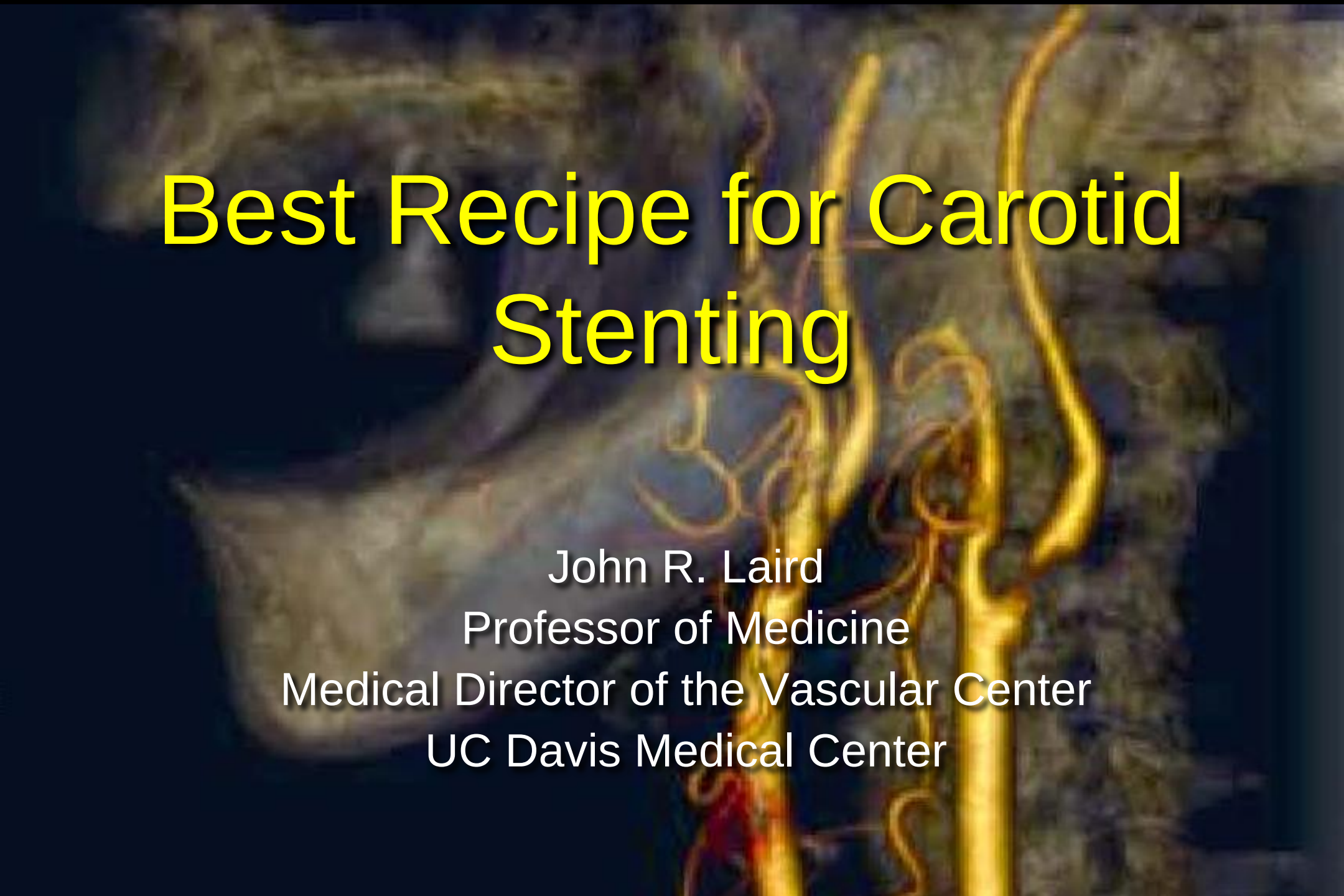

Best Recipe for Carotid Stenting

John R. Laird
Professor of Medicine
Medical Director of the Vascular Center
UC Davis Medical Center

Best Recipe for Success

1. Optimal peri-procedural medical management
2. Careful vascular access and groin management – avoidance of bleeding complications
3. A “tailored approach” to complex patients and lesions
    1. Best and safest access to the carotid artery
    2. Enlightened use of embolic protection
    3. Appropriate stent selection

Best Recipe for Success

- Pre-procedure medical management
  - DAPT with 600 mg Plavix load
  - Statin load
- Intra-procedure medical management
  - Appropriate anticoagulation (Bivalirudin?)
  - Prompt treatment of hypotension
- Post-procedure medical management
  - DAPT
  - Appropriate management of hypertension (Avoidance of hyperperfusion syndrome)

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CLINICAL RESEARCH — Interventional Cardiology

Strategies of Clopidogrel Load and Atorvastatin Reload to Prevent Ischemic Cerebral Events in Patients Undergoing Protected Carotid Stenting

Results of the Randomized ARMYDA-9 CAROTID (Clopidogrel and Atorvastatin Treatment During Carotid Artery Stenting) Study

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Rome, Italy

Study Design

- Prospective, randomized open label study at 2 Italian sites
- 2 x 2 factorial design
- DW-MRI performed 24-48 hours after procedure

