E-147 COMBINING TIME RESOLVED CONTRAST ENHANCED MR ANGIOGRAPHY WITH VOLUMETRIC HIGH RESOLUTION T2-WEIGHTED IMAGING IS A HIGHLY ACCURATE, NON-INVASIVE METHOD FOR LOCALIZATION OF SPINAL DURAL AV FISTULAS: A CASE SERIES

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Objective To describe a non-invasive method for prospectively localizing Spinal Dural AV Fistulas (SDAVF) with contrast enhanced magnetic resonance imaging prior to spinal angiography and treatment, by combining Time Resolved Contrast Enhanced MR Angiography (TRCE-MRA) with Volumetric High Resolution T2-weighted Imaging (VHR-T2-I) sequences.

Background The gold standard for the localization of SDAVF is spinal angiography. A complete spinalangiogram involves the sampling of all segmental arteries, which can be time consuming and carries the risks of contrast nephropathy and radiation exposure. A non-invasive method of prospectively localizing the SDAVF feeding segmental arteries would be highly beneficial, as it would allow focusing the spinalangiogram to only a few vessels, decreasing procedure time and mitigating these risks. TRCE-MRA has been utilized in the localization of SDAVFs in the past. This method, however, has been limited by the inherent tradeoff that exists between temporal and spatial resolution in MR imaging. Even on advanced 3 Tesla systems, TRCE-MRA of the spine at frame rates higher than 1 per 2 seconds have poor signal to noise and anatomical detail, making the identification of the small SDAVF feeding vessels a challenge. VHR-T2-I sequences have very high anatomical detail but cannot assess vessel flow. In this case series, we present a method that co-registers the temporal information from TRCE-MRA and the spatial information from VHR-T2-I to prospectively identify the feeding vessels of SDAVFs with a very high accuracy.

Methods Five consecutive patients with clinical and imaging findings consistent with SDAVF underwent 3 Tesla CE-MRA on a Siemens MAGNETOM Skyra system prior to spinal angiography. For each patient, Siemens Time-resolved angiography With Stochastic Trajectories (TWIST) sequences at frame rates of 1 per 2 seconds or higher were obtained. A single slab 3D single slab turbo spin echo (SPACE) sequence was then obtained and the sequences were co-registered. The images were reviewed by a neuroradiologist and the feeding segmental artery to the SDAVF was identified. Subsequently, each patient underwent spinal angiography. In all patients the segmental artery feeding the SDAVF was correctly prospectively identified by the CE-MRA.

Results In all patients in this case series, CE-MRA with TWIST/SPACE co-registration prospectively identified the SDAVF feeding artery. This resulted in a reduction in procedure time, contrast dose and radiation exposure. No procedure complications were encountered. In one patient with advanced atherosclerotic disease, the CE-MRA was critical in identifying the SDAVF feeding artery, as severe stenosis at the origin of the feeding artery made catheterization difficult and the vessel might have been missed if not for the prospective information from the CE-MRA.

Conclusion This case series illustrates how combining TRCE-MRA and VHR-T2-I can prospectively identify the feeding

segmental branches of SDAVFs, resulting in reduced procedure time and risks of pre-treatment spinal angiography.

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E-148 PIPELINE EMBOLIZATION DEVICE TREATMENT OF INTRACRANIAL ANEURYSMS IN PEDIATRIC PATIENTS: A PATIENT-LEVEL META-ANALYSIS

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Introduction While the Pipeline Embolization Device (PED, Medtronic) is safe and effective in the treatment of intracranial aneurysms in adults, less is known about its safety and effectiveness in pediatric patients. We aim to report clinical outcomes in patients aged 18 or younger undergoing flow diversion with PED for intracranial aneurysms.

Methods PubMed, Embase, and Scopus were searched for reports of pediatric patients treated with PED. Disaggregated data was available for 44 pediatric patients with 48 aneurysms. Data regarding demographics, aneurysm characteristics, treatment, follow-up, clinical outcomes, and complications were collected.

Results The average age of patients was 10.5 ± 4.3 years, 47.8% of whom were male, while 34.1% were female, and the sex of 18.1% was not reported. A total of 23 aneurysms (52.2%) were in the posterior circulation. Fourteen aneurysms (29.2%) were fusiform, and 12 (25.0%) were dissecting. Fifteen aneurysms (31.3%) were giant, 14 (29.2%) were small, and 9 (18.9%) were large. Fourteen aneurysms (29.2%) presented with mass effect, followed by 11 (22.9%) with subarachnoid hemorrhage, and 6 (12.5%) each with headache and recurrence. The number of PEDs used for an aneurysm was 2.0 ± 1.5 , and 10 aneurysms (20.8%) were treated with adjunct coiling. The average imaging and clinical follow-up for the aneurysms were 10.1 ± 7.9 and 10.5 ± 8.1 months, respectively. Thirty-four aneurysms (70.8%) were completely occluded. Four patients (10.0%) experienced complications, including one death, recurrence, brainstem compression, and in-stent stenosis.

Conclusions PED is safe and effective for intracranial aneurysm treatment in pediatric patients. Proper guidelines regarding use of PED in children should be created.

