E-101 ENDOVASCULAR SIMULATION USING ANATOMICAL-REALISTIC 3D-REPLICAS OF PEDIATRIC NEUROVASCULAR PATHOLOGIES

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Introduction/Purpose Brain vascular anomalies are an important cause of brain injury in the paediatric population. The exposure of operators to endovascular surgeries outside of large pediatric centers is limited, resulting in unfamiliarity and unfortunate exclusion of patients from receiving timely treatments. Furthermore, neuroendovascular surgical procedures are challenging due to the complexity of the diseases and would benefit from presurgical simulation allowing more precise control, reduced complications and better clinical outcomes. Our study introduces a hands-on pediatric-specific endovascular neurosurgery simulator for skills training and treatment planning.

Materials and Methods This work is a multidisciplinary collaboration between Neuroradiology, Neurosurgery, MRI physics, Cardiovascular Radiology and Materials Science. Parameters based on neuroimaging were used as inputs to formulate anatomical-realistic 3D-replicas. The following tasks were performed: 1. Image acquisition: Six representative cases with pediatric brain vascular malformations were included in the design phase of the project. Patients underwent 3D-MRI including anatomical and angiographic sequences. These images were used for anatomical rendering of 3D-models. 2. Image segmentation: Anatomical images were manually post-processed and segmented with the aid of a 3D-image-based engineering software (Mimics/3-Matics by Materialize). 3. Manufacturing development: Based on the initial shape and size, a spectrum of vessel models was generated. Molds were designed around the models using Fused-Deposition Modeling 3D-printing with Acrylonitrile Butadiene Styrene plastic material. 4. Silicone Casting of Phantom Model: Smooth On Dragon Skin 20 silicone was filled into the molds forming the vessel models. The external parts were removed and internal parts chemically dissolved to create a lumen, resulting in a finished anatomical vessel model which replicates the nature of the initial structures. All vascular materials are radiolucent to allow for fluoroscopy, whereas the model-holder mimics anatomical and radiographic properties of the age-specific pediatric skull base and vascular peripheral anatomy. The complete phantom was attached to a pulsatile flow pump which is controlled by an Arduino microcontroller for generating specific pressure/flow rates.

Results We developed a pediatric neurovascular simulator from patient-specific MRI anatomy that reproduces the experience of treating pediatric brain pathologies. The simulator materials imitate vascular properties including wall patency, thickness, and elasticity and flow is provided by a high-fidelity pump. The simulator accuracy and feasibility for pediatric endovascular training and presurgical planning was assessed for anatomy, realism, haptics, tactility, and general usage.

Conclusion We present a pediatric-specific endovascular neurosurgery simulator using anatomical-realistic 3D-replicas of neurovascular pathologies, with a goal to provide anatomically and hemodynamically accurate training and treatment planning.

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E-102 SUPER-SELECTIVE INTRA-ARTERIAL TREATMENT OF GLIOBLASTOMA: CURRENT STATE AND FUTURE DIRECTIONS

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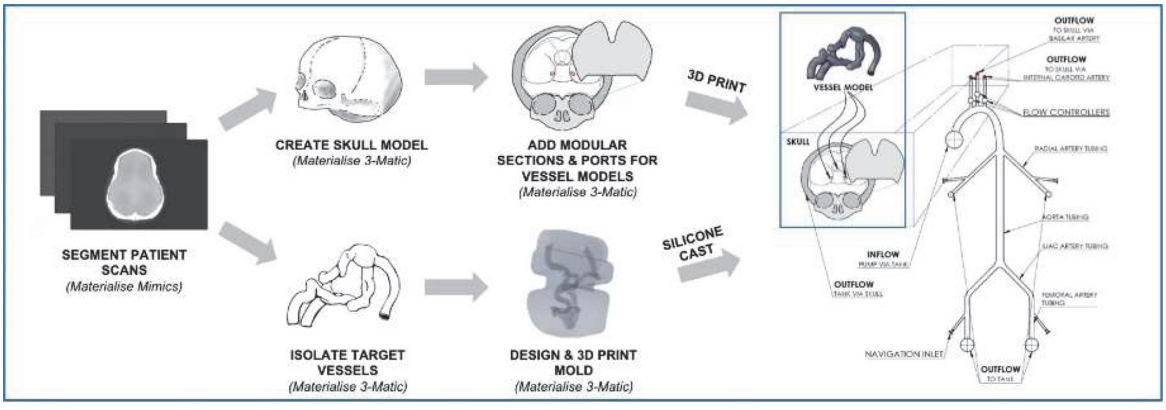
Introduction Despite years of research and continued attempts at improving surgical outcomes and chemotherapeutic regimens, glioblastoma multiforme (GBM) remains a devastating diagnosis with a dismal overall survival of approximately 15 months.[1] Given this, the need to continue innovating within the field remains. One such innovation is the use of super-selective intra-arterial delivery to better target tumors while minimizing the off-target effects. Here we discuss the current state of intra-arterial delivery of chemotherapeutic agents and novel cellular therapies and future directions within the field.

