predicting patients who may go on to have long-term disability or worsened neurological outcomes are lacking.

METHODS: Data used to train our models included demographic data (gender, age and race), history of medical conditions (hypertension, diabetes, coronary artery disease, hyperlipidemia, tobacco use), Hunt and Hess scale, ventriculostomy data (external ventricular drain (EVD) output, EVD level, EVD age), and cerebrospinal fluid (CSF) lab values (CSF protein and glucose levels). The models were trained on a sub-population of 85% of subjects and then individually validated in a training-naive subset of 15% of subjects with high accuracy.

RESULTS: Using this data, we have generated artificial neural network classifiers with hyperparameter tuning which predict the need for long-term cerebrospinal fluid (CSF) diversion via placement of a shunt (receiver operating characteristic area under the curve) (ROC AUC) = 0.8312, vasospasm (ROC AUC = 0.8058), and the categorical outcome of patient disposition (model accuracy = 0.7786).

CONCLUSIONS: We hope the use of artificial intelligence and machine learning techniques will continue to demonstrate power in predicting complex medical outcomes and ultimately help neurosurgeons and neuro-critical care personnel prognosticate and provide appropriate and timely treatment.

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Characterization of Ex Vivo and In Vivo Intraoperative Neurosurgical Confocal Laser Endomicroscopy Imaging
Yuan Xu; Irakliy Abramov; Giancarlo Mignucci-Jiménez; Grant Koskay; Evgenii Belykh, MD; Marian Park; Jennifer Eschbacher; Mark C. Pfeul, MD

INTRODUCTION: The new FDA-cleared fluorescein sodium (FNa)-based confocal laser endomicroscopy (CLE) imaging system allows for intraoperative on-the-fly cellular level imaging. Two feasibility studies have been completed with intraoperative use of this CLE system in ex vivo and in vivo modalities.

METHODS: Images acquired from two prospective CLE clinical studies, one ex vivo and one in vivo, were analyzed quantitatively. Two image quality parameters — brightness and contrast – were measured using Fiji software and compared between ex vivo and in vivo images for imaging timing from FNa dose and in glioma, meningioma, and intracranial metastatic tumor cases. The diagnostic performance of the two studies was compared.

RESULTS: Overall, the in vivo images have higher brightness and contrast than the ex vivo images (p < 0.001). A weak negative correlation exists between image quality and timing of imaging after FNa dose for the ex vivo images, but not the in vivo images. In vivo images have higher brightness and contrast than ex vivo images acquired after FNa redosing. In vivo images have higher image quality than ex vivo images (p < 0.001) in glioma, meningioma, and intracranial metastatic tumor cases. In vivo imaging yielded higher sensitivity (90% vs. 72%) and negative predictive value (81% vs 38%) than ex vivo imaging.

CONCLUSIONS: In our setting, in vivo CLE optical biopsy outperforms ex vivo CLE by producing higher quality images and less image deterioration, leading to better diagnostic performance. These results support the in vivo modality as the modality of choice for intraoperative CLE imaging.

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A Cell Resolution Atlas of the Human Cerebrovasculature Reveals Angiogenic and Inflammatory Cell Programs in Arteriovenous Malformations
Etham A. Winkler, MD, PhD; Chang Kim; Jayden Ross; Joseph Garcia; Eugene Gil; Irene Oh; Lindsay Chen; David Wu; Joshua Catapano, MD; Kunal P. Raygor, MD; Kazim Narshin; Helen Kim; Shantel Weinsheimer; Daniel Cooke; Brian Patrick Walcott; Michael T. Lawton, MD; Nalin Gupta, MD, PhD; Berislav Zlokovic; Edward F. Chang, MD; Adib Adnan Abla, MD; Daniel A. Lim, MD, PhD; Tomasz Nowakowski

INTRODUCTION: Coordinated communications between multiple cell types is responsible for cerebrovascular structure and function. Cellular dysfunction results in cerebrovascular diseases, a leading cause of death and disability. However, we lack a complete census of human cerebrovascular cells necessary to advance understanding of disease mechanisms and therapeutic strategies.