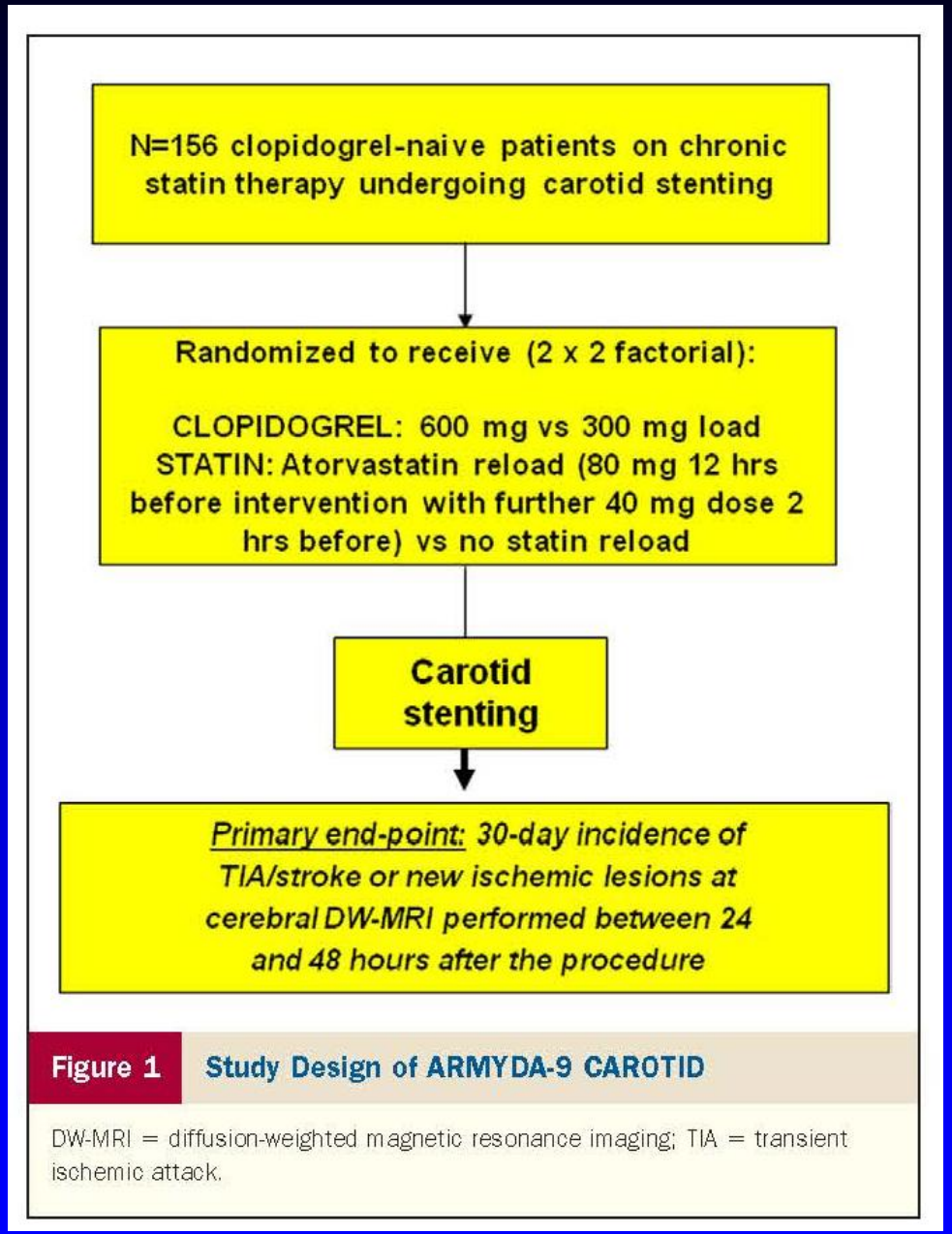

Figure 1 **Study Design of ARMYDA-9 CAROTID**

DW-MRI = diffusion-weighted magnetic resonance imaging; TIA = transient ischemic attack.

Table 2 Main Outcome Measures According to Clopidogrel Dose Comparison

Outcome	600-mg Clopidogrel Load (n = 78)	300-mg Clopidogrel Load (n = 78)	p Value
Primary endpoint: 30-day incidence of TIA/stroke or new cerebral lesions	14 (18.0)	28 (35.9)	0.019
Patients with post-angioplasty new cerebral lesions	14 (18.0)	26 (33.3)	0.044
Patients with contralateral new cerebral lesions	5 (6.4)	9 (11.5)	0.78
Median no. of new cerebral lesions in the arm	2.5 (1-3)	6 (1-3)	0.015
Patients with new cerebral lesions >5 mm	5 (6.4)	13 (16.7)	0.08
30-day incidence of TIA/stroke	—	7 (9.0)	0.02
30-day incidence of death, any stroke, or MI	—	5 (6.4)	0.07
Patients with vascular/bleeding complications	5 (6.4)	8 (10.3)	0.56

Values are n (%) or median (interquartile range).

MI = myocardial infarction; TIA = transient ischemic attack.

Table 3 Main Outcome Measures According to Statin Comparison

Outcome	Atorvastatin Reload (n = 76)	No Atorvastatin Reload (n = 80)	p Value
Primary endpoint: 30-day incidence of TIA/stroke or new cerebral lesions	14 (18.4)	28 (35.0)	0.031
Patients with post-angioplasty new cerebral lesions	13 (17.1)	27 (33.8)	0.028
Patients with contralateral new cerebral lesions	4 (5.3)	10 (12.5)	0.19
Median no. of new cerebral lesions in the arm	1 (1–3)	2 (1–3)	0.79
Patients with new cerebral lesions >5 mm	5 (6.6)	13 (16.3)	0.10
30-day incidence of TIA/stroke	1 (1.3)	6 (7.5)	0.14
30-day incidence of death, any stroke or MI	—	5 (6.3)	0.08
Patients with vascular/bleeding complications	6 (7.9)	7 (8.8)	0.92

Values are n (%) or median (interquartile range).

MI = myocardial infarction; TIA = transient ischemic attack.

Editorial

Bivalirudin for Carotid Artery Stenting

A New Approach on the HORIZON(s)?

Ehrin J. Armstrong, MD, MSc; John R. Laird, MD

Circ Cardiovasc Interv 2013

Bivalirudin During Carotid Stenting

- 10,560 procedures from CARE Registry analyzed
- May 2005 – March 2012
- Propensity matched analysis performed to obtain a balanced cohort of 3,555 treated with each anticoagulant
- Patients treated with Bivalirudin less likely to experience hematoma or bleeding complication requiring transfusion

Wayangankar SA, Circ Cardiovasc Interv 2013

Bivalirudin During Carotid Stenting

	Heparin (n = 3,555)	Bivalirudin (n = 3,555)	OR (95% CI)	*P Value*
Bleeding or Hematoma Requiring Transfusion	**1.5%**	**0.9%**	**0.57 (0.36-0.89)**	**0.01**
Intracerebral Hemorrhage	**0.2%**	**0.1%**	**0.62 (0.20-1.91)**	**0.41**
Death/MI/Stroke	**2.7%**	**2.1%**	**0.78 (0.58-1.06)**	**0.11**

Wayangankar SA, Circ Cardiovasc Interv 2013

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Carotid arteries, angiography, 172.1248, 908.122
Carotid arteries, flow dynamics, 172.76, 908.76
Carotid arteries, interventional procedures, 172.1286, 908.1286
Carotid arteries, US, 171.1298, 172.1298, 908.1298

Radiology 2000; 215:677–683

Abbreviation:
CAS = carotid artery stent

[1] From the Division of Cardiology and the Departments of Neuroradiology and Neurology, Washington Hospital Center, Washington, DC. Received April 7, 1999; revision requested June 1; final revision received August 17; accepted August 26. Supported in part by an educational grant from the Cardiovascular Research Foundation, New York, NY. **Address correspondence to** M.B.L., Cardiovascular Research Foundation, 55 E 59th St, 6th Floor, New York, NY 10022 (e-mail:

Postprocedural Hypotension after Carotid Artery Stent Placement: Predictors and Short- and Long-term Clinical Outcomes[1]

PURPOSE: To describe the predictors of persistent hypotension after carotid artery stent (CAS) placement and define the clinical outcome of patients with this hemodynamic disturbance.

MATERIALS AND METHODS: One hundred forty CAS procedures were performed in 133 consecutive patients. Post-CAS hypotension—defined as a greater than 40 mm Hg decrease in arterial pressure without evidence of hypovolemia, with a systolic pressure lower than 90 mm Hg at the end of CAS and lasting at least 1 hour—was observed in 25 patients (group 1); 108 patients did not have hypotension (group 2).

RESULTS: Post-CAS hypotension developed in 33.9% of cases after balloon-expandable stent placement versus in 13.6% of cases after self-expanding stent placement ($P = .04$). In-hospital minor ipsilateral strokes occurred in 16% of cases in group 1 versus in 3% of cases in group 2 ($P = .03$). There was one (0.9%) major stroke (transient) and three (2.6%) transient ischemic attacks, all of which occurred in group 2 (not significant vs group 1 for both conditions). At 10 months ± 4 (SD) of follow-up, there was greater total mortality in group 1 than in group 2 (20% vs 4%, $P = .02$), whereas neurologic events did not differ significantly between the groups.

CONCLUSION: Hypotension due to carotid sinus stimulation is frequent after CAS with balloon-expandable stents. This phenomenon correlates with increased in-hospital complications and long-term risk of death.

