Presentation Number: 11

Publishing Title: Carotid Artery Stenting May Be Performed Safely in Patients with Radiation Therapy Associated Carotid Stenosis Without Increased Restenosis or Target Lesion Revascularization: Results of a Multi-center Review

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Abstract Body:
OBJECTIVE: Neck radiation therapy (XRT), may induce carotid artery atherosclerosis, and may increase the technical difficulty of endarterectomy(CEA). It is considered a relative indication for carotid angioplasty and stenting (CAS). This study sought to evaluate differences in CAS embolic potential and restenosis performed on XRT and non-XRT patients.
METHODS: Three hundred and sixty-six CAS procedures were performed on 321 patients (XRT [N = 43], non-XRT [N = 323]) at three institutions. Mean follow-up was 410 days (median, 282 days; range, 3-1920 days). Patients were followed with duplex ultrasound to assess for restenosis. Additional endpoints included target lesion revascularization, myocardial and cerebrovascular events and perioperative complications. Captured particulate from embolic protection filters were analyzed using photomicroscopy and image analysis software for 27 XRT and 214 non-XRT filters.
RESULTS: XRT patient were more likely to be male, and had lower rates of HTN, CAD and DM, although the mean age at procedure did not differ (Table). There was a trend towards increased severe internal carotid tortuosity among XRT patients (XRT: 50% vs. non-XRT: 34.7% P=.05). Indication for CAS did not differ between the two groups, including the number of CAS performed for symptomatic carotid stenosis (XRT: 39.7% vs. non-XRT: 39.0% P=NS). Perioperative outcomes, including the composite 30 day stroke/myocardial infarction/mortality were not significantly different (XRT: 2.6% vs. non-XRT: 3.9% P=NS.) There was no significant differences in restenosis rate at the 50% (XRT: 9.4% vs. non-XRT: 8.6% P=NS) or 70% (XRT: 3.5% vs. non-XRT: 8.6% P=NS) threshold. Filter particle analysis revealed that filters from XRT patients had more numerous large particles per filter and larger particles (Table). Target lesion revascularization(TLR) did not differ significantly between the groups.
CONCLUSIONS: In contrast to earlier studies, this analysis reveals that there are significant differences in XRT and non-XRT patients undergoing CAS, in terms of medical comorbidities, anatomy and embolic potential. Decreased incidence of atherosclerotic risk factors was observed in XRT patients likely because XRT was the primary factor responsible for carotid stenosis. Despite increased tortuosity and embolic particle size, CAS can be performed safely with no increased morbidity, TLR or restenosis in XRT patients.

Table 1. Demographics and Particulate Data (P values by chi-square and T-test)

	XRT	Non-XRT	P value
Mean Age	68.9	71.1	NS
Male	79% (n=34)	56.7% (n=183)	P<.01
HTN	63.4% (n=26)	90.6% (n=292)	P<.0001
CAD	36.5% (n=15)	59.6% (n=192)	P<.05
DM	19.5% (n=8)	36.3% (n=117)	P <.05
Particulate Data			
Mean maximum particle size / filter(μm)	1.4	.74	P<.05
Mean maximum particle size / filter(μm)	1504.5	307.8	P<.01

Presentation Number: 12

Publishing Title: **Upper Extremity Blood Pressure Differential Strongly Predicts Cerebrovascular Disease and Carotid Artery Stenosis**

