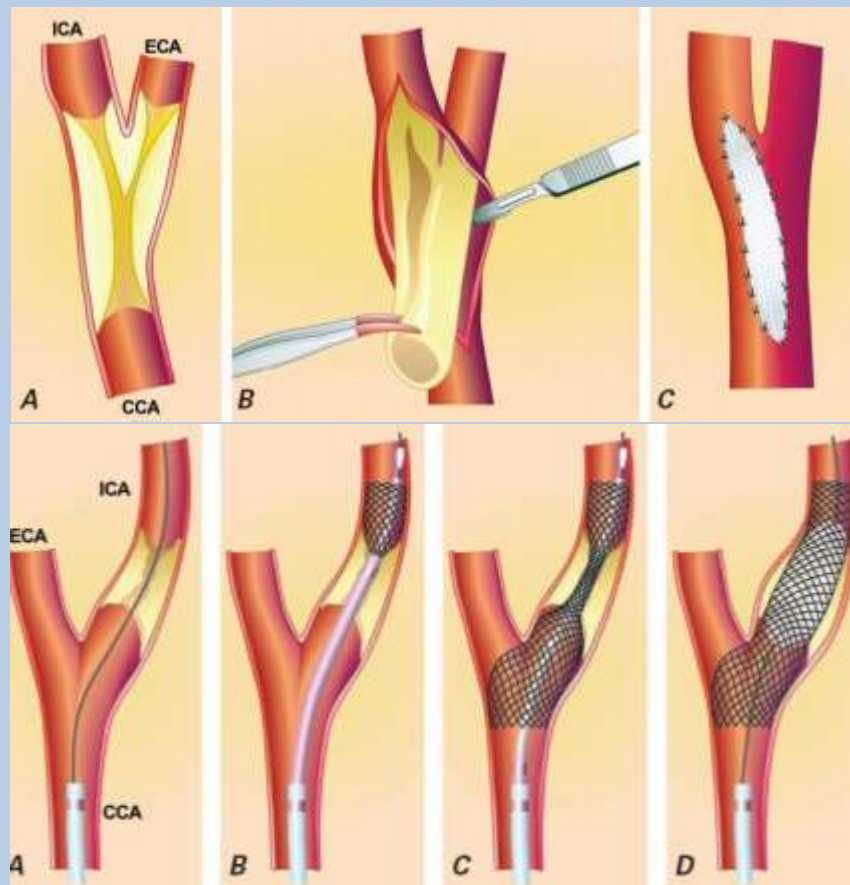


Endovascular Carotid Revascularization

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XXIII Jornadas SOLACI
Region Centroamerica y el Caribe
Agosto 8, 2014

BACKGROUND

- For the last 20 years investigators have been comparing stenting versus surgery regarding effectiveness and safety treating carotid artery stenosis
- At present more carotid revascularization procedures are performed via endovascular approach



Carotid Endarterectomy

RISKS

Cardiovascular

Hypertension (20%)

Hypotension (5%)

Myocardial infarction (1%)

Wound

Infection (1%)

Hematoma (5%)

Neurological

Hyperperfusion syndrome

Intracerebral hemorrhage

Cranial nerve injury (7%)

Seizures

Stroke (2%–6%)