METHODS: To provide a human cerebrovascular cell atlas, we used single-cell RNA sequencing (scRNAseq) to molecularly profile dissociated vascular cells isolated from the adult human brain and AVMs. Joint comparative analyses profiled patterns of aberrant gene expression in AVMs and resolved cell states enriched in AVMs that bled. Results were validated with fluorescent in situ hybridization, immunostaining, and in vitro functional assays.

RESULTS: By performing scRNAseq on 181,388 single-cells, we identified > 40 molecularly-defined vascular or neighboring cell states from the human cerebrovasculature and AVMs. We identified endothelial molecular signatures underlying arteriovenous phenotypic changes known as “zonarions.” Our study uncovered an expanded diversity of perivascular cells unique to humans. In AVMs, there was a loss of normal arteriovenous molecular patterning characterized by the emergence of an endothelial cell state with heightened angiogenic potential and immune cell cross-talk within the AVM nidus. We characterized the cellular ontology of cerebrovascular-derived immune cell response and identified infiltration of distinct immune cell states, such as GPNMB+ monocytes, which deplete stabilizing smooth muscle cells in AVMs that bled.

CONCLUSIONS: Our single-cell atlas highlighted the heterogeneity underlying cell function and interaction in the human cerebrovasculature and defined molecular and cellular perturbations in AVMs, a leading cause of stroke in young people. The identified interplay between vascular and immune cells will aid development of therapeutics targeting angiogenic and inflammatory programs in vascular malformations.

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Stereotactic Implantation of Autologous Mesenchymal Stem Cells Improves Neurological Outcomes in a Rat Model of Chronic Middle Cerebral Artery Stroke
Kevin Hines, MD; Max Myers; Gabrielle Spagnuolo; Andrew Gray; Yolanda Gomez Galvez; Jingli Cai; Stavropoula I. Tjoumakaris, MD; Robert H. Rosenwasser, MD, FACS, FAHA; Lorraine Iacovitti, PhD
INTRODUCTION: Limited treatment options exist for patients with chronic infarcts. Multipotent adult mesenchymal stem cells (MSC) show promise as a treatment for chronic stroke. Allogeneic MSCs have been implanted successfully in chronic stroke1,2. However, no literature evaluates the use of autologous MSCs delivered via stereotactic implantation. Autologous MSCs provide safety and accessibility benefits.

METHODS: Male Sprague-Dawley rats underwent transient right MCAO for 120 minutes. Brain MRI and sensorimotor behavior were used to evaluate stroke. Sixteen days post stroke, tibial bone marrow was aspirated and MSCs were grown in a closed bioreactor. At 28 days post stroke, 3 trajectories of MSCs were implanted in the peri-infarct zone using a stereotactic robot. The treatments consisted of group 1 (5 x 10^6 cell dose, N = 6), group 2 (1 x 10^6 cell dose, N = 6) and a control group (saline injection, N = 9). In a second cohort of animals, Q-dot labeled cell dose, N = 6), group 2 (1 x 10^6 cell dose, N = 6) and a control group (saline injection, N = 9). In a second cohort of animals, Q-dot labeled autologous MSCs were tracked in the brain for 7 or 30 days.

RESULTS: Behavior as determined by the modified neurological severity score (0-16) significantly improved in both groups. Stroke volume did not decrease. Histological analysis confirmed increased astrocyte and microglia presence in the affected hemisphere. Quantum dot analysis of injections showed presence of MSCs along trajectory as well as targeting perilesional brain tissue at 7 and 30 days post-implantation.

CONCLUSIONS: Stereotactic injection of autologous MSCs represent an effective treatment for chronic stroke. Cells were effective at the lowest dose studied, with no added benefit at higher cell dosages. Unlike allogeneic MSCs which disappear over days to weeks3, autologous MSCs persist long term in the brain, potentially providing continued benefit. This treatment warrants human trials to study its effectiveness.

ICU Utilization in Elective Endovascular Treatment of Unruptured Intracranial Aneurysms

Varun Padmanaban; Austin Cohrs; Francis Jareczek, MD; Sprague Hazard; Chris Christopher Zacko, MD, MS; Ephraim W. Church, MD; Scott Douglas Simon, MD; Kevin M. Cockroft, MD; Douglas Leslie, Ph.D.; D. Andrew Wilkinson, MD, MS

INTRODUCTION: Evidence suggests routine post-operative intensive care unit (ICU) admission in high-risk neurosurgical procedures, including endovascular treatment of unruptured intracranial aneurysms (UIA), may be unnecessary, though current practice patterns are undescribed. We sought to evaluate trends in ICU utilization in patients undergoing elective endovascular repair of UIA in the United States.