Author Block: **Karan Garg, MD**, Jeffrey S. Berger, MD, Yu Guo, MS, Mark A. Adelman, MD, Glenn R. Jacobowitz, MD, Thomas S. Maldonado, MD, Thomas S. Riles, MD, Caron B. Rockman, MD
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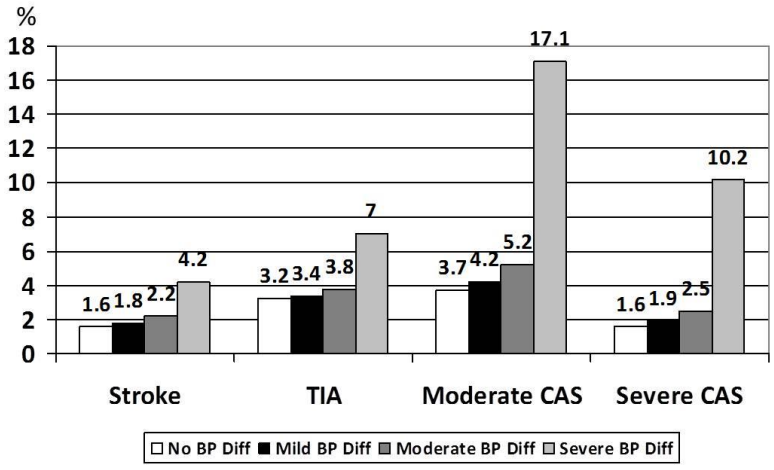
Abstract Body:
OBJECTIVES: An upper extremity (UE) systolic blood pressure (SBP) differential has been reported to be a marker for systemic atherosclerosis. However, the relationship between the degree of SBP differential and the prevalence of cerebrovascular disease has not been specifically defined. The goal of this study was to analyze a large cohort of patients who underwent vascular screening tests, and to determine the relationship between an UE SBP differential, clinical cerebrovascular disease, and carotid artery stenosis.
METHODS: Of 3,696,778 patient screened, 241,959 did not have both UE SBP recorded, and were excluded. The remaining subjects were characterized as having no significant SBP difference (< 10 mm Hg differential), mild (11-15 mm Hg), moderate (16-20 mm Hg), and severe (≥ 20 mm Hg) differences. Standard statistical analysis was performed.
RESULTS: Of 3,454,819 subjects, 86.8% had no significant UE SBP differential; 9.1% (313,352) had a mild difference, 3.9% (134,278) had a moderate difference, and 0.2% (7,657) had a severe difference. Increasing degrees of UE SBP differential were directly and significantly associated with increased age, tobacco use, hypertension, hypercholesterolemia, diabetes, and obesity (p<.001). Increasing degrees of UE SBP differential were directly and significantly associated with a history of stroke, and a history of TIA. Increasing degrees of UE SBP differential were directly and significantly associated with both moderate (≥50%) and severe (≥80%) carotid artery stenosis (p<.001) (Figure 1). In multivariate analysis, an UE SBP difference of ≥ 15 mm Hg was an independent predictor of carotid artery stenosis (OR 1.3); a differential of > 20 mm Hg nearly quadrupled the risk of having significant carotid artery disease (OR 3.9).
CONCLUSIONS: Subjects with UE SBP differentials are more likely to have traditional atherosclerotic risk factors. However, even after adjusting for these risk factors, an UE SBP difference is an independent risk factor for cerebrovascular disease. SBP differentials noted in the upper extremities can be potentially used as an excellent screening marker for the presence of extracranial cerebrovascular disease.



Presentation Number: 13

Publishing Title: **Long term Carotid Artery Disease Progression and Related Neurologic Events Following Carotid Endarterectomy**

Author Block: **Efthymios D. Avgerinos, MD**, Catherine Go, MD, Jennifer Ling, MD, Abdallah Naddaf, MD, Amy L. Steinmetz, Michel S. Makaroun, MD, Rabih A. Chaer, MD.
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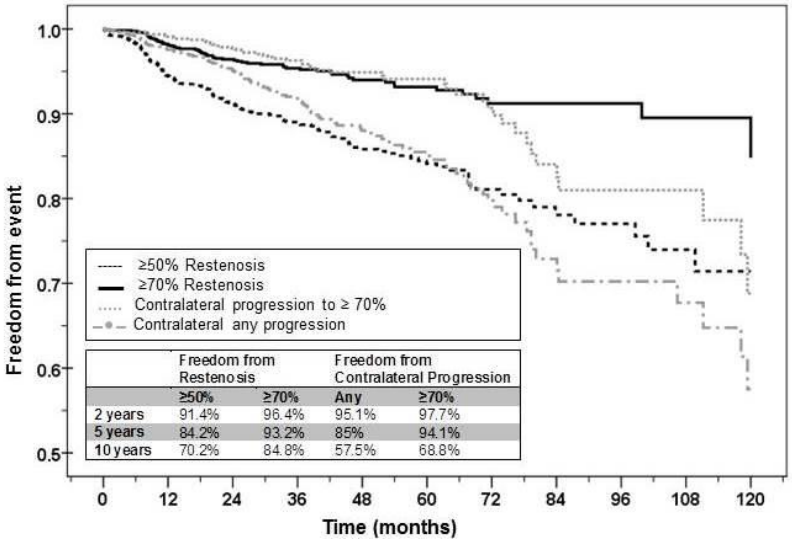
Abstract Body:

OBJECTIVES: The purpose of the study was to assess predictors of long term disease progression and clinical outcomes following carotid endarterectomy (CEA) in contemporary practice.

METHODS: A consecutive cohort of CEAs between 1/1/2000 - 12/31/2010 was retrospectively analyzed. Endpoints were restenosis ≥50% and ≥70%, contralateral carotid disease progression (50-69%, 70-99% or occlusion) and stroke. Survival analysis and Cox regression models were used to assess the effect of baseline predictors.

RESULTS: 1782 CEAs (bilateral 142, mean age 71.4±9.3 years; 56.3% male; 35.4% symptomatic, 2.7% combined CABG) were performed during the study period with a mean clinical follow up of 54.8 months (1-155 months). Periprocedural stroke and death rates were 1.9% and 0.8% respectively (stroke/death: overall 2.6%, asymptomatic cohort 1.8%).Freedom from restenosis and contralateral carotid stenosis progression is shown in Figure 1, both events attaining higher rates of critical values (≥70%) after 5 years. Thirty one (20.4%) restenosis were symptomatic (5 at ≥50%, 26 at ≥70%) and 40 (26.3%) underwent reintervention. Restenosis was predicted by hypertension (HR 2.06, p=.031), female gender (HR 1.54, p=.012) and younger age ≤65 (HR 1.64, p=.009); contralateral progression was predicted by smoking (HR 1.85, p=.007) and renal insufficiency (HR 2.40, p=.001) resulting in carotid intervention in 27.1% of patients. No association was shown with either closure technique (primary vs patch vs eversion) or statins.Any stroke (118 events, 68 ipsilateral, 49 contralateral) rates at 5 and 10 years were 7.2% and 14.9% respectively. Predictors were symptomatic indication (HR 1.51, p=.033), renal insufficiency (HR 1.58, p=.046) and no statin use (HR 3.41, p=.006) at baseline. The rate of stroke referable to contralateral progression was 5.6% (6/107).

CONCLUSIONS: Restenosis and contralateral carotid stenosis following CEA progress significantly after 5 years, with possible impact on surveillance strategies. Restenosis was not associated with closure technique. Statin use reduces new symptoms but not the rate of disease progression.



	Freedom from Restenosis		Freedom from Contralateral Progression	
	≥50%	≥70%	Any	≥70%
2 years	91.4%	96.4%	95.1%	97.7%
5 years	84.2%	93.2%	85%	94.1%
10 years	70.2%	84.8%	57.5%	68.8%

Presentation Number: 14

Publishing Title: Practice Patterns of Carotid Endarterectomy as Performed by Different Surgical Specialties and the Impact on Perioperative Stroke and Cost