Prompt Treatment of Hypotension

- Hypotension is common during CAS due to stretch of carotid baroreceptor – may be profound
- Associated with an increased risk of neurologic complications in some studies
  - Micro-emboli less likely to be tolerated in the setting of hypotension
- Prompt reversal of hypotension necessary to minimize risk of complications

Optimal Blood Pressure Management

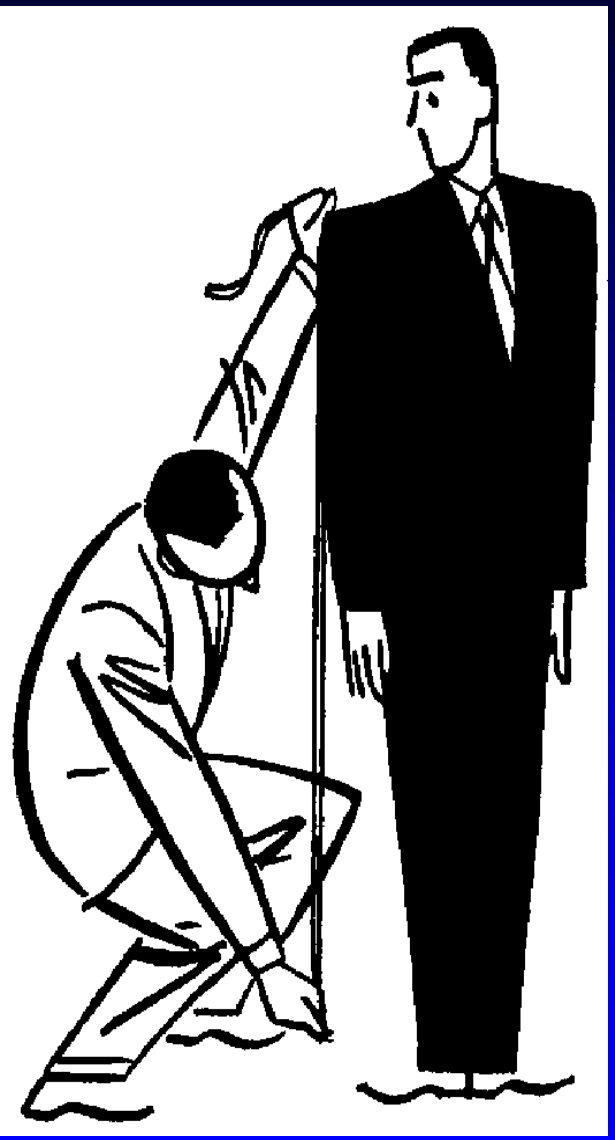
- Appropriate management of hypotension during and after procedure:
  - Rapid correction of intra-procedure hypotension (IV bolus of norephinephrine – 5 -10 mcg)
  - IV pressors for 12 – 24 hours post procedure to maintain adequate BP (phenylephrine best)
- Aggressive management of hypertension post procedure – minimize the risk of hyperperfusion syndrome

Vasopressor Use for Persistent Post CAS Hypotension

- Retrospective analysis of 623 CAS procedures
- CCU admission for significant hypotension requiring pressors in 6.7%
- 3 different pressors used: dopamine (DA), norepinephrine (NE), phenylephrine (PE)
- Shorter infusion time, shorter CCU stay, and fewer major adverse events with NE and PE compared to DA

Neurocritical Care 2007;7:232-7

Optimal Device Selection



The “Tailored Approach”

Definition: One approach does not fit all cases. Modification of the approach to “best fit” the clinical situation or patient anatomy

The Tailored Approach
Choice of…..

- Proximal versus distal embolic protection
- Open versus closed cell stent (or hybrid)
- Standard sheath/guide position versus guiding catheter from the arch
- Radial/brachial approach versus femoral

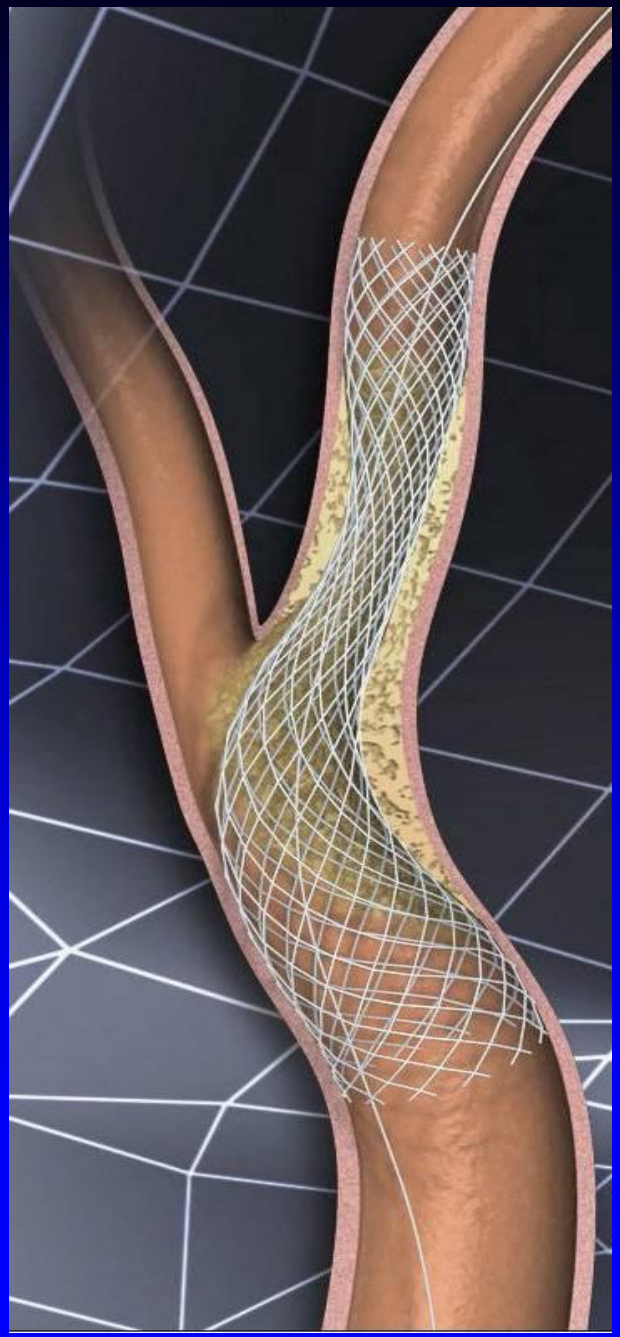
The above considerations are not mutually exclusive

History

- 87 male with symptomatic right carotid artery stenosis.
- Two 15min episodes of difficulty speaking, weakness, unsteady gait.
- Multiple co-morbidities: COPD, PAD, history of Lung CA, CAD, HTN
- 80- 99% RICA stenosis: PSV in excess of 640 cm/sec, EDV of 330 cm/sec.