METHODS: This is a retrospective cohort study utilizing commercial claims from a nationwide longitudinal database of multiple payors in the U.S. (MarketScan) to evaluate ICU use in patients undergoing elective endovascular repair of UIA between 2005 and 2019. Our initial cohort was defined using diagnosis codes and CPT procedural codes. Patients with ruptured aneurysms were excluded, and the remaining unruptured patients were separated by ICU revenue codes to identify those who were likely admitted to the ICU post-operatively. A combination of diagnosis codes and procedural codes were utilized to evaluate demographics, pre-operative comorbidities, post-procedural complications, and discharge status. Cost analysis was also performed.

RESULTS: Of 6218 patients who underwent elective endovascular treatment of UIA, 78.6% (4890) of patients were placed in the ICU post-operatively, and this percentage remained stable over the study period. No differences in age, sex, comorbidity scores, or smoking history were found between patients admitted to the ICU versus those admitted to the floor. ICU utilization was more common in urban locations (p < 0.001). The average total payment was higher in patients admitted to the ICU post-operatively ($46,429 versus $40,552, p < 0.0001).

CONCLUSIONS: Almost 80% of patients undergoing elective endovascular repair of UIA are admitted to the ICU postoperatively, despite multiple studies suggesting this practice is unnecessary. Costs are significantly higher in patients utilizing the ICU. Reducing routine ICU use in this subgroup of patients may reduce costs and resource utilization in a safe manner.

387 Percutaneous Transluminal Angioplasty and/or Stenting for the Treatment of Basilar Artery Stenosis: A Systematic Review and Meta-Analysis

Paolo Palmisciano; Samer Saad Hoz, FRCS, FABNS, M.B.Ch.B; Hagar A. Alghuri; Giancarlo Javier Venture; Seth Street; Nana Agyeman; Michael Robinson, MD, PhD; Matthew Smith; Peyman Shirani; Aaron W. Grossman; Charles J. Prestigiacomo, MD, FIACS

INTRODUCTION: Basilar artery stenosis (BAS) carries high morbidity and mortality, with variable outcomes reported after endovascular treatments.

METHODS: PubMed, EMBASE, Web-of-Science, Scopus, and Cochrane were searched upon the PRISMA guidelines to include studies describing PTAS for BAS. Pooled rates of intervention-related complications and outcomes were analyzed with random-effect model meta-analyses.

RESULTS: We included 25 studies comprising 1016 patients. Patients were mostly male (79.5%), with hypertension (81.1%) and/or dyslipidemia (56.4%), and presenting with transient ischemic attack (54.4%) or stroke (45.6%). BAS frequently involved the middle basilar artery (51.4%), and were mostly classified as Mori-B (57.4%). PTAS for BAS was indicated in patients with severe (≥50%-70%) symptomatic BAS refractory to dual antiplatelet therapy. Patients underwent angioplasty (95.5%) and/or stenting (92.2%), preferably using Wingspan or Apollo stents. Median baseline BAS was 81% (range, 53%-99%), while median post-intervention BAS was 13% (0%-75%). Actuarial rates of successful intervention and “good” final outcome were 100% (95% CI: 100%-100%) and 89% (95% CI: 85%-93%). Intervention-related recurrent ischemic stroke occurred in 85 patients (8.3%) with actuarial rates of 5% (95% CI: 4%-7%), and was differentiated into perforator (5.4%), in-stent (2.6%), and embolic (0.4%). Actuarial rates of intervention-related dissection, restenosis, and death were 0% (95% CI: 0%-0%), 1% (95%CI: 0%-1%), and 0% (95% CI: 0%-2%).

CONCLUSIONS: Elective PTAS is safe and effective in selected patients with medically-refractory, severe, symptomatic, and non-acute BAS. Different stent types and angioplasty-assisted procedures should be considered based on specific clinicoradiological characteristics of the lesions.