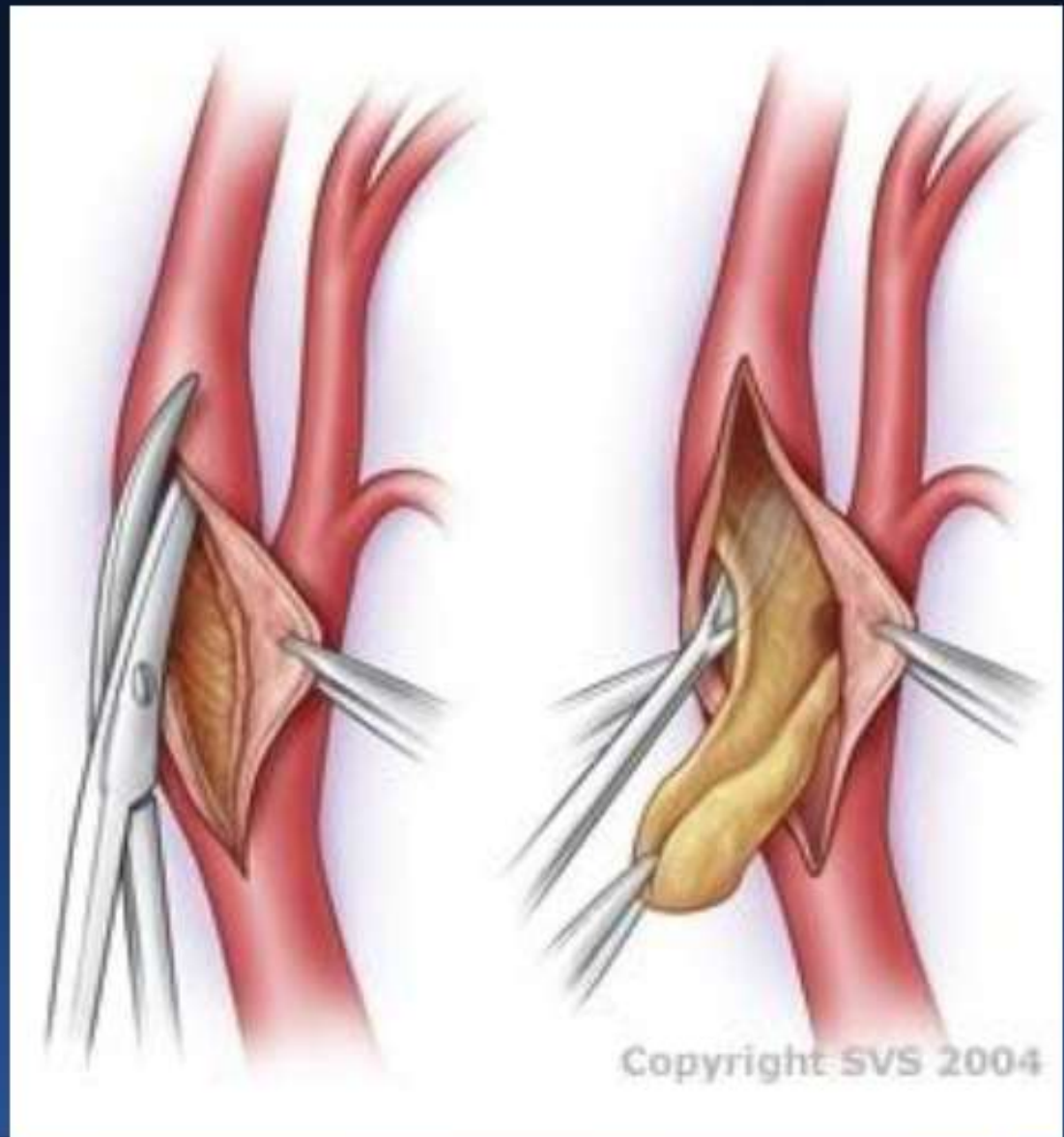
Carotid artery

Carotid artery thrombosis

Carotid artery dissection

Restenosis (5%–10%)

Death (1%)



RISKS

Cardiovascular

- Vasovagal reaction (5%–10%)
- Vasodepressor reaction (5%–10%)
- Myocardial infarction (1%)

Carotid artery

- Dissection (<1%)
- Thrombosis (<1%)
- Perforation (<1%)
- ECA stenosis or occlusion (5%–10%)
- Transient vasospasm (10%–15%)
- Restenosis (3%–5%)

Neurological

- TIA (1%–2%)
- Stroke (2%–3%)
- Intracranial hemorrhage (<1%)
- Hyperperfusion syndrome (<1%)
- Seizures (<1%)

General

- Access site injury (5%)
- Blood transfusion (2%–3%)
- Contrast nephropathy (2%)
- Contrast reactions (1%)

Death (1%)

Carotid Stenting



BACKGROUND

- Trials and Registries showed us interesting data that could affect the outcomes of the procedures
 - Patient selection
 - Clinical presentations
 - Operators expertise
 - Protection devices

- Patient selection
- Clinical presentations
- Operators expertise
- Protection devices

Patient Selection

High Risk Co-morbidities

- Advanced age (>75-80)
- UA
- Recent MI (4-6 weeks)
- Abnormal stress test or \geq 2-vessel CAD
- LVEF < 30-35% or NYHA Class III-IV HF
- Dialysis dependent renal failure
- Severe COPD
- Need for CABG or valve surgery
- Need for vascular surgery

Patient Selection

Anatomic High Risk Criteria

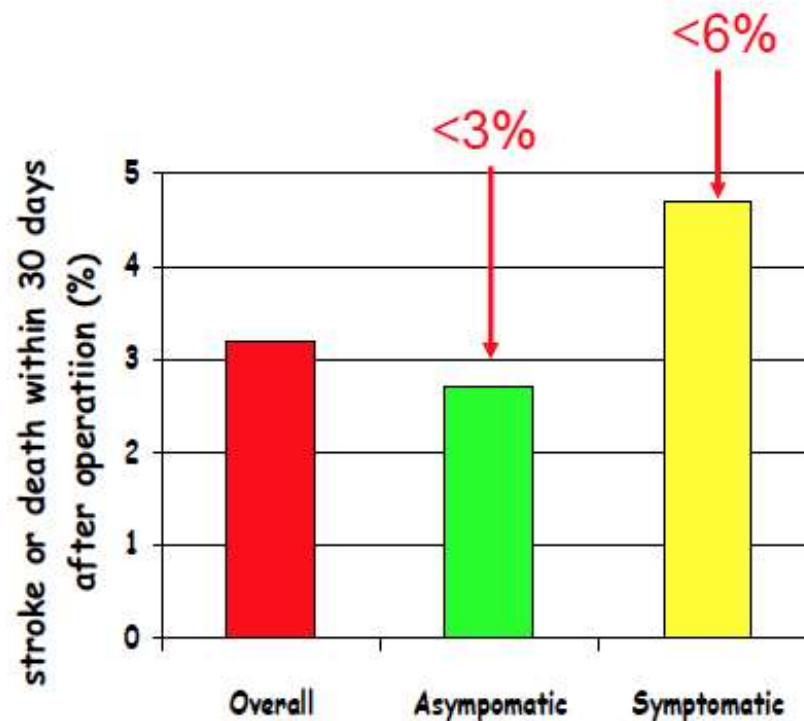
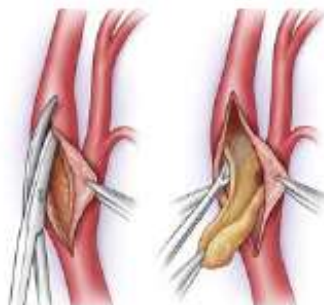
- Surgically Inaccessible
- Contralateral Occlusion
- Restenosis after CEA
- Previous Radiation to Carotid Area
- Ipsilateral Radical Neck Dissection
- Obese/Short Neck
- FMD
- Spinal Immobility due to Arthritis
- Laryngeal Palsy
- Tracheostoma

Background

- Current American Heart Association/American Stroke Association guidelines, published in 2006, state that CAS is reasonable when performed by operators with established periprocedural morbidity and mortality rates in the 4% to 6% range.