Discussion Current use of super-selective intra-arterial therapies in the treatment of GBM are focused on clinical trials. These trials are focused on one of two treatments: 1) intra-arterial chemotherapy with opening of the blood-brain barrier or 2) novel cell-based therapies. The combination of super-selective



Abstract E-101 Figure 1

intra-arterial bevacizumab with mannitol to disrupt the blood-brain barrier is currently being studied in relapsed GMB and anaplastic astrocytoma (AA) (NCT01269853). An early report has shown radiographic benefit based on RANO criteria in a patient with prior bevacizumab failure.[2] Additional ongoing trials are assessing cetuximab with reirradiation for relapsed/refractor GBM, AA, and anaplastic oligoastrocytoma (AOA) (NCT02800486) and the combination of bevacizumab with temozolomide and radiation in newly diagnosed GBM (NCT05271240). Combining super-selective intra-arterial delivery with novel treatment agents is another area of significant advancement. As cell-based therapies advance, their delivery will become a pivotal factor in their success. Novel imaging techniques have been developed for the current trial utilizing super-selective intra-arterial delivery of mesenchymal stem cells loaded with an oncolytic virus (NCT03896568).[3] This trial developed a method to fuse MRI and cone-beam imaging performed in the angiography suite, helping better guide infusion of the therapeutic agent. This targeted approach is designed to mitigate the off-target adverse effects of treatment. Utilization of therapies that combine immune modulation and direct oncolysis will necessitate this super-selective approach to balance antitumor effects with an overactive antiviral/inflammatory response.[4] The question remains: where do we go from here? Challenges remain both procedurally and with the therapies themselves. Angiographically, GBMs rarely show the tumor blush seen in hypervascularized tumors. This makes the selection of feeding vessels significantly more difficult, requiring the neurointerventionalist to refer to additional imaging modalities and mentally correlate imaging to select the optimal vessel(s) for delivery. And while novel techniques have evolved to help target tumors, optimizing infusion protocols, better defining feeder vessels, and becoming increasingly more selective through smaller microcatheters all remain necessary in the future.

Conclusions Super-selective intra-arterial delivery of both chemotherapeutic and novel cell-based therapies remains at the forefront of current GBM research, bringing together the fields of neurointervention, neurosurgical oncology, and medical neuro-oncology. This work shows significant promise in its aim to provide new pathways to better treat these patients. Further advancement of microcatheters and therapies alike will continue to grow this burgeoning sub-focus within neurointervention.

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E-103 TRANSRADIAL CAROTID STENTING USING A 6 FRENCH SIMMONS-2 GUIDE CATHETER IN COMPARISON TO TRANSFEMORAL APPROACH: A SINGLE CENTER EXPERIENCE

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Introduction Transradial neurointerventional procedures have become increasing popular in the past few years including carotid stenting, however lack of a dedicated workhorse catheter for transradial carotid stenting leave much to be desired. Here we describe our initial experience of transradial carotid stent using a low profile 6F Envoy Simmons-2 guide catheter and comparison of safety and efficacy to conventional transfemoral approach.

Materials and Methods We retrospectively analyzed all consecutive elective CAS procedures performed at our institute in last 12 months by same neurointerventionalist and divided procedures based on initial approach (transradial/transfemoral). Both approaches were used to minimize inter-operator variability. Transradial cases were done on an all-comer basis after enough procedural experience with the 6F Sim2 guide catheter was attained without any strict exclusion criteria other than severe right subclavian artery stenosis. Although this method limits stent size to 8 mm, it proved to be a more reliable guide catheter. We reviewed clinical indications, technical success including crossover rates, procedure and fluoroscopy times, clinical outcomes, and complications rates.

Results Of the total 35 consecutive elective CAS procedures performed; 16 were initiated as transradial approach but 4 (25% crossover rate) of them had to be switched to transfemoral for reasons including irreducible radial artery loop, severe BCTA and CCA tortuosity, and thrombosis of radial sheath. Eventually 23 (65%) patients had transfemoral and 12 (35%) patients had transradial CAS. Type 1 arch (58% cases) were more common in transradial group whereas type II arch (60% cases) in transfemoral group. In transradial cases, guide catheters used included 6F Envoy Sim-2 XB (75%), R2P destination slender sheath (17%), 6F Cook Shuttle (8%) and stents included Cordis Precise (50% cases) and Wallstent (42% cases) with majority (92% cases) of them being 8 mm width or lower. Mean age was similar between the two groups (72.7 years vs 71.7 years) with 65% of patients being males in both groups. 67% of cases were symptomatic in transradial group against 74% patients in transfemoral group. Carotid lesion was right sided in 58% cases of transradial group as opposed to left sided in 65% of transfemoral cases. Of the symptomatic cases treated transradially (n=8), 4 had non-disabling strokes, 3 had TIA and 1 had amaurosis fugax as treatment indications. Majority of the symptomatic cases were treated <7days from symptom onset in both groups (42% vs 65%). 1 patient (4%) had post-operative decline in NIHSS and 1 patient had a groin hematoma in the transfemoral group and no adverse events noted in the transradial group. The rate of any stroke/death within 30 days post procedure were 0 and 2 (8.7%) in transradial and transfemoral groups respectively. The mean procedure times were 52.3 and 59.5 minutes (p=0.02), whereas mean fluoroscopy times were 28.3 and 30.7 minutes (p=0.34) in transradial and transfemoral groups respectively.

Conclusions Transradial carotid stenting using lower profile technique appears to be a safe, effective, and faster option for carotid revascularization compared to traditional transfemoral approach although conversion rate may be high which can be mitigated through proper case selection.

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