Table. Blood vessel characteristics before and after AVF

	Preoperative (n = 5)	*Immediately postop (n = 2)*	*1 month postop (n = 2)*	*Mature (>1 year) (n = 2)*
Brachial artery				
Diameter, mm (SD)	4.5 (0.48)	5.4 (0.56)	5.1 (0.41)	4.9 (1.8)
Average velocity, cm/s (SD)	5.5 (3.2)[a]	62 (17)[a]	70 (7)[a]	112.5 (57)[a]
Volumetric flow, mL/min (SD)	56 (33)[a]	850 (58)[a]	878 (225)[a]	1120 (236)[a]
Cephalic or basilic vein				
Diameter, mm (SD)	3.7	4.8 (0.05)	4.7 (1.3)	13.2 (7.2)
Average velocity, cm/s (SD)	2.25	55 (17)	64 (14)	15.7 (9.7)
Volumetric flow, mL/min (SD)	14.8	596 (201)	733 (530)	1054 (492)
Percent of blood flow in the distal artery	N/A	30%	17%	6%
Percent of blood flow in the venous limb	N/A	70%	83%	94%

[a]$P < .01$, ANOVA.

protocol consisted of 2D and 3D time of flight (TOF) sequences performed at 1.5T (Siemens Avanto, Germany). Through-plane blood flow velocities in the artery and vein were measured 3cm above the anastomosis with a 2D phase contrast (PC) sequence. CE-MRA was done with superparamagnetic iron oxide particles (ferumoxytol, AMAG, Lexington MA). Computational fluid dynamics (CFD) simulations were performed using a finite volume solver to determine velocity field and wall shear stress distributions (Fluent, Lebanon NH).

Results: Twelve subjects (median age 67 years, IQR 59-76) had 22 scans. Among patients with a brachial artery AVF, the average arterial diameter increased while arterial velocity and volumetric flow both increased by 20 times, $P < 0.01$. Both vein diameter and volumetric flow increased after AVF surgery (Table). CFD demonstrated decreasing blood velocities and asymmetric wall shear stress mappings along the AVF from 5 to 90 days postop. Importantly, areas of stagnation persisted during this critical time frame. Compared to TOF, ferumoxytol-enhanced MRA significantly increased spatial resolution, increased fistula coverage (12.8cm vs 6cm) and decreased imaging time (20 sec vs 3 min).

Conclusions: Development of a rapid, high-resolution MRI protocol with CFD models, allowed for a comprehensive characterization of blood vessel structure and hemodynamic forces in newly created and mature AVFs. This MRI protocol is now being used prospectively to investigate the relationship between hemodynamic forces, blood vessel remodeling and AVF maturation. Additionally, ferumoxytol in CE-MRA shows promise as a safe, non-invasive method for evaluating AVFs, especially non-maturing AVFs and potentially other vascular structures in patients with end-stage renal disease.

Important Predictors of DWI Lesions and Neurological Sequelae Following Carotid Intervention

Mohamed A. Zayed, MD, Jeffrey Stephens, Simin Gholibeikian, MD, Shahrzad Ossareh, MD, Allyson Rosen, PhD, Barton Lane, MD, and Wei Zhou, MD, Department of Surgery, Veterans Affairs Hospital Palo Alto, Palo Alto, Calif.

Objectives: Embolic detection on diffusion weighted imaging (DWI) by magnetic resonance imaging (MRI) is a promising outcome measure for carotid interventions. We previously reported that patients undergoing carotid artery stenting (CAS) have a 50% greater chance of developing new microemboli on DWI compared to carotid endarterectomy (CEA). We sought to re-evaluate these outcomes in a larger patient set after technical modifications to our CAS program. We also examined the risk factors for DWI lesions and correlated neurologic symptoms with DWI-derived MLV.

Methods: From July 2004 to December 2010, a total of 228 patients (143 CEA, 85 CAS) who underwent carotid interventions also received preoperative and postoperative DWI evaluations at a single academic institution. A novel neuroimaging analysis technique was used to derive MLV on DWI. Hospital records for all patients were reviewed for comorbidities, lesion characteristics, postoperative outcomes, and incidence of periprocedural microemboli.