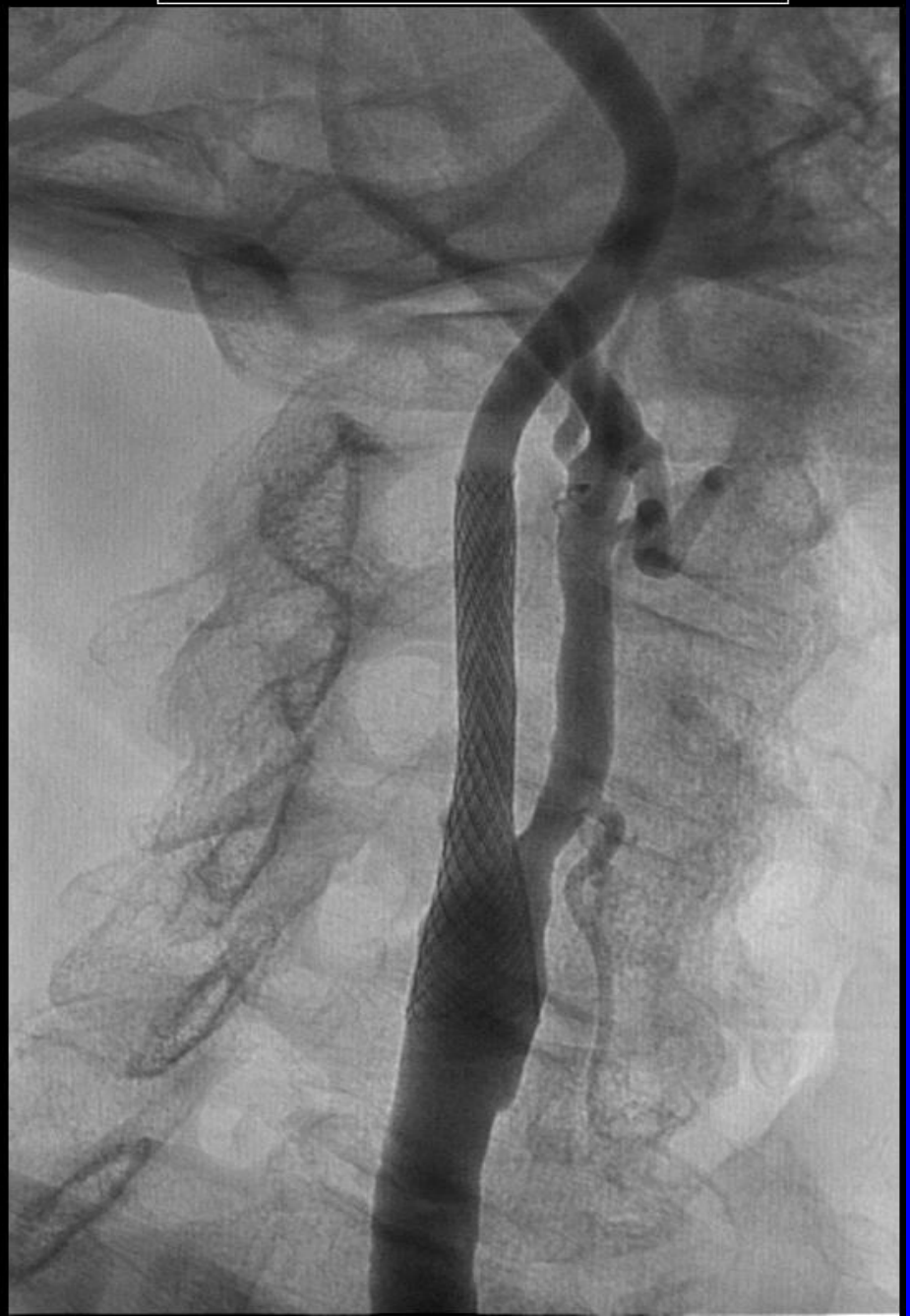
The Complex Patient

- High risk features: Age > 80, recently symptomatic, long, complex, severe stenosis
- Tailored approach:
  - Proximal protection?
  - Closed cell stent design

