Anatomic and Procedural Correlates Of Intra- and Postoperative Hypotension With CAS: What Should Be Done About It

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Disclosures

Consultant agreements
Terumo
SilkRoad Medical
W.L. Gore & Associates
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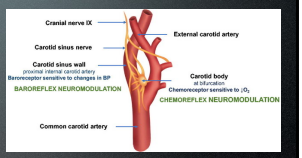
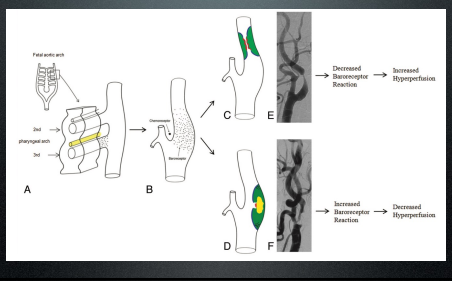
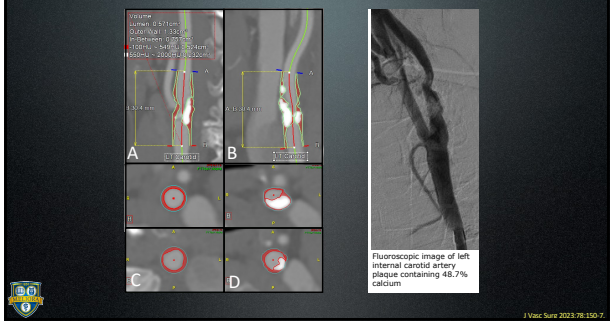
Pathophysiology

- Baroreceptor neurons
- Sympathetic suppression
- GABA release
- Angiotensin pathway
- Risk factors:
  - Age, low EF, CAD, de-novo lesion (not post-CEA), calcification, plaque length



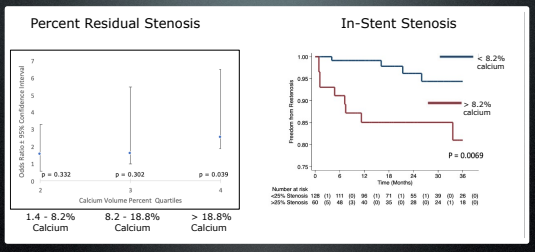
Anatomic Risk





Fluoroscopic image of left internal carotid artery plaque containing 48.7% calcium

J Vasc Surg 2023;78:150-7.



Plaque Management and hTN

- Post-operative hypotension in patients undergoing CAS for asymptomatic carotid artery stenosis
  - Unplanned ICU utilization
  - Longer length of stay
  - Increased morbidity/mortality
- Does carotid bulb distension cause post-operative hypotension after CAS for the treatment of carotid artery stenosis?

Methods

- University of Rochester Medical Center (Single-institution, VQI database)
- TCAR operations for asymptomatic carotid artery stenosis from 2019 - 2022

159 Total TCARs Performed

↓ Removed Symptomatic, Trauma, Dissection, Age<18, etc.

107 Asymptomatic TCARs

↓ Removed Patients for whom aCAS was not index admission diagnosis

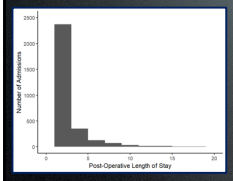
103 in Study Population

Intraoperative Patient Variables

↓

Univariate & Multivariate Analysis
Post-operative Hypotension, ICU utilization

Mean LOS = 2.1d



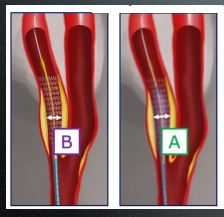
Negative Binomial Regression Model				
Factor	**Higher LOS Group**	**IRR**	**95% CI**	**Order Added**
Age	Increasing Age (continuous)	1.02	1.01 - 1.02	1
Lesion Type	Atherosclerosis	1.49	1.37 - 1.62	2
Biological Sex	Women	1.09	1.03 - 1.16	3
Transfer Status	**Transfer from hospital or SNF/Rehabilitation**	**1.97**	1.39 - 2.85	4
Preop Beta Blocker	Current use	1.14	1.08 - 1.20	5
Race	non-White	1.31	1.19 - 1.44	6
Calcification	Greater than 50%	1.07	1.01 - 1.13	7

Figure 1: Multivariate analysis of pre-operative risk factors impacting length of stay. All factors had a p-value <0.05. IRR: Incident Rate Ratio. CI: Confidence Interval