Results: Forty patients (47%) with CAS compared to 15 patients (10%) with CEA had postoperative DWI lesions ($P < .01$), and a higher incidence of contralateral microembolization ($P = .01$). Multivariant analysis demonstrated that the strongest predictors of DWI lesions after CAS or CEA were body mass index (BMI) > 30 ($P < .01$; confidence interval [CI], 1.4-8), preoperative stroke ($P < .01$; CI, 2.9-15.3), chronic obstructive pulmonary disease (COPD; $P = .03$; CI, 1.1-6.2), and coronary artery disease (CAD; $P = .05$; CI, 1-6.2; Table). Subset analysis of MLV demonstrated a significant correlation with the incidence of postoperative neurological symptoms ($P = .04$; R2 0.248). MLV was not different between CAS and CEA ($P = .13$).

Conclusion: The incidence of microembolic events after CAS is higher compared to CEA, but the MLV is similar for the two groups. DWI-derived MLV highly correlates with postprocedural neurological sequelas. Further investigational use of periprocedural DWI is needed to determine the utility and cost-effectiveness of identifying patients at risk of neurological sequelas after carotid intervention.

Table. Multivariant analysis of perioperative factors

Factor	P *value*	*CI*
Age >70	.70	5.2-2.6
Gender	.09	0.02-1.3
Smoking	.68	0.4-1.9
Hypertension	.53	0.1-3.4
Hyperlipidemia	.89	0.2-5.3
Obesity (BMI >30)	< .01	1.4-8
CAD	.05	1-6.2
COPD	.03	1.1-6.2
PVD	.16	0.2-1.3
Preoperative stroke	< .01	2.9-15.3
Carotid lesion calcification		

BMI, Body mass index; CAD, coronary artery disease; CI, confidence interval; COPD, chronic obstructive pulmonary disease; PVD, peripheral vascular disease.

Upregulation of Mitochondrial Chaperone Proteins in Vein Grafts: A Potential Mechanism of Apoptosis-Resistance in the Arterialized Vein

Khanh P. Nguyen,[a] Christopher Owens, MD,[a] Pen-G Yu, MD,[b] Sara J. Runge, MD,[a] and Michael S. Conte, MD,[a] [a]Department of Surgery, University of California – San Francisco, San Francisco, Calif; and [b]Brigham and Women's Hospital, Boston, Mass.

Objectives: Resistance to apoptosis is a salient feature of neoplasia and neointimal hyperplasia. In cancer, a mitochondrial chaperone network consisting of heat shock proteins (HSP)75 and HSP90 mediates apoptosis-resistance. We hypothesize that these mitochondrial proteins regulate survival in venous smooth muscle cells (VSMC) after arterialization, and may be critical in the hyperplastic response.

Methods: Primary cultured VSMC from human saphenous veins were stimulated with platelet-derived growth factors (PDGF)-BB (100 ng/mL) or tumor necrosis factor-α (TNF-α; 10 ng/mL) for 24 hours. Cells were fractionated for immunoblotting and cytosolic and mitochondrial fractions probed for HSP75 and HSP90. Excised segments of diseased human vein grafts (n = 12) and control saphenous veins (n = 10) were obtained from discarded specimens. Rabbits (n = 9) underwent carotid interposition vein grafting and grafts were harvested on day 5 or 28. Specimens were stained for HSP75, HSP90, or the inducible isoform HSP90β.

Results: Immunoblotting showed that HSP90 and HSP75 were expressed primarily in the cytosol and mitochondria of VSMC, respectively. Mitochondrial HSP75 was significantly increased after either cytokine or growth factor stimulation in vitro. After arterialization, HSP75 expression was notably increased in all vein grafts. In the rabbit, both early (5 days, n = 2) and late (28 days, n = 7) vein grafts had significantly greater HSP75 staining throughout the intima and media as compared to absent or minimal expression in control jugular veins (n = 9; analysis of variance [ANOVA];