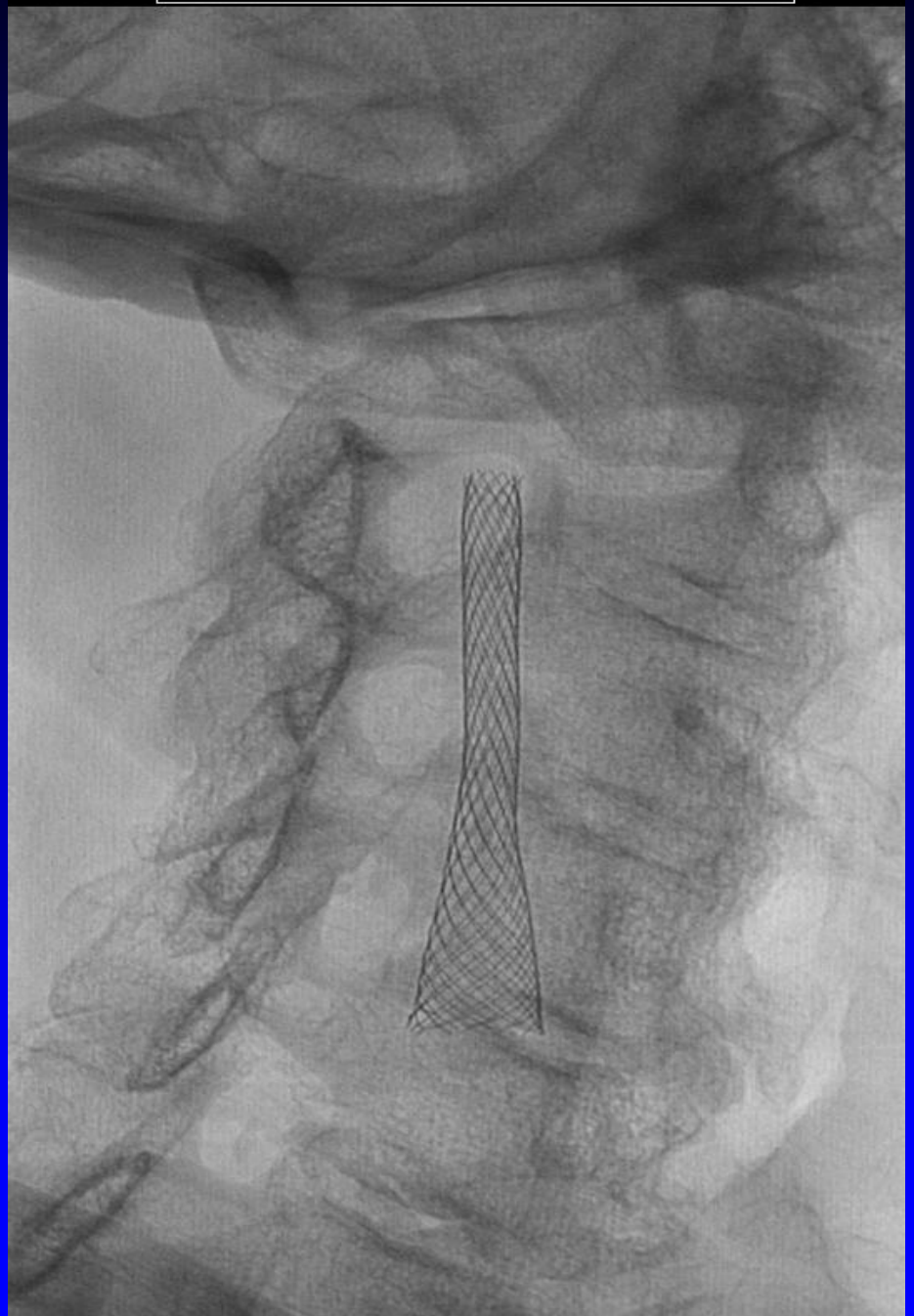


nch

9mm X 30mm WallStent



9mm X 30mm WallStent



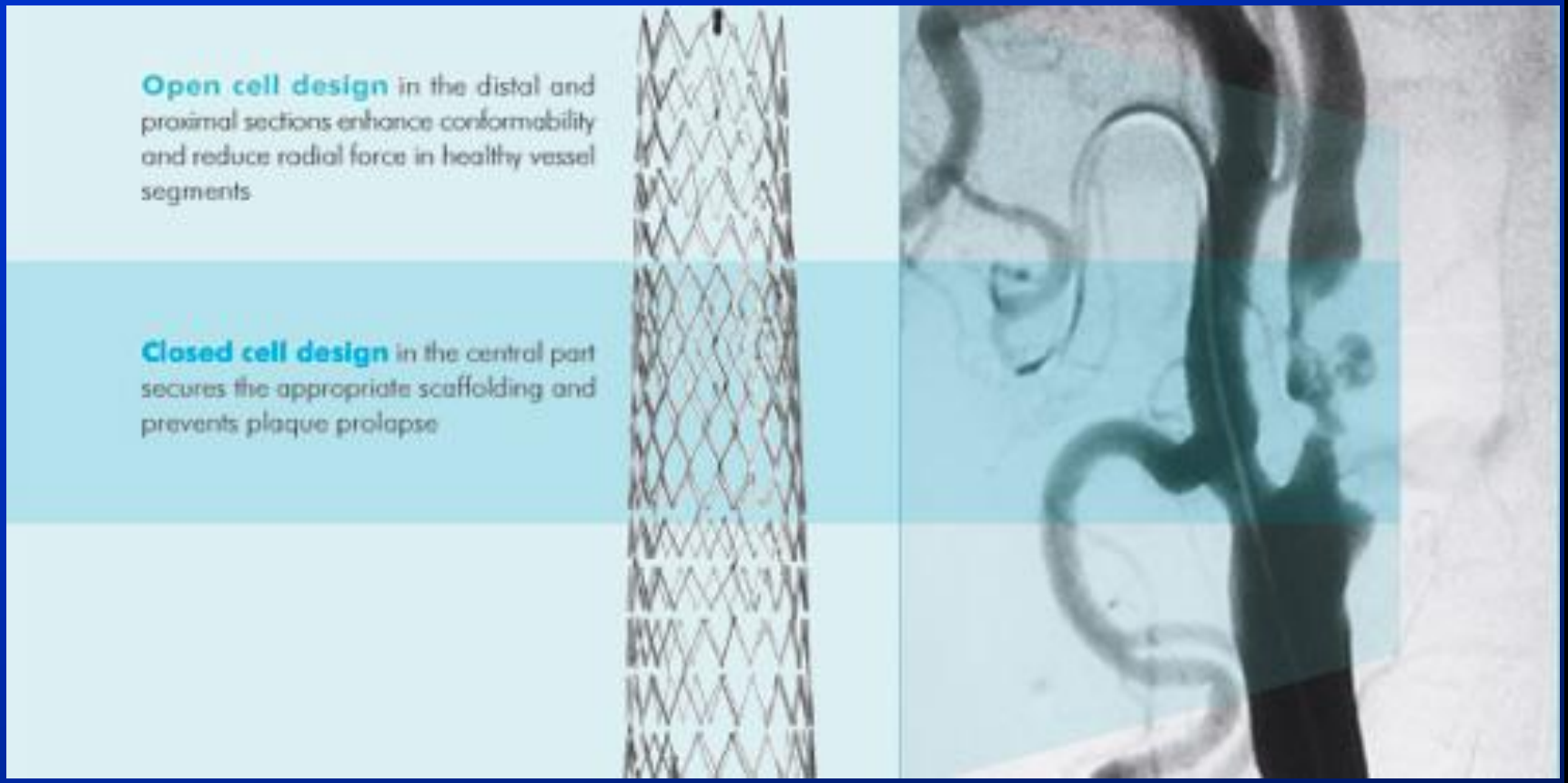
Carotid Stent Design and Outcomes

Open vs Closed Cell

All Events	Total Population n/N	%	Symptomatic n/N	%	Asymptomatic n/N	%
Closed	51/2242	2.3%	21/934	2.2%	30/1308	2.3%
Open	39/937	4.2%	27/383	7.0%	12/554	2.2%
Total	90/3179	2.8%	48/1317	3.6%	42/1862	2.3%
	P = 0.005		P <0.0001		P = 1.00	

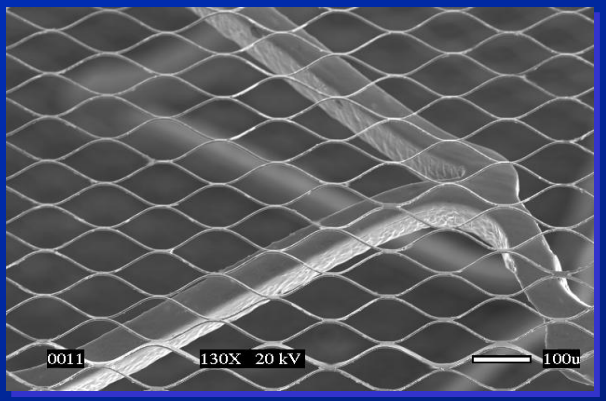
Bosiers M et al Eur J Vasc Endovasc Surg 2007; 33:135-141

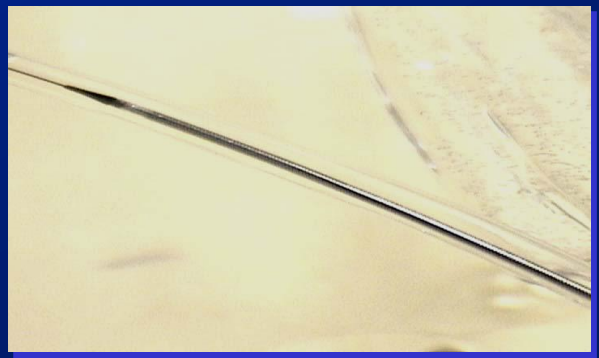
Evolution of Closed Cell and Hybrid Carotid Stent Designs



