determine significant reduction in midline shift and SDH volume. Multivariate analysis was performed using logistic and linear regression for percent improvement from baseline volume.

**Results** Across 81 patients and 98 cSDHs, the mean initial SDH volume was 66.54 mL (SD: 34.67 mL), with the mean midline shift as 3.79 mm (SD: 2.85 mm). There was a significant mean reduction in SDH volume post-operatively (12.1 mL (95% CI: 9.32 - 14.27 mL), p < 0.001). There was also a significant mean reduction in midline shift (0.8 mm (95% CI: 0.24 - 1.36 mm), p = 0.006). 22% of patients had a reduction of over 30% in the immediate post-operative period. A multivariate analysis of 36 patients was performed. There were no significant parameters observed influencing degree of reduction.

**Discussion** MMA embolization is a safe, and effective approach for the management of cSDH patients. We show a significant reduction of hematoma volume and reduction of midline shift even in the acute post-operative period. Larger studies, randomized trials, and longer-term studies are needed to confirm these findings.


**Abstracts**

**E-080 LESSONS FROM THE OTHER SIDE: THE ORIGINS AND EVOLUTION OF TRANSVENOUS TECHNIQUES IN NEUROINTERVENTIONAL SURGERY**

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**Introduction/Purpose** Neurointerventional surgery emerged in the early 1960’s, when Lusenhop and Spence described the first intravascular embolization of a cerebral arteriovenous malformation. Since then, neuroendovascular techniques have grown exponentially, becoming the standard of care for many pathologies. To date, this growth has been attributed largely to transarterial techniques; however, there has been a resurgent interest in transvenous (TV) neurointerventional methods, driven by a groundswell in technical innovation and advances in knowledge of the role of the cerebral venous system in health and disease. The purpose of this historical review is to chronicle the origins and evolution of TV neurointervention by highlighting seminal achievements, technical breakthroughs, and controversies, all of which shape the phylogeny of TV techniques in the modern era.

**Methods** A systematic review of seminal papers in TV neurointervention was performed using Google Scholar and Medline indices, following PRISMA guidelines. The search strategy sought to identify landmark manuscripts describing TV neurointerventional techniques in three pathophysiologic states: 1) arteriovenous shunts 2) cerebral venous thrombotic disease 3) disorders of intracranial pressure homeostasis. Reference lists of selected articles were also reviewed for additional potential citations.

**Results** Foundational manuscripts in each of the three disease categories were identified: The genesis of therapeutic TV neurointerventional surgery can be traced to 1981, when Debrun et al. described TV occlusion of direct carotid-cavernous fistulas via detachable balloons. In 1986, Mickle and Quisling performed the first TV embolization of Vein of Galen malformation, representing the first TV therapy in a child. In 1989, Halbach et al. demonstrated efficacy of TV embolization for dural arteriovenous fistulas. In 1995, King et al. identified cerebral venous stenosis as the culprit for idiopathic intracranial hypertension (IIH), with innovative use of TV manometry. The first application of rheolytic venous sinus thrombectomy was reported by Dowd et al. in 1999. In 2002, Higgins et al demonstrated efficacy of TV stenting in IIH. These, and other landmark innovations are the direct antecedents of ongoing revolutions in TV therapy including AVM embolization, CSF-diversion, and embolization of CSF-venous shunts.

**Conclusions** Pioneering work in the 1980s and 1990s paved the way for modern transvenous neurointervention. Despite the relative paucity of literature investigating transvenous approaches, their role in disease management has been clearly established and is expected to grow considerably. Therefore, the importance of transvenous skills for contemporary neurointerventionalist cannot be understated.


**E-081 COMBINED TRANSRADIAL AND TRANSVENOUS ACCESSES IN THE TREATMENT OF CAROTID Cavernous Fistulae**

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**Introduction** The expansion of indications for neurointerventional procedures, combined with the need to treat a diverse patient population, has driven a need for broader access options. Concurrent arterial and venous access is often necessary for diagnosis and treatment of various neurovascular diseases. Although complication rates are low, life-threatening severe complications have been reported with these access methods. Moreover, venous access through traditional routes can be challenging in patients with large body habitus. There is a growing trend of utilizing radial artery access for neuroendovascular procedures due to the increased ease of access and similar efficacy. Nevertheless, the use of upper limb veins in neurointerventional procedures is still rare. Upper extremity transvenous access (UETV) has recently emerged as an alternative strategy for the neurointerventionalists, but data is limited.

**Methods** Case study

**Case Description** Case #1 An 82-year-old male underwent successful mechanical thrombectomy for large vessel occlusion of the right middle cerebral artery (MCA) M1 segment. During the procedure, he sustained perforation of the cavernous internal carotid artery (ICA) at the posterior genu due to severe tortuosity and underlying atherosclerosis, resulting in a direct CCF. The next day, the patient was noted to have worsened visual acuity of the right eye along with chemosis and proptosis. The senior author was consulted, and the decision was made to perform embolization of the CCF using combined
TRA and UETV, with hopes of preventing further loss of vision and restoring baseline visual acuity. Transvenous coil embolization to obliterate the CCF went without complications, and the patient’s vision was noted to have returned to his pre-operative baseline the following day. No access site complications were encountered.