ACCF/SCAI/SVMB/SIR/ASITN 2007 Clinical Expert Consensus Document on Carotid Stenting

- Current AHA guidelines recommend CEA in **symptomatic** patients with stenosis 50% to 99%, if the risk of 30 days stroke or death is less than 6%.
- For **asymptomatic** patients, AHA guidelines recommend CEA for stenosis 60% to 99%, if the risk of 30 days stroke or death is less than 3%.



Events in Registries

Thirty-Day Death/Stroke Rates in CAS Registries Enrolling More Than 1,000 Patients

	Overall	Death/Stroke	
		Symptomatic Patients	Asymptomatic Patients
CAPTURE	5.7%	10.6%	4.9%
CASES PMS	4.5%	NA	NA
PRO-CAS	3.6%	4.3%	2.7%
SAPPHIRE-W	4.0%	NA	NA
SVS	NA	NA	NA
EXACT	4.1%	7.0%	3.7%
CAPTURE 2	3.4%	6.2%	3.0%

The NEW ENGLAND JOURNAL *of* MEDICINE

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Stenting versus Endarterectomy for Treatment of Carotid-Artery Stenosis

Thomas G. Brott, M.D., Robert W. Hobson, II, M.D.,* George Howard, Dr.P.H., Gary S. Roubin, M.D., Ph.D., Wayne M. Clark, M.D., William Brooks, M.D., Ariane Mackey, M.D., Michael D. Hill, M.D., Pierre P. Leimgruber, M.D., Alice J. Sheffet, Ph.D., Virginia J. Howard, Ph.D., Wesley S. Moore, M.D., Jenifer H. Voeks, Ph.D., L. Nelson Hopkins, M.D., Donald E. Cutlip, M.D., David J. Cohen, M.D., Jeffrey J. Popma, M.D., Robert D. Ferguson, M.D., Stanley N. Cohen, M.D., Joseph L. Blackshear, M.D., Frank L. Silver, M.D., J.P. Mohr, M.D., Brajesh K. Lal, M.D., and James F. Meschia, M.D., for the CREST Investigators†

CREST

CREST (Carotid Revascularization Endarterectomy vs. Stenting Trial)

2,502 patients

symptomatic (n = 1,321)

asymptomatic (n = 1,181)

Randomized CAE or CAS at 117 centers in the USA and Canada
over 9-years

Average age of 69 years, received neurological exams and best medical
therapy and risk factor management

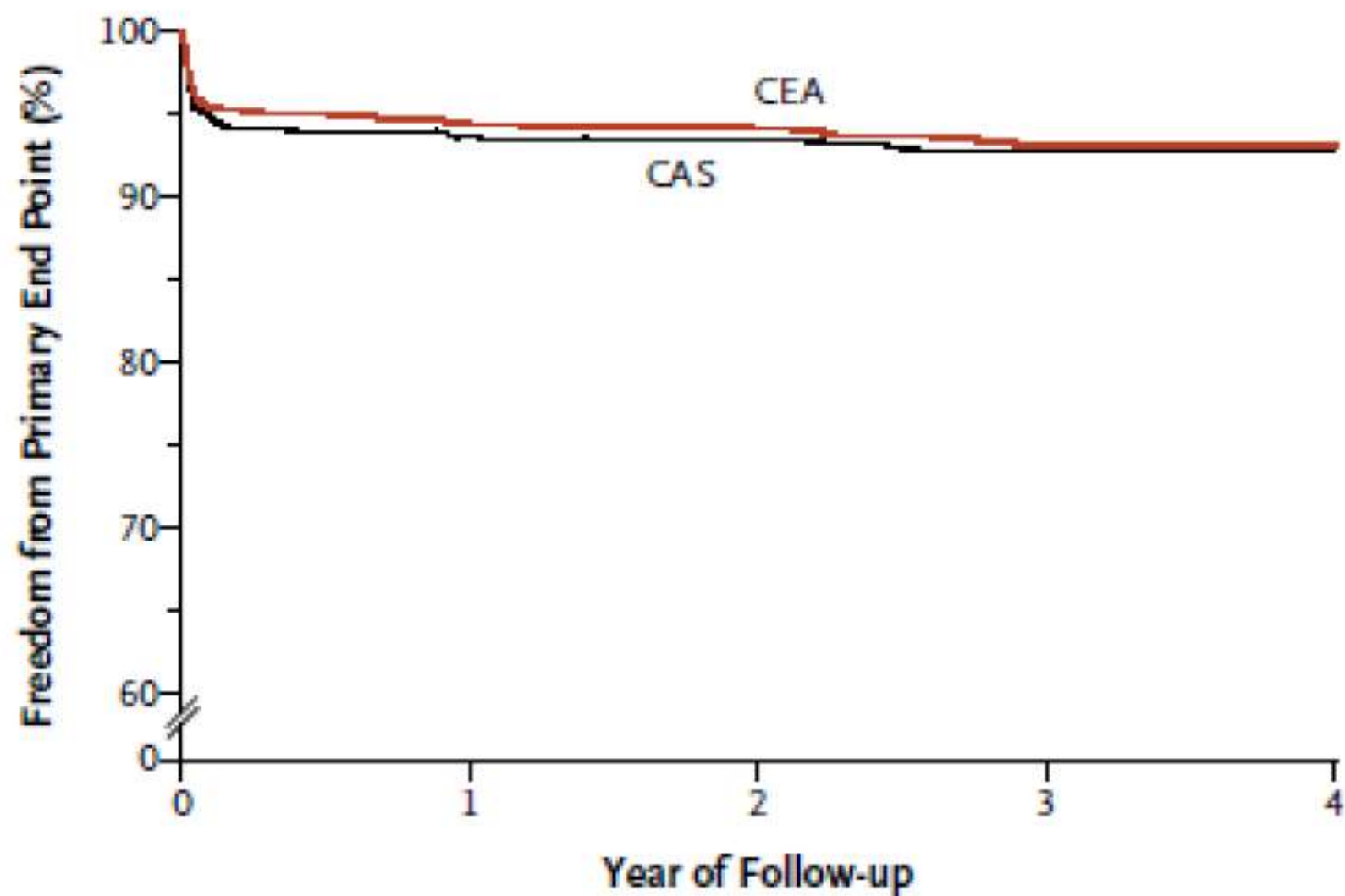
Follow-up was out to 4 years (median 2.5)