Author Block: **Ali F. AbuRahma, MD**, Mohit Srivastava, MD, Benny Y. Chong, MD, Zachary AbuRahma, MS, Stephen M. Hass, MD, L. Scott Dean, PhD, MBA, Patrick A. Stone, MD, Albeir Y. Mousa, MD
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Abstract Body:
OBJECTIVES: Carotid endarterectomy (CEA) is currently performed by various surgical specialties with varying outcomes. This study analyzes different surgical practice patterns and their impact on perioperative stroke and cost.
METHODS: This is a retrospective analysis of prospectively collected data of 1,000 consecutive CEAs performed at our institution by three different specialties: general surgeons (GS), cardiothoracic surgeons (CT), and vascular surgeons (VS).
RESULTS: 474 CEAs were done by VS, 404 by CT, and 122 by GS. VS tended to operate more often on symptomatic patients than CT and GS: 40% versus 23% and 31%, respectively ($p<0.0001$). Preoperative work-ups were significantly different between specialties: duplex ultrasound (DUS) only in 66%, 30%, and 18%; DUS and CTA in 27%, 35%, and 29%; DUS and MRA in 6%, 35%, and 52% for VS, CT, and GS, respectively ($p<0.001$). The mean preoperative carotid stenosis was not significantly different between the specialties. The mean heparin dosage was 5168, 7522, and 5331 units ($p=0.0001$) and protamine was used in 0.2%, 19%, and 8% ($p<0.0001$) for VS, CT, and GS, respectively. Postoperative drains were used more often by VS; however there was no association between heparin dosage, protamine, and drain use and postoperative bleeding. Patching was used in 99%, 93%, and 76% ($p<0.0001$) for VS, CT, and GS. Bovine pericardial patches were used more often by CT and ACUSEAL (Gore) patches were used more often by VS ($p<0.0001$). The perioperative stroke/death rates were 1.27% for VS and 3.04% for CT and GS combined ($p=0.055$); and for asymptomatic patients, 0.7% for VS and 3.02 for CT and GS combined ($p<0.034$). Perioperative stroke rates for patients who had preoperative DUS only were 0.88%, versus 3.29% for patients who had extra imaging (CTA/MRA) ($p=0.009$); and for asymptomatic patients, it was 0.94% versus 3.01% ($p=0.05$). When applying hospital billing charges for preoperative imaging work-ups (cost of DUS only versus DUS and other imaging), the VS practice pattern would have saved $1180 per CEA over CT and GS practice patterns; a total savings of $1,180,000 in this series.
CONCLUSIONS: CEA practice patterns differ between specialties. Although the cost was higher for non-VS practices, the perioperative stroke/death rate was somewhat higher. Therefore, educating physicians, who perform CEAs, on cost-saving measures may be appropriate.

Presentation Number: 15

Publishing Title: A Propensity Score Matched Analysis of Asymptomatic Patients Undergoing Carotid Endarterectomy (CEA) vs. Coronary Artery Bypass Graft (CABG) vs. Combined CEA-CABG in the ACS-NSQIP

Author Block: **Li Wang, BS**, Thomas Curran, MD, John C. McCallum, MD, Dominique Buck, MD, Jeremy Darling, BA, Mark Wyers, MD, Raul J. Guzman, MD, Allen Hamdan, MD, Elliot Chaikof, MD, PhD, Marc L. Schermerhorn, MD
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Abstract Body: **OBJECTIVES:** Carotid endarterectomy (CEA) and coronary artery bypass graft (CABG) may be combined to treat concomitant coronary artery and carotid artery atherosclerotic disease. Previous reports on combined CEA/CABG have shown wide variation in adverse event rates for asymptomatic patients and have often been limited by small sample size and/or lack of granularity. We aim to compare stroke and death after CEA/CABG with CEA or CABG alone in asymptomatic patients using the ACS-NSQIP.
METHODS: All patients undergoing CEA, CABG or CEA/CABG from 2005 to 2011 in the NSQIP database were identified. NSQIP documented neurologic symptoms lack laterality and temporal detail for assignment of positive current neurologic symptoms while asymptomatic patients are captured with excellent accuracy. Accordingly only asymptomatic patients were analyzed. Propensity score matched groups of asymptomatic patients were based on age, sex and ASA class 4. Chi-square, ANOVA and multivariable logistic regression were used to compare stroke, death and combined stroke/death across procedures.
RESULTS: We identified 47,667 patients; 42,474 CEA (89%), 5,018 CABG (11%), 175 CEA/CABG (&lt1%). Forty percent of all patients had a history of neurologic symptoms and were omitted from consideration; 43% CEA, 12% CABG, 28% CEA-CABG. Unmatched rates of stroke/death in asymptomatic patients were: 1.4% (CEA), 3.3% (CABG) and 6.7% (CEA/CABG). Propensity score matching identified 1,332 asymptomatic patients; 606 CEA, 607 CABG, 119 CEA/CABG. Stroke, death and stroke/death rates are compared across procedures in the Table. Independent risk factors for stroke/death among matched asymptomatic patients were: recent myocardial infarction OR: 4.0 (95% CI: 2.0-8.0), COPD OR: 4.7 (95% CI: 2.4-9.2) and age &gt 70 years OR: 2.7 (95% CI: 1.4-5.2); CEA/CABG, as compared to CABG alone, did not have increased risk of stroke/death (OR: .6, 95%CI: .2-1.4). No significant difference was seen between the stroke/death rate of CEA/CABG (6.7%) as compared to the aggregate of CEA and CABG alone (2.1% + 4.2%).
CONCLUSIONS: In asymptomatic patients CEA/CABG does not confer increased risk for stroke/death as compared to the combined risk of CEA and CABG alone. CEA/CABG should be considered a safe approach in asymptomatic patients requiring both CEA and CABG.

