840

Brain and Spine 4 (2024) 103504

The role of microsurgery in the management of cranial dural arteriovenous fistulas– a 30-year experience including 72 cases

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Vascular Malformations (Vascular Parallel Session), October 17, 2024, 8:00 AM - 9:30 AM

Background: Cranial dural arteriovenous fistulas (dAVFs) are rare vascular lesions and an increasing number are treated with endovascular embolization. However, due to the rarity and heterogeneity of dAVFs the generation of high-level evidence is challenging, and the best treatment option is still unclear. Over the past decades, only a few retrospective series have evaluated microsurgery as a primary treatment option, and it might be underrepresented in the literature. To further evaluate the role of microsurgery without prior embolization in the treatment of dAVFs we present our 30-year experience.

Methods: Medical records, imaging studies, and surgical reports of 72 patients diagnosed with a dAVF and treated with microsurgery between 1990 and 2022 were reviewed. 42 patients were treated before 2010 (prior to the use of liquid embolic agents i.e. premodern era) and 30 between 2010 and 2022 (after the introduction of liquid embolic agents i.e. modern era). We evaluated presenting symptoms, location, surgical strategy, surgical complications, occlusion status of the dAVF, and neurological outcome.

Results: No difference in patient characteristics was demonstrated between patients treated in the premodern and modern area. Overall, 46% (33/72) of patients developed neurological symptoms due to cerebral hemorrhage. 24% (17/30) of fistulas were classified as Borden type II and 76% (55/76) as Borden type III. In the combined patient cohort, a permanent surgery-associated morbidity of 6% (4/72) and an overall occlusion rate of 97% (70/72) was demonstrated. None of the patients died due to the surgery or as a consequence of the initial bleeding.

Conclusions: The presented surgical series shows that the operative morbidity is low and the dAVF occlusion rate is high in both non-sinus and sinustype fistulas. We therefore propose that microsurgery should be considered early in the treatment of both types of aggressive dAVFs.

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1328

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Optimization of a Liquid Biopsy Technique for Detection of Somatic Mutations in Vascular Malformations

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Vascular Malformations (Vascular Parallel Session), October 17, 2024, 8:00 AM - 9:30 AM

Background: Vascular malformations (VMs) harbour activating somatic mutations in major cellular pathways, which may be targeted with various small molecule inhibitors. We aimed to optimize a liquid biopsy protocol for detecting somatic mutations from VMs using cell-free DNA (cfDNA) in lesional blood at time of endovascular therapy.

Methods: A group of 21 patients with either venous malformations (VeMs) or arteriovenous malformations (AVMs) were selected. Blood samples from the peripheral vein and efferent vein of the VM were collected. Serum was centrifuged and plasma was extracted. cfDNA was isolated from the plasma with either silica-membrane or magnetic bead technologies before being sequenced with digital droplet polymerase chain reaction (ddPCR) for targeted mutations. Variant allele frequencies (VAF) were calculated by determining the frequency of mutant alleles compared to wild-type droplets, with a threshold of VAF >0.05. External validation of cfDNA isolation methods was conducted at the Ontario Insitute of Cancer Research.

Results: cfDNA was isolated from all patients, including 4 patients with VeMs, 5 patients with extracranial AVMs, and 12 patients with AVMs of the central nervous system (CNS). We demonstrated that in 11 patients (52%), an activating mutation in either KRAS, MAP2K1 or PIK3CA were present in the efferent vein, with VAF ranging from 0.06-0.78%. These results were externally validated, showing that the same genetic mutational variant was detected with similar VAF in patients across both institutions using both isolation techniques. The magnetic bead isolation method was superior in isolating cfDNA for sequencing.

Conclusions: We demonstrate that cfDNA can be isolated from lesional blood of patients with VMs and mutations detected even from low plasma volumes and from VMs of the CNS. Magnetic bead technology can improve upon yield and purity. Validation in larger cohort of patients is required for clinical translation.

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335

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In-Situ Microsurgical Disconnection of Highly Eloquent CNS Arteriovenous Malformations

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Vascular Malformations (Vascular Parallel Session), October 17, 2024, 8:00 AM - 9:30 AM

Background: Extirpation of a nidus is the criterion-standard microsurgical method to obliterate an arteriovenous malformation completely and permanently in the central nervous system. The angioarchitecture of a nidus may preclude its safe removal when adjacent to- or within eloquent nervous tissue. Isolation of a nidus by surgically disconnecting both the arterial irrigation as well the venous drainage has been demonstrated as an effective means to treat some eloquent and/or diffuse malformations that otherwise defy treatment. We present our experience with this technique in a highly selected group.

Methods: Retrospective case review of cases treated with a planned in-situ disconnection. This strategy was selected only when it was anticipated from imaging that all arterial inflow to the malformation as well as venous outflow could be interrupted at the pial surface or in the subarachnoid space without embarrassment to the perfusion of viable neurological tissue in the region. Dural, pial and perimedullary fistulae were excluded from the analysis. So too were malformations where extirpation had been the intention and while not accomplished, the arteriovenous shunt had subsequently thrombosed.

Results: 6 cases were identified as treated in this way between 2007 and 2014. All had originally presented with central nervous system haemorrhage. In one case surgery was undertaken after a second haemorrhage. Endovascular treatment had been attempted in 2 cases but was unsuccessful. In 5 out of 6 cases in-situ disconnection was feasible based on pre-operative imaging. In one case an intramedullary aneurysm did not present to the pial surface necessitating a dorsal root entry zone myelotomy to complete treatment. 2 patients experienced post-operative neurological worsening- 1 had diplopia which normalised within 3 months. The other non-disabling dermatomal sensory loss. All arteriovenous shunts were abolished on control catheter angiography. At last follow-up no further haemorrhages had occurred (median follow-up duration 30.5months, range 9-120 months).

Conclusions: In-situ disconnection proved to be an effective means of preventing rebleeding in this series of patients who presented following haemorrhage from AVMs in highly eloquent locations. The procedure was well tolerated with minimal morbidity and merits serious consideration for similar selected lesions where definitive treatment is challenging.

Optional Image

Case ID	Age (yrs)	Gender	Presentation	Previous Treatment	Location	Angio-architecture	Post-op Neurological Exam	Residual AV Shunt?	Duration of Follow-up (months)	Comment
1	30	F	IM haemorrhage x 2	No	Cervical- C1	Diffuse AVM	Unchanged	No	120	
2	56	M	SAH	No	Cervical- C1	Diffuse AVM, aneurysm	Unchanged	No	60	
3	28	F	IVH	No	Thalamus (pulvinar)	Compact AVM	Diplopia- resolved at 3 months	No	36	
4	60	F	ICH	Embolisation	Dorsal midbrain	Compact AVM	Unchanged	No	25	
5	35	F	IM haemorrhage	Embolisation	Cervical- C5	Compact AVM	Unchanged	No	13	
6	38	M	IM haemorrhage	No	Cervical- C6	Diffuse AVM, aneurysm	Slight increase in left LE sensory loss, otherwise unchanged	No	9	Myelotomy required to access aneurysm

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