CREST Outcomes

	CAS	CEA	HR (95% CI)
Primary Endpoint ≤ 4 Years^a	7.2%	6.8%	1.11 (0.81-1.51)
Periprocedural Complications^b	5.2%	4.5%	1.18 (0.82-1.68)

^a Primary Endpoint, any stroke, MI, or death within 30 days plus subsequent ipsilateral stroke

^b Periprocedural Complications, any periprocedural stroke, MI, or death.

A**No. at Risk**

CAS	1262	1100	787	460	162
CEA	1240	1099	770	430	145

CREST Periprocedural MI and Stroke

	<u>CEA</u>	<u>CAS</u>	<u>HR (95% CI)</u>	<u>P Value</u>
Stroke	2.3%	4.1%	1.79 (1.14-2.82)	0.01
MI	2.3%	1.1%	0.50 (0.26-0.94)	0.03

Stent patients experienced more strokes and fewer MIs in the peri-procedural period than did surgery patients

CREST “Strokes”

- Minor stroke 2.7% for CAS vs. 1.4% for CEA
- Major stroke 1.4% for CAS vs. 0.8% for CEA ($p > 0.05$)
- Stroke and death in the surgical and stent groups was the lowest ever reported in a large stroke prevention trial
- At 4-year follow-up, recurrent event rates were low in both groups: 2.0% for CAS, 2.4% for CEA

“Expert Comments” CREST Strokes

- **Most Strokes Were Non-Disabling**
- The incidence of major strokes and death between the CEA and CAS groups “was comparable”
- Non-disabling strokes caused numbness or weakness that resolve few days later
- “Minor strokes are comparable to a surgical cranial nerve palsy. It’s a minor deficit that typically goes away”
- The rate of cranial nerve palsy in the CEA was 4.7%, compared with 0.3% in CAS group ($P < 0.001$)

- Patient selection
- Clinical presentations
- Operators expertise
- Protection devices

Operators expertise

- **Higher annual operator volume of carotid artery stenting is associated with benefits**
 - lower post-operative mortality, fewer complications, shorter length of hospitalization, and reduced cost
- **Symptomatic Patients & Low-Volume Operators Fare Worse**

Predictors of Mortality & Complications after CAS

<u>Value</u>	<u>OR</u>	<u>95% CI</u>	<u>P</u>
Female vs Male	1.47	1.23-1.76	< .001
Symptomatic vs Asymptomatic	2.17	1.78-2.65	< .001
Operator Volume of 5-13 Procedures/Year vs < 5	0.74	0.59-0.92	.01
Operator Volume of 14-68 Procedures/Year vs < 5	0.70	0.54-0.91	.01

Badheka AO, Chothani A, Panaich SS, et al. Impact of symptoms, gender, co-morbidities and operator volume on outcome of carotid artery stenting (from the Nationwide Inpatient Sample [2006-2010]). *Am J Cardiol.* 2014

Operators expertise

- Higher annual operator volume remained an **independent predictor** of lower post-procedural mortality and complications
- Common complications reported
 - Iatrogenic stroke (1.6%)
 - Cardiac complications post-procedure (2%)
 - Vascular (3.7%) complications
 - Renal complications (0.1%)
 - 0.8% requiring transfusion due to postoperative hemorrhage

Operators expertise

- Any post-procedural complication was associated with an average increase in LOS of 2.48 days ($P < .001$) and an increase in hospitalization costs of \$7,466 ($P < .001$)
- Compared with those who were asymptomatic, symptomatic patients had hospital stays that were on average 1.3 days longer ($P < .001$) and \$3,223 more costly ($P < .001$)
- Higher annual operator volume predicted shorter LOS (1.11 days shorter for operators with 5-13 annual procedures, 1.17 days shorter for operators with 14-68 cases) as well as reduced hospitalization cost (\$2,956 less for operators with 5-13 annual procedures, \$2,778 less for operators with 14-68 cases)

Operators Expertise

Impact of Symptoms, Gender, Comorbidities, and Operator Volume on Outcomes of CAS

Data from Nationwide Inpatient Sample on 13,564 patients who underwent carotid stenting, 2006-2010.