Propensity Score Matched Group Outcome Comparison

	CEA (N=606)	CABG (N=607)	CEA-CABG (N=119)	p value (CABG vs. CEA/CABG)
Death (%)	1.2	2.3	3.4	.516
Stroke (%)	1.2	2.0	3.4	.314
Stroke/Death (%)	2.1	4.1	6.7	.227

Presentation Number: MP11

Publishing Title: A Robust Risk Predictive Model of Adverse Outcomes after Carotid Endartrectomy

Author Block: **Mohammad H. Eslami, MD**[1], Denis Rybin, MS[2], Gheorghe Doros, PhD[2], Alik Farber, MD[1].
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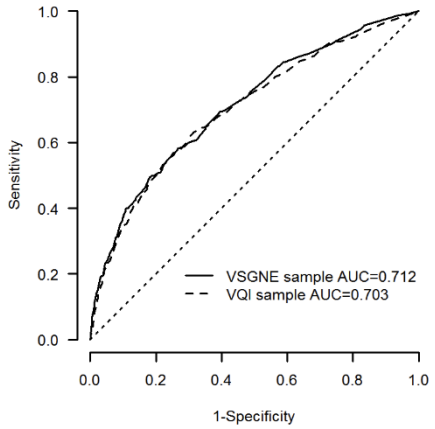
Abstract Body:
INTRODUCTION: The goal of our study was to construct and validate a robust risk prediction model for patients undergoing carotid endartrectomy (CEA).
METHODS: Vascular Group of New England (VSGNE) and Vascular Quality Initiative (VQI) databases were queried for patients who underwent CEA. Pre-operative variables including age, gender, pre-admission living, diabetes, dialysis, history of congestive heart failure, coronary artery disease, peripheral arterial disease, use of statins, beta-blockers, urgency of the operation and symptomatic neurological status were entered into a logistic regression model as predictors of the composite adverse outcomes. Backward elimination (alpha level of 0.5) was then used to select a more parsimonious model. Calibration was performed to measure how closely predicted outcomes agree with observed outcomes. To assess calibration we used Hosmer-Lemeshow for dichotomous outcomes, R2 for continuous outcomes and a modified version of Hosmer-Lemeshow for time to event data. The predictive value of the model was assessed via *C*-statistic. The external validation was then performed using VQI sample after excluding those in VSGNE sample (VQI-VSGNE) following similar method. Chi-square test was used to compare the two groups.
RESULTS: A significantly higher rate of adverse outcomes was noted for the VQI sample (5.21%, n=12,075) compared with VSGNE sample (4.49%,n=8,661) (p<0.017). Table below summarizes the risk models in the VSGNE cohort. The discriminating ability of the model on the VSGNE is substantial (C=0.712) and the model fit is good (Hosmer-Lemeshow lack of fit test p=0.494). The discriminative ability of the VSGNE model remained substantial in the external data (VQI-VSGNE) (C=0.703) (Figure).
CONCLUSION: The internally validated VSGNE CEA risk model was externally validated by testing it against the remainder of VQI on patients who underwent CEA by a diverse array of physicians. This tool provides a simple and reliable method to risk stratify CEA patients using their pre-operative conditions. A risk score based on this model can reliably stratify patients according to their risk of adverse outcomes after CEA.