TCAR-LOS Hierarchy

Negative Binomial Regression Model		
Factor	**Higher LOS Group**	**Decreasing IRR**
Transfer Status	Transfer from hospital or SNF/Rehabilitation	1.97
Lesion Type	Atherosclerosis	1.49
Race	non-White	1.31
Preop Beta Blocker	Current use	1.14
Biological Sex	Women	1.09
Calcification	Greater than 50%	1.07
Age	Increasing Age (continuous)	1.02

Dilation Index



$$\text{Carotid Bulb Distension Index} = \frac{\textit{Post-Dilation Balloon Diameter (A)}}{\textit{Narrowest ICA Stent Diameter (B)}}$$

$$\text{Carotid Bulb Distension Index} = \frac{\textit{10mm Balloon}}{\textit{8mm ICA stent}} = 1.25$$

Results

Table 1a: Key Demographicss		
	Group	
Characteristic	No Post-Stent Dilation (N=68); (N, %)	Post-Stent Dilation (N=35) (N, %)
Age (Years)	74	77
Gender (% Male)	47 (69%)	17 (48%)
Race (% White)	61 (90%)	33 (94%)
Diabetes (% DM)	22 (33%)	13 (38%)
CAD (% CAD, CHF, CABG, or PCI)	40 (59%)	23 (65%)
Smoking (%Currently Smoking)	49 (73%)	32 (91%)
Pre-Operative Hypertension (% HTN)	64 (94%)	35 (100%)
Number in Group (N); Percentage (%)		

Results

Table 1b: Interoperative Variables

Intraoperative Variables	Group: No Post-Stent Dilation (N=68, std dev)	Group: Post-Stent Dilation (N=35, std dev)	p-value*
Flow Reversal Time (min)	9.8 (1.6)	12.6 (2.4)	0.78
Average MAP (mmHg)	74 (21)	75 (27)	0.82
Max MAP (mmHg)	135 (18)	135 (25)	0.42
Max HR (bpm)	92 (18)	90 (18)	0.68
Stent Diameter (mm)	8.92 (1.84)	8.60 (1.77)	0.53
Narrowest in-Stent Diameter (mm)	4.17 (0.80)	4.47 (1.12)	0.25
Post-Op Result	**No Post-Stent Dilation (N,%)**	**Post-Stent Dilation (N,%)**	
ICU Admission post-operatively (N, %)	12 (18%)	14 (40%)	0.001
Post-Operative Hypotension (N, %)	14 (21%)	19 (54%)	0.002
Post-Dilation Index (Average)	-	1.27	

*Wilcoxon Rank-Sum Test, Fisher's Exact Test, Pearson's Chi-Square Test

Who's at Risk?

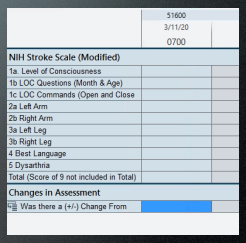
- Rochester study:
  - Standard DAPT, statin, hold angiotensin blockade, GLP-1 and metformin pre-op
  - Older, white, female, diabetic, smoker
  - Smaller index carotid diameter (smaller stent)
  - Need to post-dilate after stent

Preop Steps to Enhanced Recovery

- Hold angiotensin blockade (vasculoplegic agent) and GLP-1 agents (gastroparetic agent)
- Oral hydration with clears or Gatorade 4 hours prior
- Stress and verify importance of therapeutic anti-platelet therapy and statin
  - Postpone asymptomatic cases not on verified therapy
- Dexamethasone 8 mg IV 1 hour pre-op and post-op
- Void in the holding area

PACU

- Access sites, vitals signs, mNIHSS checks (6h stay)
  - q15m x4
  - q30m x2
  - q1h x4
- Elevate head of bed
- Fluids vasopressors as need to support normotension



Hospital

- Eating / drinking as soon as patient able
- Out of bed and ambulatory once out of PACU
- Hold anticoagulation (provisional 1 week nurse visit)
- Restart all home meds POD1
- Non-narcotic pain management strategy
- Dexamethasone 8 mg IV 6h and 12h post-op (CNI risk mitigation, antiemetic)

Baroreceptor Management

- Phenylephrine gtt first-line
- Dopamine gtt or norepinephrine gtt secondary
- Start oral therapy if does not resolve in PACU
- More than 24h: Rule-out other causes
  - Biomarkers, EKG, Echo
- Try to restore orthostatic hemostasis

Summary

- Patient profile and lesion characteristics correlate with hTN
- Primary cause of increased resource utilization
- Peri-procedural emphasis on normal hydration status, early ambulation and upright position
- Early initiation of oral agents to support
- Theoretical role of cervical block?