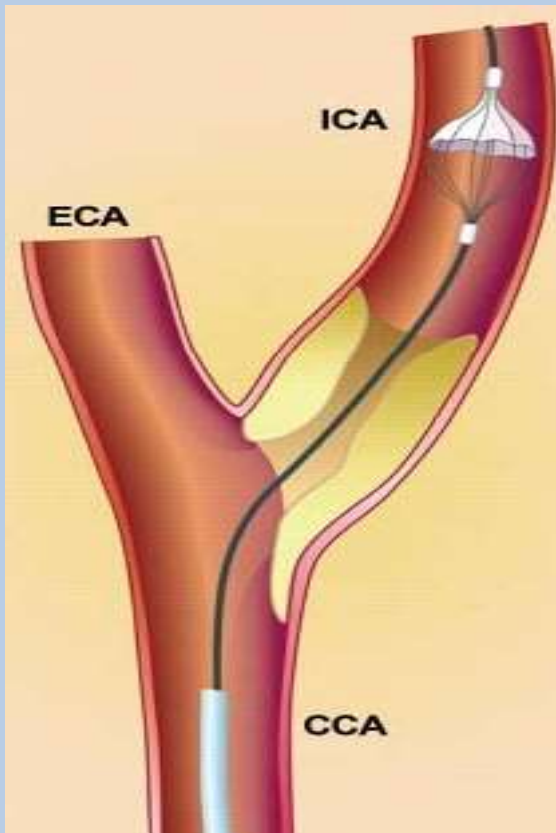
- Postprocedural mortality (0.5%), complications (8%) low overall but higher in symptomatic patients and women
- Higher annual operator volumes (threshold of ≥ 5 cases) were predictive of lower mortality and complications
- High operator volume also associated with shorter hospital stay and lower cost

Implications: CAS procedures performed by more experienced operators linked with reduced mortality, complications, cost, and hospital stay.

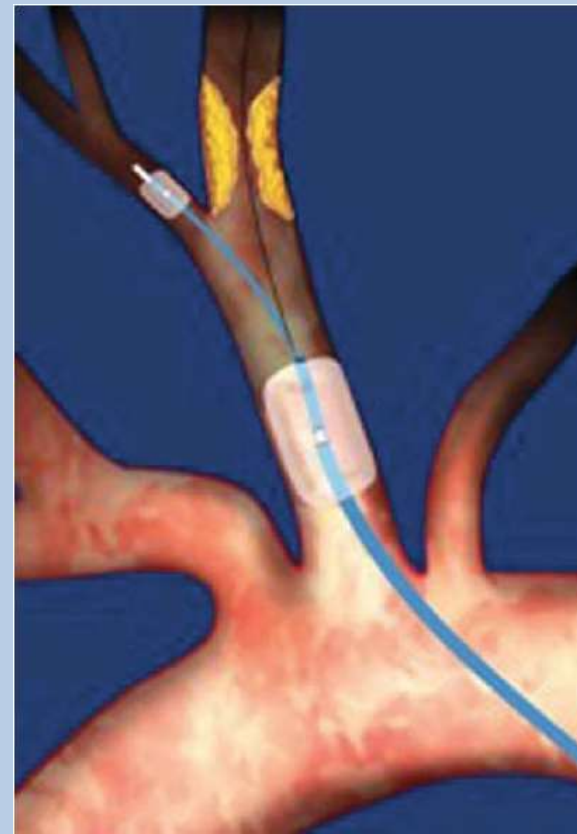
- Patient selection
- Clinical presentations
- Operators expertise
- Protection devices

Protection Devices

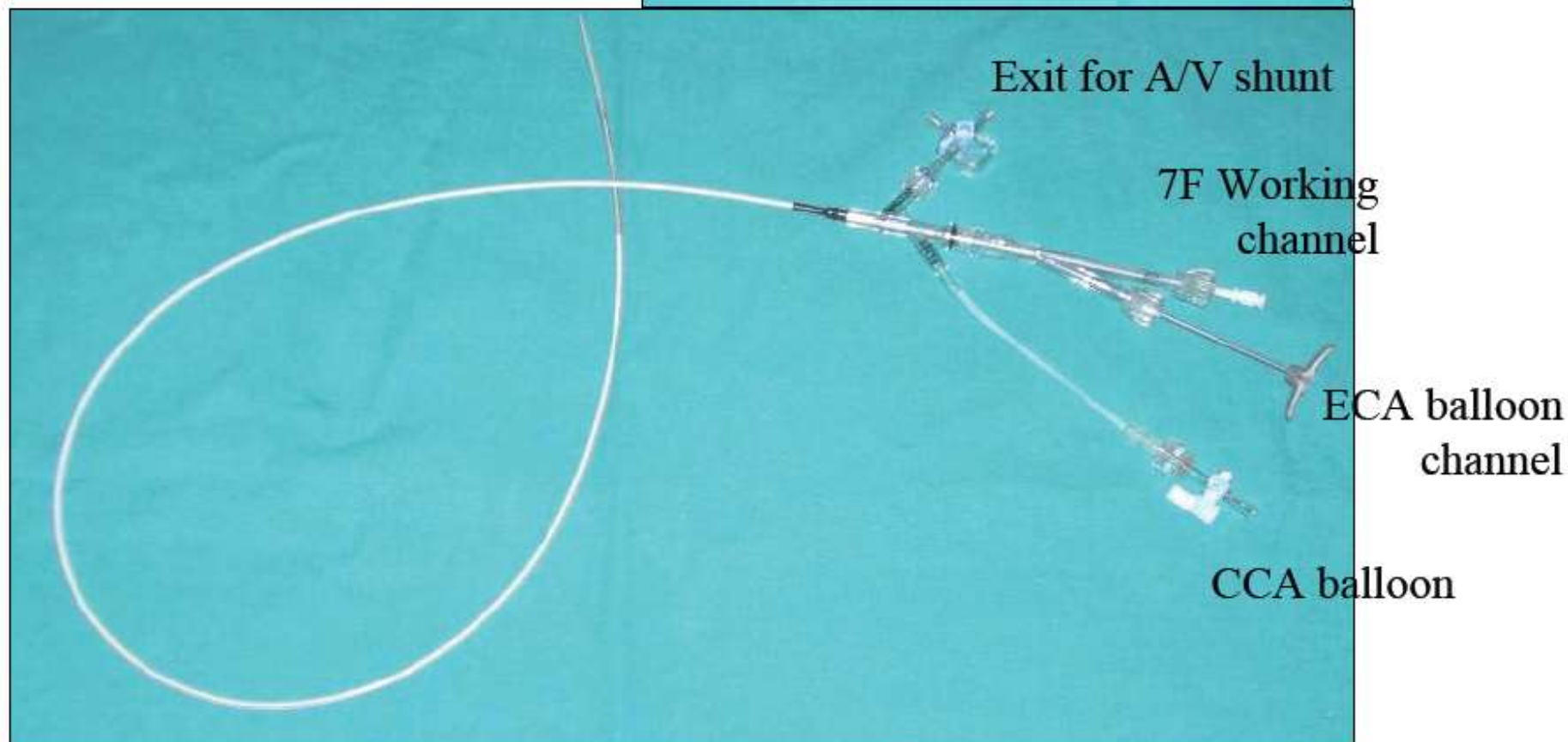
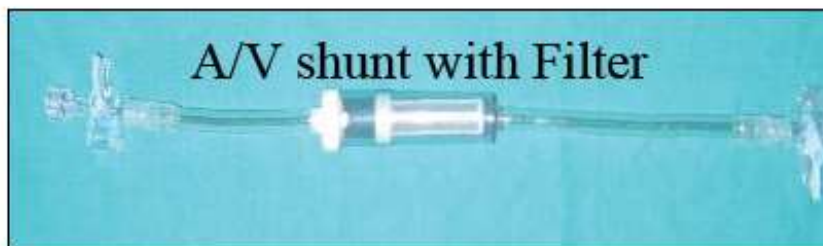
Distal Protection devices