Medtronic/Invatec Cristallo Ideale stent

Nitinol or ePTFE Membrane-Covered Stent Systems





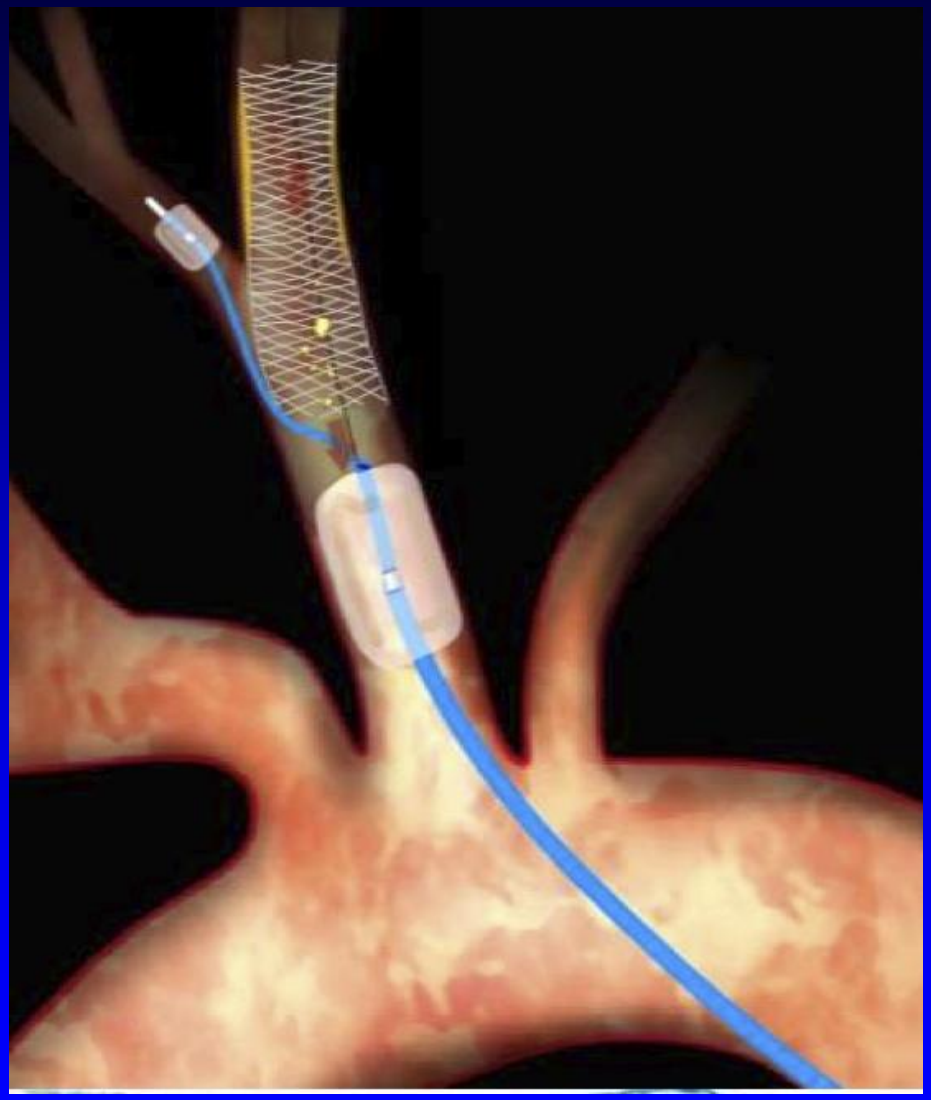
Case History

- 81 year old female
- Severe CAD
- Symptomatic right carotid stenosis – small right hemispheric stroke two weeks prior
- Carotid duplex evaluation:
  - 80-99% RICA stenosis
  - 40-59% LICA stenosis

Complex Anatomy
Vessel Tortuosity

- High risk features: Age > 80, recently symptomatic, severe carotid tortuosity beyond lesion
- Tailored Approach:
  - Proximal protection (MO.MA)
  - Open cell stent

MO.MA



- Guiding sheath with 2 anchoring balloons
  - High system stability with good back up support
  - Guidewire of choice
- Lesion crossing under protection
- No need for distal landing zone for EPD
- Any type and size of debris aspiration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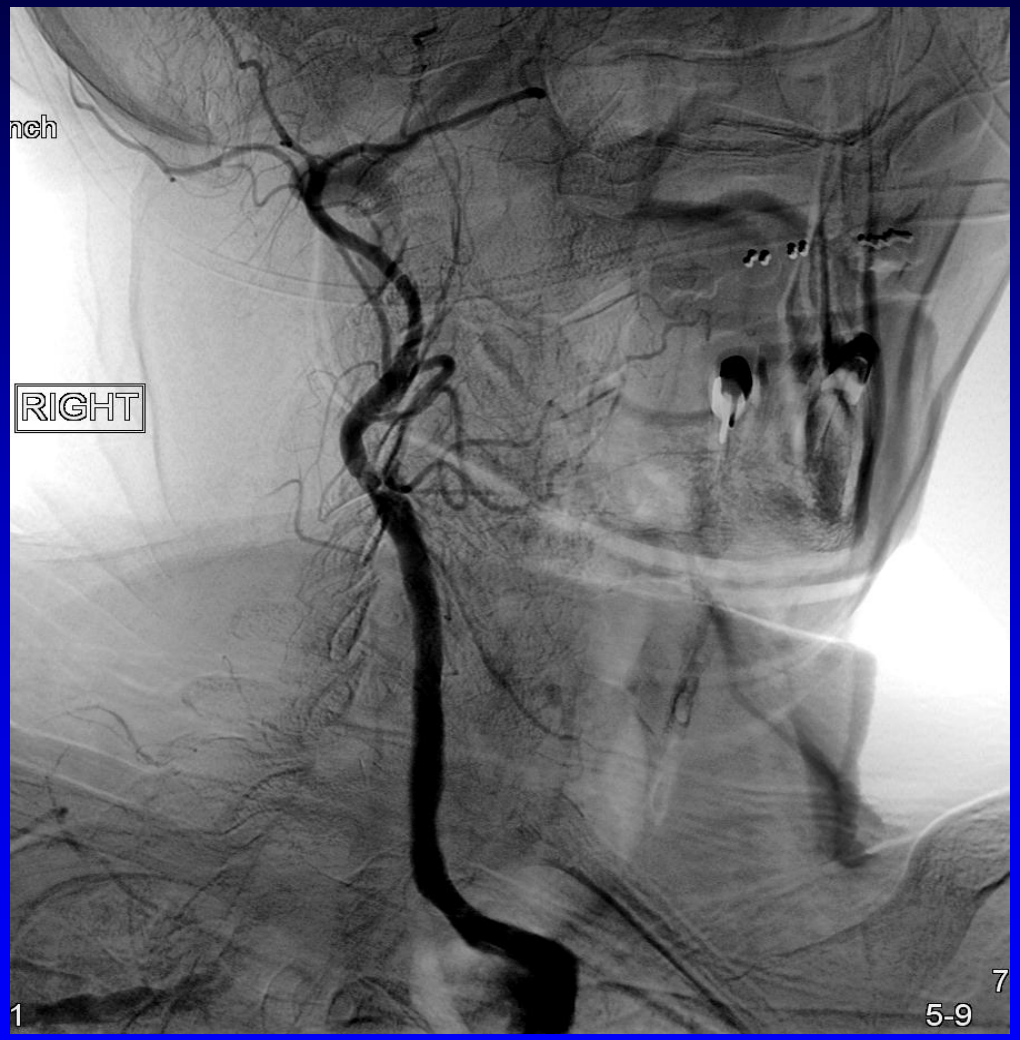
JOH

