	0.6%	1	0.6%	2	1.5%
Death	1	0.2%	0	0.0%	0	0.0%
MI	5	1.1%	1	0.6%	2	1.5%
Stroke/Death	4	0.9%	1	0.6%	2	1.5%

Outcomes by Symptom Status and Age

Enrollment by new operators: 70%
Enrollment at site new to TCAR: 80%

Stroke

CLINICAL TRIAL 2020 Sep;51(9):2620-2629

Early Outcomes in the ROADSTER 2 Study of Transcarotid Artery Revascularization in Patients With Significant Carotid Artery Disease

Vikram S. Kashyap, MD; Peter A. Schneider, MD; Mazin Foteh, MD; Raghu Motaganahalli, MD; Rasesh Shah, MD; Hans-Henning Eckstein, MD; Steve Henao, MD; Glenn LaMuraglia, MD; Michael C. Stoner, MD; Jim Melton, DO; Douglas Massop, MD; Tod Hanover, MD; Jessica Titus, MD; Wesley S. Moore, MD; Rubén Rodríguez-Carvajal, MD; Mahmoud B. Malas, MD; Frank R. Arko III, MD; Damon Pierce, MD; Paul Anain, MD; Timothy Oskin, MD; on behalf of the ROADSTER 2 Investigators*

Perioperative Outcomes in Transcarotid Artery Revascularization Versus Carotid Endarterectomy or Stenting Nationwide

National Inpatient Sample N= 369,045

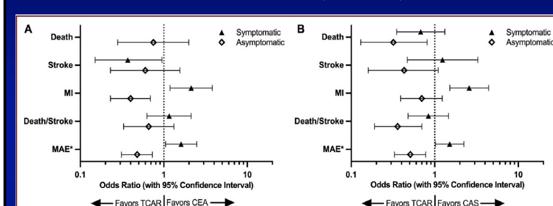

FIGURE 2. *Comparison of outcomes of carotid revascularization procedures based on symptomatic status, 2015 to 2019.* **A**, *A comparison of transcarotid artery revascularization with carotid endarterectomy (note: there were insufficient data to compare death rates in asymptomatic patients).* **B**, *Transcarotid artery revascularization compared with carotid artery stenting. *MAE is a composite outcome of death, stroke, and myocardial infarction. CAS, carotid artery stenting; CEA, carotid endarterectomy; MAE, major adverse events; MI, myocardial infarction; TCAR, transcarotid artery revascularization.*

Ramsay IA, Burks JD, Lu VM, et al. Perioperative Outcomes in Transcarotid Artery Revascularization Versus Carotid Endarterectomy or Stenting Nationwide [published online ahead of print, 2023 Sep 1]. *Oper Neurosurg (Hagerstown).* 2023;10.1227/ons.0000000000000865. doi:10.1227/ons.0000000000000865

Carotid Stent Outcomes: TCAR vs TF-CAS

Symptomatic Patients (n=3658)

Outcome[a]	Transcarotid Artery Revascularization[b] (n = 1829)	Transfemoral Carotid Artery Stenting[b] (n = 1829)	Absolute Difference (95% CI), %	Relative Risk (95% CI)	*P* Value
Stroke or death	39 (2.1)	76 (4.2)	−2.02 (−3.21 to −0.83)	0.51 (0.35 to 0.75)	<.001
Stroke or death, 30 d	47 (2.6)	88 (4.8)	−2.22 (−3.53 to −0.96)	0.53 (0.38 to 0.76)	<.001
Stroke	36 (2.0)	56 (3.1)	−1.10 (−2.17 to −0.02)	0.64 (0.42 to 0.97)	.04
Stroke, 30 d	36 (2.0)	58 (3.2)	−1.20 (−2.29 to −0.12)	0.62 (0.41 to 0.94)	.02
Transient ischemic attack	14 (0.8)	25 (1.4)	−0.60 (−1.33 to 0.12)	0.56 (0.29 to 1.08)	.08
Death	9 (0.5)	28 (1.5)	−1.04 (−1.74 to −0.33)	0.32 (0.15 to 0.68)	.002
Death, 30 d	17 (0.9)	39 (2.1)	−1.20 (−2.06 to −0.35)	0.44 (0.25 to 0.77)	.003
Myocardial infarction	1 (0.1)	6 (0.3)	−0.27 (−0.61 to 0.06)	0.17 (0.02 to 1.38)	.06
Heart failure exacerbation	11 (0.6)	17 (0.9)	−0.33 (−0.95 to 0.29)	0.65 (0.30 to 1.38)	.26
Access site bleeding complication	74 (4.0)	74 (4.1)	−0.05 (−1.40 to 1.29)	0.99 (0.72 to 1.36)	.93

Schermerhorn et al. JAMA 2019;322:2313

DW-MRI in Recently Symptomatic Patients Undergoing TCAR

Symptomatic Patients	N=31
Symptom timing	Mean 29 days (range 5-55d)
Reversed flow time	12.1 min.
Procedure time	64.4 min.
Local anesthesia	61.3%
Stroke/death	0
New DW-MRI lesions	35.5% at 48h. 15.4% at 30d
Volume new lesions	0.22ml at 48h. 0.11ml at 30d

Site Name	PI	Location	Subjects Enrolled
Complejo Hospitalario de Toledo	Dr. Jose Ignacio Leal Lorenzo	Toledo, Spain	10
Universitair Ziekenhuis Gent	Dr. Isabelle Van Herzeele	Ghent, Belgium	10
Technical University Munich	Prof. Dr. Hans-Henning Eckstein	Munich, Germany	11

TCAR in Contemporary Practice

"TCAR was increasingly used as a first-line procedural option, as patients with a history of prior ipsilateral carotid revascularization decreased by 40% over the study interval" (2016-2022)

31,447k patients entered in VQI database

606 centers performing TCAR

1 in 4 procedures are TCAR (at centers offering all 3 procedures)

~20% Standard surgical risk (2021)

20.6% ↓ 12.0% prior ipsilateral procedure 2016 vs. 2021 — Should ↓ stroke risk

19.7% ↓ 30.7% patients receiving TCAR after stroke 2016 vs. 2021 — Should ↓ stroke risk

2.3% ↓ 1.7% TCAR stroke/death rate 2016 vs. 2022 — S/D risk has fallen

Demonstrates increasing confidence in TCAR

Columbo JA et al. Adoption and Diffusion of Transcarotid Artery Revascularization in Contemporary Practice. Circ Cardiovasc Interv. 2023 Sep;16e012805. doi: 10.1161/CIRCINTERVENTIONS.122.012805. Epub 2023 Sep 19.

TCAR Is Safe In Recently Symptomatic Patients And Those With Contralateral Carotid Occlusions

Conclusion

- TCAR: competitive with CEA.
- Prospective studies with neurological control, independent adjudication show safety and efficacy.
- This is now extending to multiple specific subgroups, including; patients with recent symptoms and those with contralateral occlusion.

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