Proximal Protection Devices

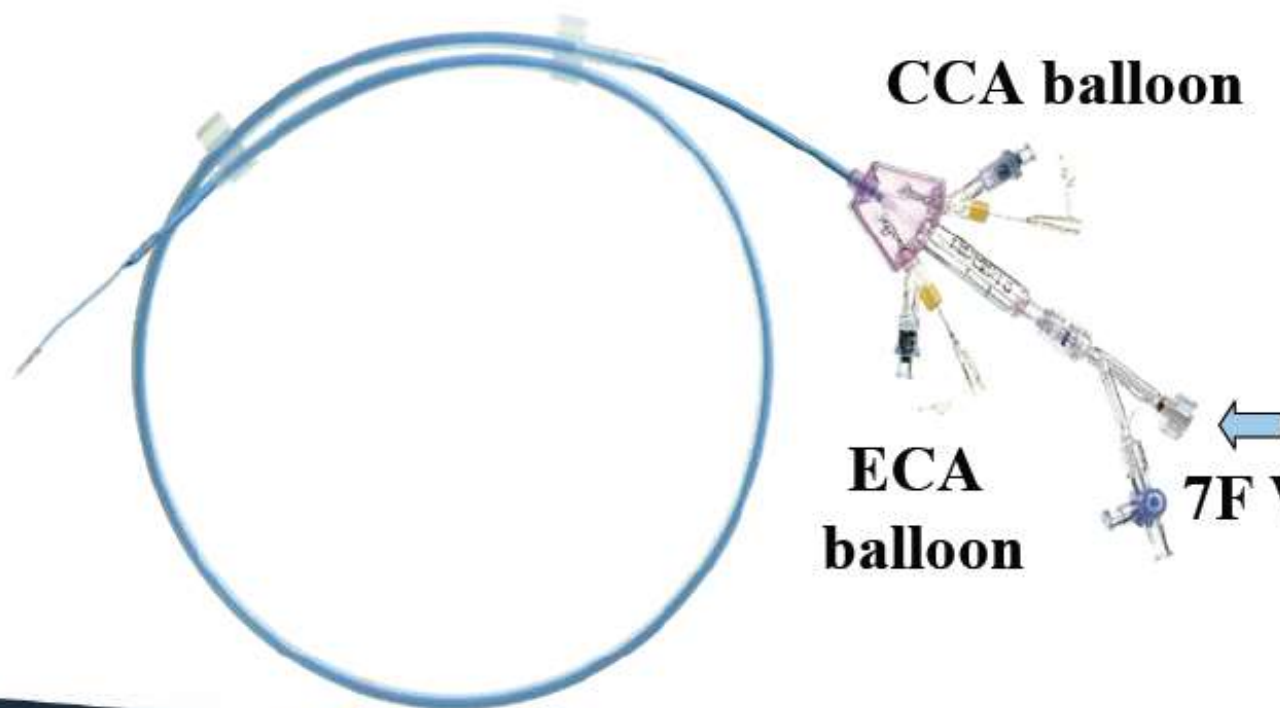


9F device



Parodi EPD system (Gore)