Safe Access to the Carotid Arteries

Complex Anatomy

The Difficult Bovine Arch

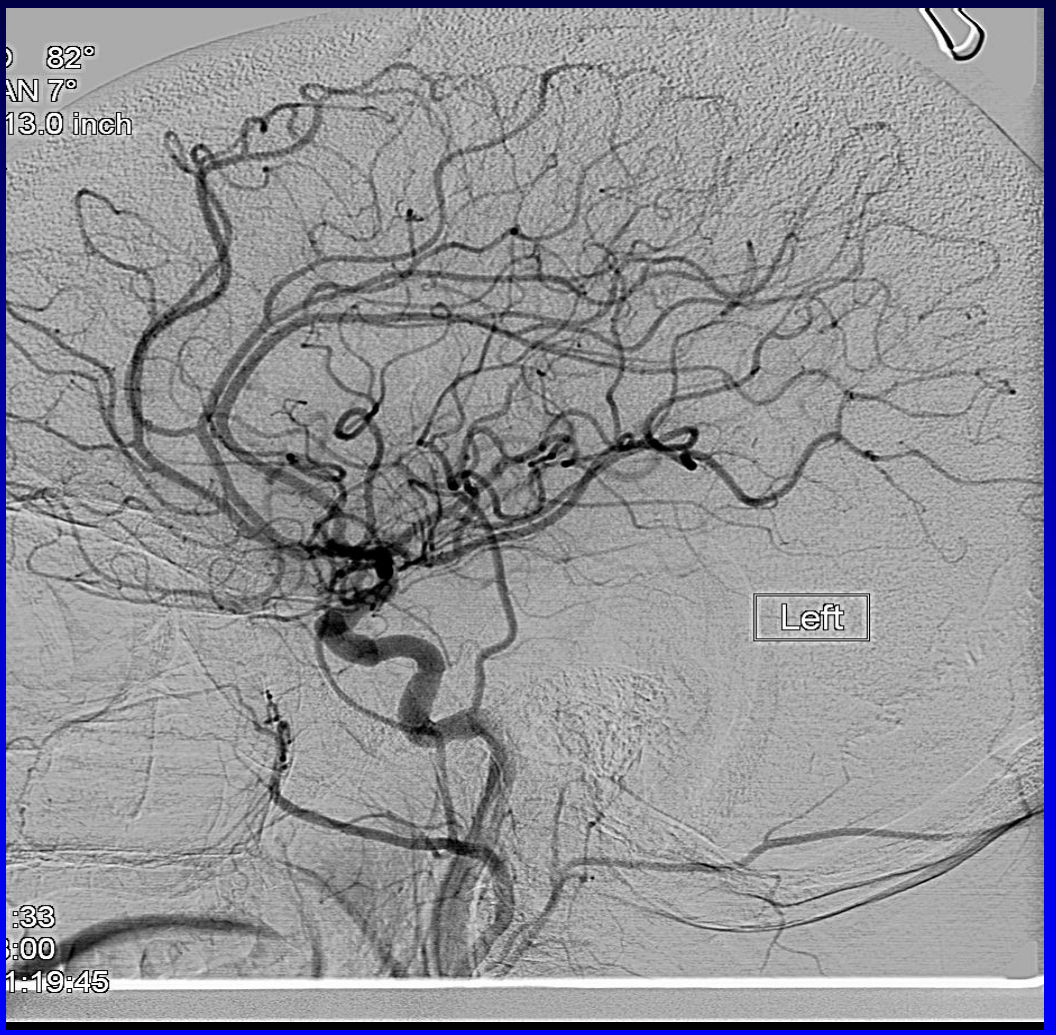
Carotid Angiography



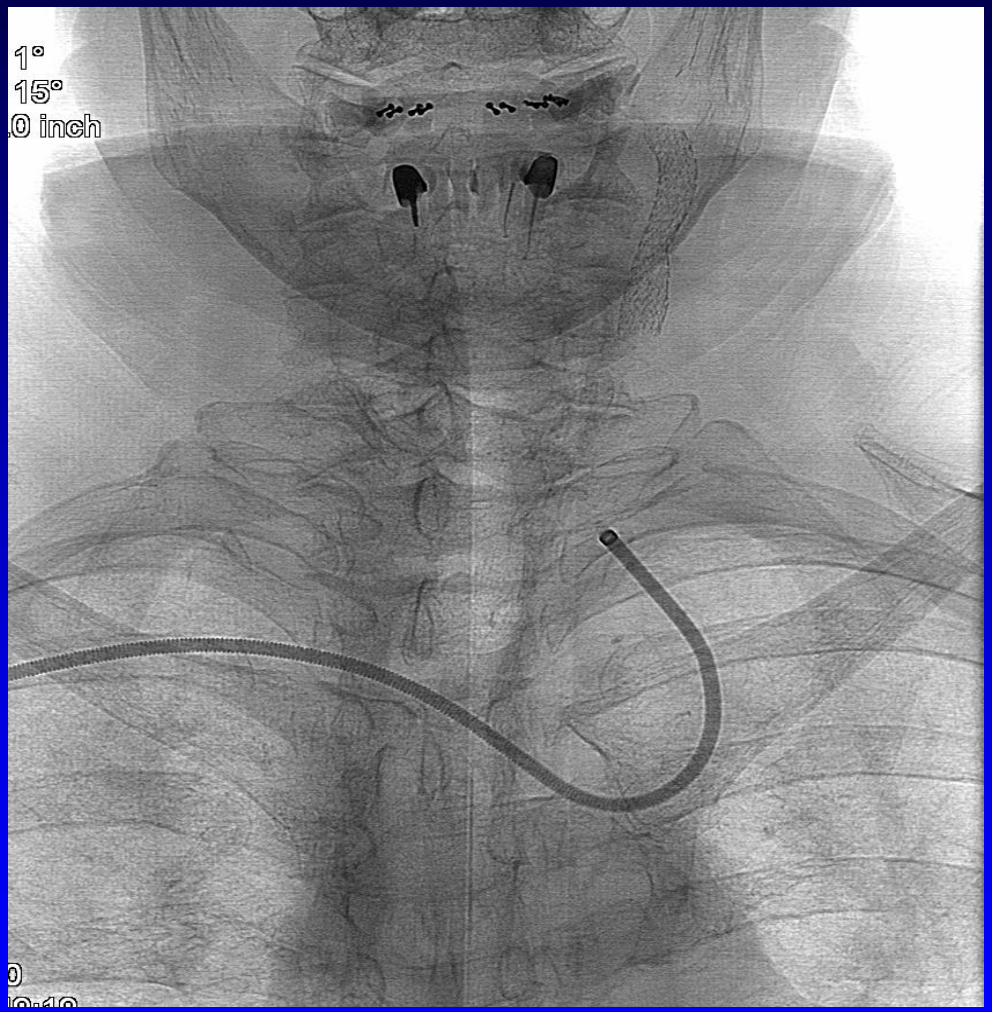
RICA Occlusion

LICA Stenosis

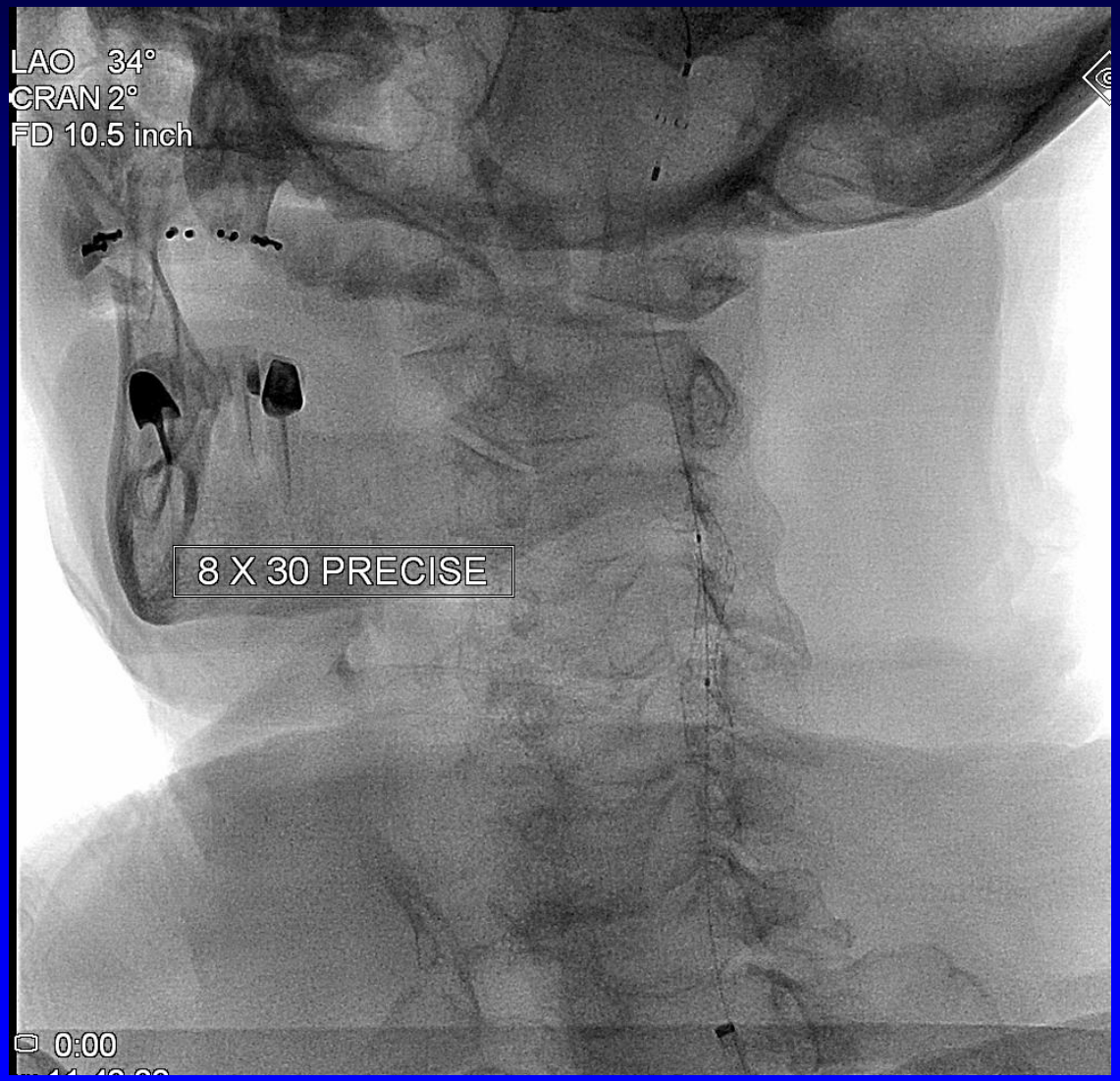
Cerebral Angiography



Right Radial Artery Approach



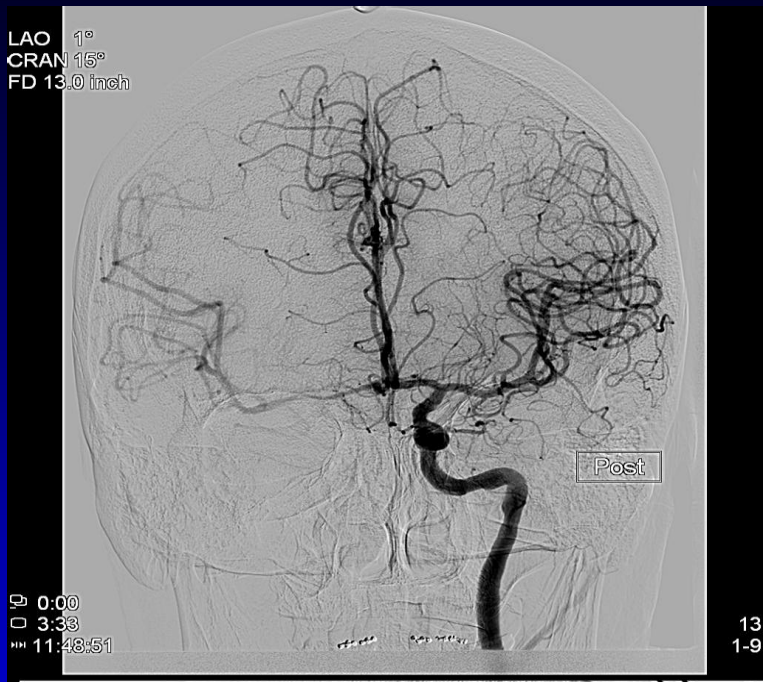
Right Radial Artery Approach

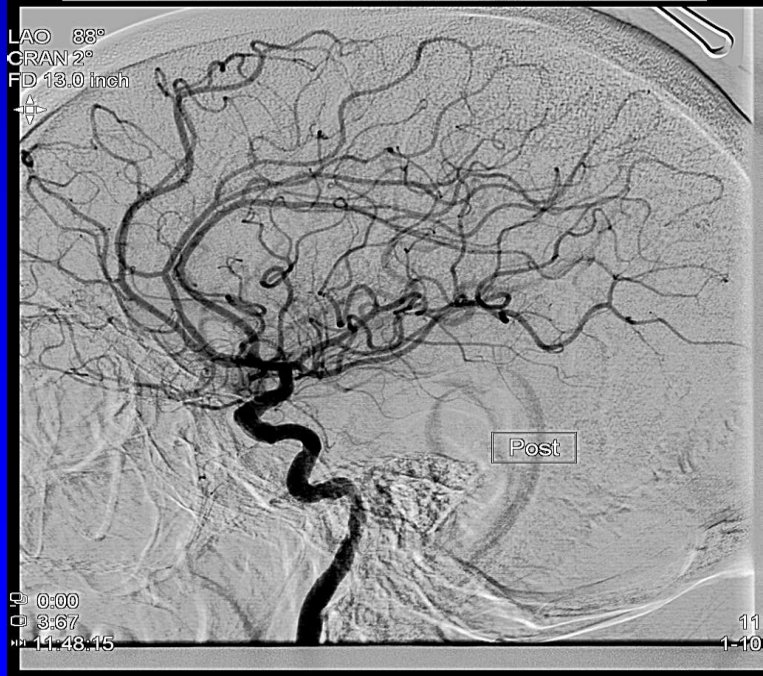


- Vertebral catheter + 0.038” angled Terumo glidewire into ECA
- 0.035” Amplatz superstiff guidewire
- 6Fr Shuttle sheath
- 8 mm x 3 cm Precise stent – Angioguard EPD

Final


LAO 34°
CRAN 2°
FD 10.5 inch
Post
0:00
3:33
11:47:33
10
1-9


LAO 1°
CRAN 15°
FD 13.0 inch
Post
0:00
3:33
11:48:51
13
1-9


LAO 88°
CRAN 2°
FD 13.0 inch
Post
0:00
3:67
11:48:15
11
1-10

Radial Access for CAS

- Avoids excessive catheter manipulation in aortic arch in some cases
  - Left carotid stenting in presence of difficult, bovine arch
  - Right carotid stenting in presence of difficult Type 2 or Type 3 arch
  - Right carotid stenting when there is extensive atherosclerotic disease or calcification in arch

Final Thoughts

- The best recipe for success with carotid stenting involves:
  - Meticulous attention to detail throughout the procedure
  - Optimal peri-procedural medical management
  - Modification of the approach or equipment to best fit the situation/anatomy