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E-149 THE OUTCOME OF TRANSVENOUS EMBOLIZATION FOR VEIN OF GALEN MALFORMATION AS A LAST PROCEDURE

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Backgrounds Vein of Galen aneurysmal malformation (VGAM) is a rare congenital vascular malformation representing <1% of all arteriovenous malformations. In the newborn period treatment is done for untreatable CHF. There have been reports of transvenous coil embolization either trans-torquar, or tran-femoral, although effective in controlling the high output failure, the results are less than optimal, and has lost

popularity. The combined transarterial and transvenous 'trapping' of the fistula, is challenging and few reports as to safety and curative are available. We have used the transumbilical arterial approach in newborns with good results. The concept of devascularization in a staged fashion over a period of time, has permit us to get a total or near total obliteration in 80% of cases. There is however a group of patients in whom the residual arterial supplies is through small perforators and in whom transvenous embolization (TVE) is technically the easiest for cure. We assessed outcomes of our vein of Galen malformation cases treated with TVE.

Materials and Methods We retrospectively reviewed 141 consecutive patients with VGAM treated in our institute between 2004 and 2019. Thalamic AVMs were excluded. 9 patient underwent TVE.

Results Among 9 TVE, 1 underwent partial TVE for palliative measures and excluded from this analysis. The other 8 underwent TVE. All of them had undergone more than 3 transarterial nBCA embolizations. 4 out of 8 patients had complete obliteration of the VOGM. 2 patients underwent stereotactic radiosurgery for the residual fistula and complete obliteration was confirmed (prior to 2000). The outcome 6 out of 8 patient head total obliteration, and achieved normal development without neurological deficit. On the other hand, two hemorrhagic complications occurred, 1 immediately after the procedure (2013), and the 2nd within 2 days after TVE (2018), where there was a small residual. Of them, the 1st expired and the 2nd had significant neurological impairment. Both had coils embolization. 2 patients with coils embolization were cured. This difficulty in predicting the risk of hemorrhage, prompted us to improve our ability to close the shunt, and the small remaining arterial supply by using the Chapot 'Pressure cooker' (CHPC) technique in 2 with complete obliteration.

Discussion There has not been any report before, about the TVE to cure the VGAM after multiple sessions of TAE. In this study, two issues can be brought up. One, there is a chance to close the fistula completely or incompletely only using coils. In addition there is the concern of impairing drainage of the normal brain. To improve these two issues, complete closure of the fistula using the CHPC technique with liquid embolic material in TVE, which we performed recently with great success, seems to be a solution.

Conclusion In endovascular treatment of the vein of Galen malformation, TVE is feasible option, once the dilated vein of Galen becomes small enough. To prevent incomplete occlusion or post procedural hemorrhagic complication, the use of the Chapot 'Pressure cooker' technique using liquid embolic material is considered to be necessary.

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E-150

SAFETY AND EFFICACY OF HIGH DOSE INTRAARTERIAL VASODILATORS FOR VASOSPASM AND THE PREVENTION OF DELAYED CEREBRAL ISCHEMIA: COMPARISON OF NICARDIPINE AND VERAPAMIL

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Introduction Delayed cerebral ischemia (DCI) continues to be a challenging complication of subarachnoid hemorrhage. This study sought to examine the impact of intra-arterial therapy on patients with medically refractory DCI. More specifically it sought to determine comparative results of nicardipine and verapamil as well as to determine if there was a relationship between IA vasodilator dose and complication rate.

Methods A retrospective chart review of all patients at a single institution undergoing endovascular IA therapy for vasospasm secondary to subarachnoid hemorrhage over a 30 month period was done. In total, 69 patients underwent 126 treatments for cerebral vasospasm in the setting of atraumatic subarachnoid hemorrhage (SAH). In total 91% of patients present with aneurysmal SAH while 9% had angiography negative SAH. 53.6% of patients had their aneurysm treated endovascularly. Median Hunt Hess grade was 3 and 88% of patients presented with Modified Fischer grade 3 or 4. Formal angiography was done in the setting of clinical vasospasm as determined by patients' neurologic exams, velocity on transcranial doppler, and other clinical factors. The majority of patients underwent a single treatment (55%) while the most treatments for a single patient was 5 (4%).

Results In total, 98% (123/126) of treatments led to an improved or stable neurological exam post treatment, and 3 patients developed a post-operative procedural neurological decline. Delayed cerebral ischemia, defined as a new neurological deficit, occurred in 55% (38/69) of patients in this cohort; however, the new neurological deficit was permanent in only 14% of patients (10/69). New infarcts were seen on imaging in 19% of patients (13/69) but were clinically silent in 3/60 patients. Patients with DCI were more likely to undergo multiple treatments of IA therapy ($P < 0.05$). Average total dose of nicardipine was 11 mg (range 3–40 mg). Average dose of verapamil was 88 mg (range 25–240 mg). There was no relationship between dose and complication rate ($P > 0.05$). There was no differential risk of DCI in the nicardipine vs the verapamil group ($P > 0.05$). Patients undergoing verapamil therapy were more likely to experience complications of IA therapy, 20% vs 5% in the nicardipine group ($P < 0.05$), however patients classified to have severe vasospasm by the angiographer were more likely to undergo treatment with verapamil ($P < 0.05$).

Conclusion This report adds to the growing body of literature that endovascular rescue therapy offers a safe and effective option in managing medically refractory vasospasm in order to prevent DCI. Importantly, it also suggests that in select patients high dose therapy can be used for maximal benefit with a reasonable side effect profile. Importantly, this series also demonstrates an initial rate of DCI of 55% in patients with vasospasm undergoing IA therapy with only 14% of patient's demonstrating permanent neurological deficit suggesting a significant overall benefit of treatment. The results of this initial study mandate further investigation into the safety and efficacy of intra-arterial verapamil and nicardipine for the treatment and prevention of DCI. More importantly it shows that dose optimization needs to be done prior to pursuing further trials.

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