Table -VSGNE model: Parsimonious 0.5 level (C=0.712, Hosmer-Lemeshow p=0.494)

	Adj. Means Ratio	Lower Confidence Limit	Upper Confidence Limit	p value
Age: 75+ vs. <75	1.6947	1.3720	2.0933	<0.0001
Male vs. Female	0.9011	0.7284	1.1148	0.3374
Pre admission: Nursing Home vs. Home	7.7144	4.7317	12.5773	<0.0001
Diabetes	1.3992	1.1256	1.7393	0.0025
Congestive heart failure	1.5379	1.1220	2.1079	0.0075
Peripheral arterial disease	1.2545	0.9892	1.5909	0.0614
[[Unsupported Character - Symbol Font β]]-blockers	1.2277	0.9367	1.6092	0.1372
Symptomatic	2.0953	1.6734	2.6235	<0.0001
Urgent vs. Elective	2.8054	2.1790	3.6118	<0.0001

Figure- Reciever operating characteristics (ROC) curves of the VSGNE applied to internal and external samples.



Presentation Number: MP12

Publishing Title: **Long Term Outcomes of Carotid Angioplasty and Stenting After Previous Carotid Endarterectomy**

Author Block: Albeir Y. Mousa, MD, RPVI, Mike Broce, BA, Shadi Abu-Halimah, MD, Michael Yacoub, MD, **Gurpreet Gill, MD**, John E. Campbell, MD, Patrick A. Stone, MD, Mark C. Bates, MD, Ali F. AbuRahma, MD
R C Byrd Health Science Center of West Virginia University, Charleston, WV

Abstract Body:

OBJECTIVES: Repeated carotid endarterectomy (CEA) for recurrent carotid stenosis (RCS) carries a significant challenge with higher rates of complications in comparison to primary CEA. Carotid angioplasty and stenting (CAS) is considered a valid treatment modality for RCS. We investigated the outcomes of patients who underwent CAS for carotid stenosis (CS) and compared outcomes of patients who received CAS with CEA history (HCAS) to those with no prior surgical history (OCAS).
METHODS: A retrospective review of all CAS cases performed at a large tertiary care center between January 2005 and May 2013. Outcomes included target vessel re-intervention (TVR) and in-stent restenosis (ISR) as defined by duplex velocity >275 cm/sec.
RESULTS: A total of 206 patients with CS underwent 231 CAS interventions. Majority were male (61.2%), mean age of 69±10 years, and 25were excluded due to multiple prior surgeries. For the HCAS group, mean elapsed time from CEA was 81.6±63.4 months. Baseline characteristics of the two groups differed in female gender 47.3 vs 30.4%, history of CHF 9.9 vs 21.7%, history of stroke 1.1 vs 8.7% for HCAS vs OCAS, (all $p<0.05$), respectively. Indication for intervention in both groups was mainly symptomatic severe CS 84.6 vs 87% ($p=0.689$). No major complication difference between HCAS and OCAS for stroke (2.2 vs 6.1%), MI (1.1 vs 0%), CHF (1.1 vs 0%) or death (1.1 vs 0%), respectively. Though non-significant, ISR in the HCAS (13.2%) than OCAS group (6.1%; $p=0.093$) and significantly more TVR for HCAS (9.9%) than OCAS (2.6%; $p=0.036$). No difference in freedom from ISR, 67.8 vs 76.5% for HCAS and OCAS at 6 years($p=0.688$). There was a strong trend for the difference in freedom from TVR with 87.4 vs 97.2% for HCAS and OCAS at 5 years ($p=0.065$). ISR independent predictors were diabetes (OR:2.5, $p=0.050$), PVD (OR:3.2, $p=0.013$), and pre-op aspirin use (OR:0.4, $p=0.049$), while predictors for TVR were asymptomatic indication (OR:4.4, $p=0.011$) and age at procedure < 65 years (OR:5.0, $p=0.009$).
CONCLUSIONS: This study suggests that CAS is a feasible and durable therapeutic option for RCS after CEA. Despite more co-morbid conditions at the time of the index procedure, long-term outcomes for patients without history of CEA were similar to those with, while having less TVR and longer survival time free from TVR.