Case #2 A 71-year-old male presented to clinic with a three-week history of decreased visual acuity in the left eye. Physical examination was significant for left sided vision loss, lid lag, and chemosis without proptosis. Cerebral angiography revealed a CCF supplied by both indirect internal and external carotid feeding arteries with drainage into the superior ophthalmic vein and ipsilateral inferior petrosal sinus. The patient underwent transvenous coil embolization of his left carotid cavernous fistula using combined TRA and UETV. The procedure went without complications. The patient was discharged on post-operative day one with improvement in his visual acuity.

Conclusion No access site or procedural complications were noted in either of the authors’ cases. Obtaining venous access with an IV in the pre-operative area likely decreased the time required to obtain venous access compared to standard TVA. Both patients were able to benefit from early mobility and ambulation compared to standard transfemoral approaches. Combined TRA and UETV is a feasible, promising access strategy for patients and may confer the same safety and patient satisfaction outcomes that have been seen with TRA in neurointerventional procedure. Further studies are needed to elucidate the exact impact this strategy has on patient outcomes and satisfaction.

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E-082 MICRO-BALLOON ASSISTED EMBOLIZATION OF ANTERIOR CRANIAL FOSSA DURAL ARTERIOVENOUS FISTULA VIA A TRANSPHALMIC APPROACH

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Introduction Dural arteriovenous fistulae (dAVF) account for approximately 10-15% of all intracranial arteriovenous abnormalities. DAVF’s carry a significant risk of mortality, particularly in cases of acute hemorrhage, of up to 10%. A small proportion of these dAVF’s are found in the anterior cranial fossa (ACF) of which the rate of hemorrhage can be as high as up to 91%. The Scepter Mini (SM) is the smallest dual-lumen micro-balloon (MB) available for neurointerventional practice. It consists of a 2.8 French outer diameter, with a 2.2 mm x 9 mm semi-compliant balloon providing a working length of 165 cm. The SM is navigated with a 0.008-inch wire making it a particularly attractive tool accessible to the pedicles normally reached with liquid embolization microcatheters.

Methods Five consecutive patients over a one year period between 2020 and 2021 were evaluated and treated for ACF dAVF using a liquid embolization approach using the SM balloon. All patients were treated using Ethylene-vinyl-alcohol copolymer(EVOH), of which Squid 18 and/or Squid 12 were the chosen viscosities. Control angiograms were performed for all patients post-embolization.

Results All patients demonstrated complete occlusion of the ACF dAVF on immediate post treatment angiography. No immediate complications were encountered, particularly there were no reports of visual field deficit in any of the patients.

Conclusions The MB is a valuable adjunctive tool that can enhance the safety and efficacy of trans-ophthalmic embolization of ACF dAVF’s, providing additional protection to the retinal and posterior ciliary arteries against unwanted reflux of liquid embolic agent.

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E-083 ASSOCIATION OF SOMATOSENSORY EVOKED POTENTIALS AND OUTCOME DURING VASOSPASM TREATMENT IN ANEURYSMAL SUBARACHNOID HEMORRHAGE


Background Delayed cerebral ischemia (DCI) and vasospasm is associated high morbidity and mortality in patients with aneurysmal subarachnoid hemorrhage (aSAH). In patients with clinical vasospasm, intra-arterial treatment with vasodilatory medication may be warranted. However, often immediately following treatment the angiographic images remain unchanged and/or only slightly improved. Furthermore, many of these patients are intubated, and a clinical exam may be difficult to assess intra-operatively. Thus, somatosensory evoked potentials (SSEP) during vasospasm treatment may offer rapid assessment if clinical vasospasm is improved and guide whether further treatment is necessary, such as angioplasty and/or additional vasodilatory agents. We therefore analyzed the association of outcomes and SSEP changes during vasospasm treatment in an aSAH patient cohort.

Methods A retrospective analysis of the Post-Barrow Ruptured Aneurysm Trial Database (PRAT) was performed for all patients treated for an aSAH from 1/1/2014 to 7/31/2019. Inclusion criteria included intra-arterial vasospasm treatment with SSEP monitoring. SSEP monitoring during vasospasm treatment was performed in patients with severe vasospasm in which angioplasty would be considered. Patient demographics, presentation characteristics, intraoperative and post-operative management, and in-hospital and discharge outcomes were abstracted. The primary outcome was improvement in SSEPs associated with clinical improvement. Univariate statistics used Welch’s two-sample t-test for continuous data and chi-squared test for frequency-based variables.

Results During the study period, 25 patients met the inclusion criteria. Comparing patients with SSEP improvement (N=9, 36%) vs. non-improvement (N=16, 64%), there were no significant differences in demographic or clinical characteristics including age, sex, BMI, Hunt-Hess and Fisher grades. In patients with SSEP improvement during the procedure, 5 (56%) were found to have improvement of clinical vasospasm following the procedure compared to only 2 patients (12.5%) in the non-improvement cohort (p=0.064). The duration of vasopressors following the procedure was significantly elevated in patients without improvement (median days: 13.5 (IQR: 5 vs. 3 (IQR: 3), p < 0.001). Greater duration of vasopressor usage was also observed in patients without clinical improvement (median 11.5 (4.75), vs. 4 (7.5), p = 0.015).