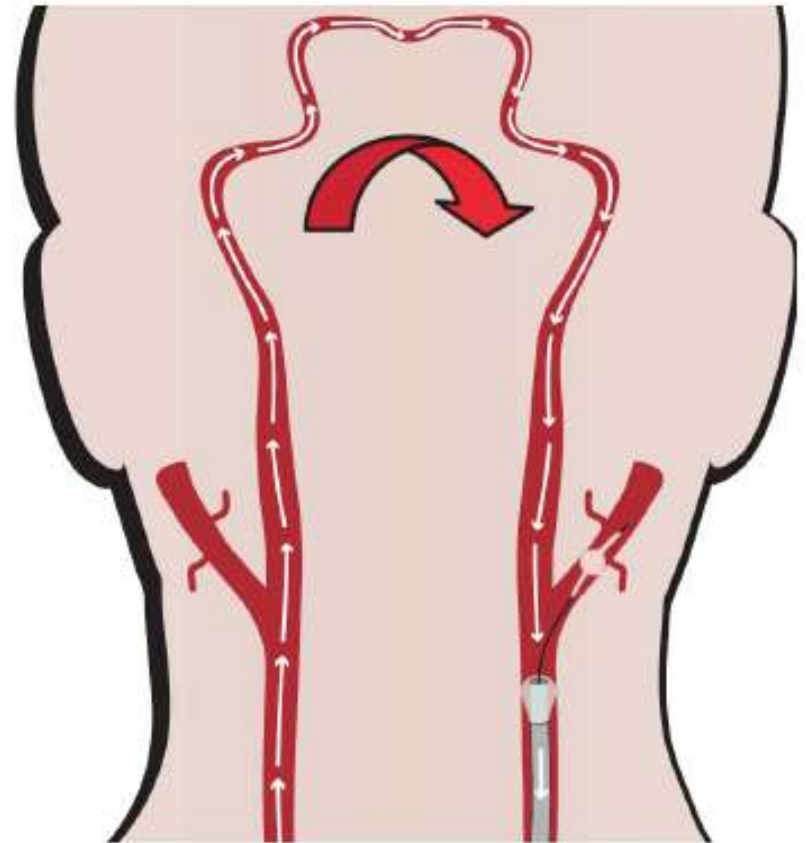
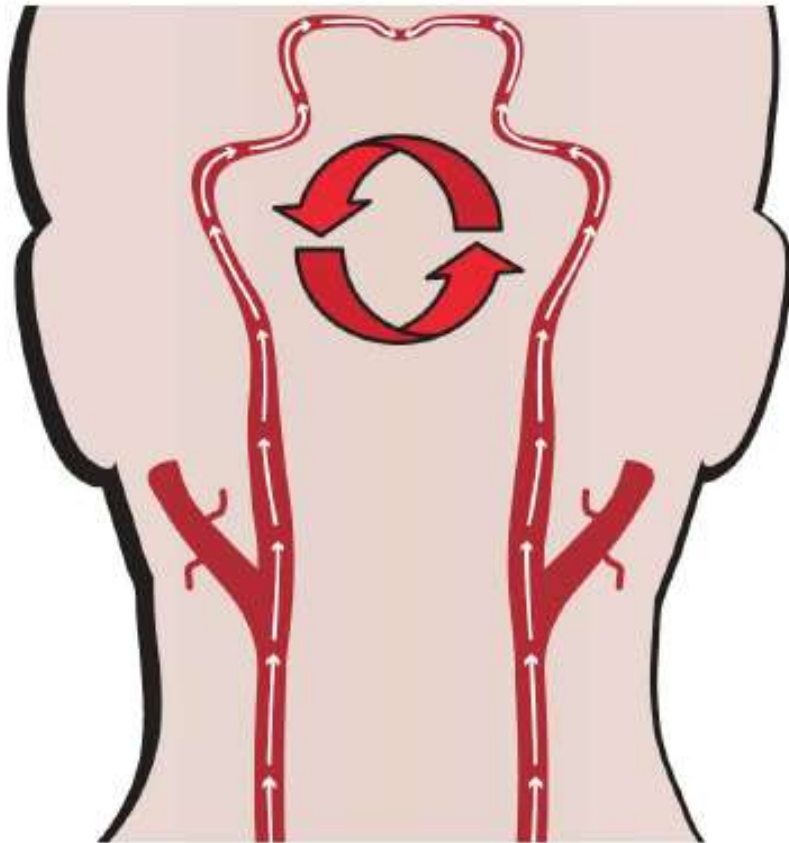
**Single Device consisting of
long 90 cm sheath and 2
occlusion balloons**



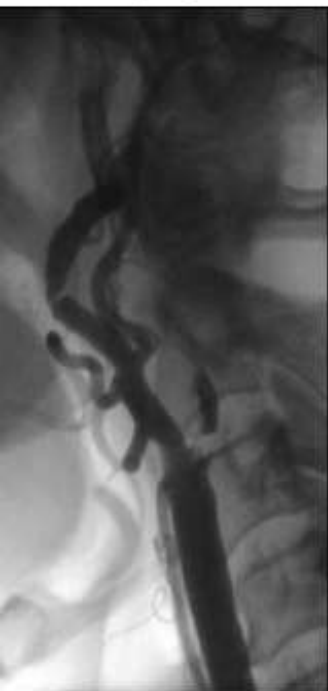
8 and 9F device available

Proximal protection devices could be the first choice for most carotid artery stenting procedures?

Willis circuit



The Carotid Workshop



Can carotid stenting be safely performed in patients with the angiographic string sign?

Historical outcomes and results with proximal protection

Bernhard Reimers, MD
Mirano, Italy

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The Mercogliano – Mirano String – Sign Study

- **A prospective study to evaluate safety and outcome of CAS using proximal protection devices in patients presenting with angiographic evidence of string-sign**
- **25 patients included between January 2006 and January 2008 (2.62%, total 954 patients treated with CAS)**

Paolo Rubino, Bernhard Reimers, et al



String sign

The Mirano Experience

30-days follow-up

Patients	<i>n</i> =23
Death, <i>n</i>(%)	0 (0)[†]
Stroke , <i>n</i>(%)	0 (0)
Death/Stroke , <i>n</i>(%)	0 (0)
MI , <i>n</i>(%)	1 (4.3)
MACCE , <i>n</i>(%)	1 (4.3)

6-month follow-up

Patients	<i>n</i> =23
Death, <i>n</i>(%)	1 (4.3)[*]
Stroke , <i>n</i>(%)	0 (0)
Death/Stroke , <i>n</i>(%)	1(4.3)[†]
MI , <i>n</i>(%)	1 (4.3)
MACCE , <i>n</i>(%)	2 (8.6)

Paolo Rubino, Bernhard Reimers, et al

A Meta-Analysis of Proximal Occlusion Device Outcomes in Carotid Artery Stenting

Robert M. Bersin,^{1*} MD, MPH, Eugenio Stabile,² MD, Gary M. Ansel,³ MD, Daniel G. Clair,⁴ MD, Alberto Cremonesi,⁵ MD, L. Nelson Hopkins,⁶ MD, Dimitrios Nikas,⁷ MD, PhD, Bernhard Reimers,⁸ MD, Horst Sievert,⁹ MD, and Paolo Rubino,² MD

Background: The clinical risk predictors for adverse events in carotid stenting using distal embolic protection devices are well established and include patient age and symptomatic status. The risk predictors for adverse events with proximal occlusion devices are not as well established. This study is a meta-analysis of available data on proximal occlusion devices to determine the risk predictors of adverse events in carotid stenting. **Methods:** Study-specific results on 2,397 patients from six independent databases of two different proximal occlusion devices were meta-analyzed by an independent statistical analysis organization for predictors of 30-day major adverse clinical events including stroke, myocardial infarction, and death using random effects models. The primary endpoint was the composite of total stroke, myocardial infarction, and death at 30 days. **Results:** The incidence of stroke was 1.71%. The incidence of myocardial infarction was 0.02%. The incidence of death was 0.40%. The composite primary endpoint at 30 days was 2.25%. Age and diabetic status were found to be the only significant independent risk predictors; however, total stroke rates remained below 2.6% in all subgroups, including symptomatic octogenarians. The other baseline demographic variables including patient gender, symptomatic status, and contralateral carotid occlusion were not found to be independent risk predictors. **Conclusions:** A meta-analysis of CAS procedures performed with proximal occlusion devices demonstrated a very low incidence of adverse events at 30 days. 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. © 2012 Wiley Periodicals, Inc.

Key words: cerebrovascular disease; cerebrovascular accident; myocardial infarction

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

^aTwo databases (8, 10) were provided as a single data file.

^bDefined as intolerance that resulted in interruption of use of the POD to complete the procedure without the use of an alternate protection device.

^cNR denotes not recorded and indicates that the data was not collected.

^dDefined as intolerance that resulted in the use of an alternate protection device.

A Diffusion-weighted MRI Study of Transcervical Carotid Stenting with Flow Reversal vs. Transfemoral Filter Protection

Single-center study looking at cerebral white matter lesions in 2 groups of consecutive patients with carotid disease.

Postprocedural DW-MRI Follow-up	Flow Reversal (n = 31)	Filter Protection (n = 33)	P Value
Pts with New Lesions	12.9%	33.3%	0.03
Number of New Lesions	4	13	0.02

Age, recent symptomatic status, and closed cell stent type were predictors of embolization in the distal filter group, but not the flow reversal group.

Conclusion: Proximal protection via flow reversal during carotid stenting reduces new ischemic cerebral lesions compared with filter protection.

Leal I, et al. *J Vasc Surg.*
2012;Epub ahead of print.

Evaluation of proximal protection devices could be the first choice for most carotid artery stenting procedures

Frankfurt CardioVascular Center (Dr Sievert) 124 consecutive patients undergoing carotid angioplasty with proximal protection

First 92 patients received the Gore Flow Reversal System (WL Gore; Flagstaff, AZ)

Next 32 pts received the Mo.Ma Ultra System (Medtronic; Minneapolis, MN)

21% of the population presented a symptomatic lesion

Predilation was necessary in 33.1% of lesions

Evaluation of proximal protection devices could be the first choice for most carotid artery stenting procedures

The primary end point, a combination of new transitory ischemic accident and minor or major stroke within 30 days, was observed in one patient only.

Stroke rate of 0.08%

The patient had no procedural complications but suffered a stent thrombosis 9 days after discharge

Transitory neurological symptoms due to intolerance of antegrade flow interruption were observed in 10 patients (8.1%), but were promptly and completely solved once flow was reestablished

Only 2 patients were not able to benefit from the proximal embolic protection device. None of these patients presented neurological complications

Evaluation of Proximal Protection Devices During CAS as the First Choice for Embolic Protection

124 patients, 21% with symptomatic stenoses, received the Gore Flow Reversal System (n = 92) or the Mo.Ma Ultra device (n = 32) at a single center.

- Technical success was achieved in all but 2 cases and clinical success in 100% of cases
- No procedural neurological complications and only 1 stroke occurred within 30 days
- Neurological symptoms due to intolerance of interruption of antegrade flow were reported in 10 patients (8.1%) but resolved after flow was reestablished

Implications: In experienced hands, proximal devices are a safe and effective first approach to embolic protection in CAS procedures.

- Reasons for the superiority of proximal to distal protection, less lesion manipulation only after embolic protection and more complete protection with flow reversal

“Wrap-Up”

- Patient selection
- Clinical presentations
- Operators expertise
- Protection devices

- *GRACIAS!!!!!!!!!!!!*