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Clinical Outcomes Following Multi-modality Treatment of Pediatric Arteriovenous Malformations

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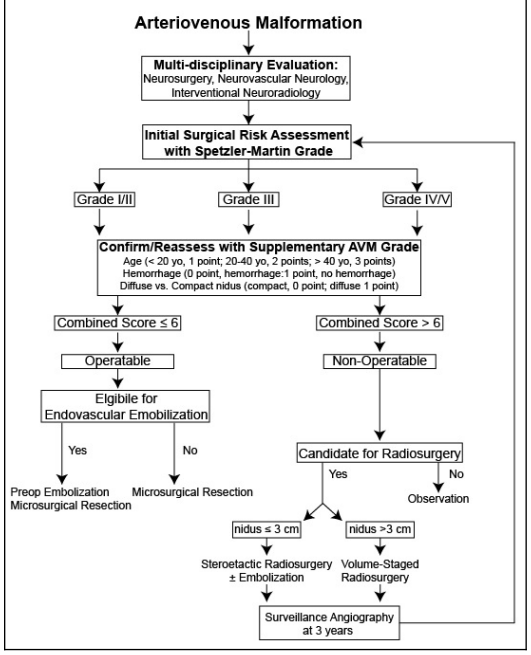
Introduction

Brain arteriovenous malformations (bAVMs) are rupture-prone dysplastic blood vessels with direct arterial-venous shunting. The optimal treatment strategy in children remains unclear because a greater life expectancy is believed to be associated with a greater cumulative hemorrhage risk. We describe our collaborative strategy of effective, yet safe treatment of bAVMs through coordinated multi-disciplinary care.

Figure 1. UCSF Multi-Disciplinary Brain Arteriovenous Malformation Decision Making Algorithm.



Methods

A retrospective analysis of a prospectively maintained database of treated and non-treated bAVMs at the University of California San Francisco from 1998-2016. Inclusion criteria include age = 18 and angiographically proven bAVM.

Results

In total, 172 patients were included for analysis. Mean age of diagnosis was 11.7 ± 4.5 years. With respect to Spetzler Martin grading, there were 38 (22.1%) grade I, 43 (25.0%) grade II, 53 (30.8%) grade III, 32 (18.6%) grade IV, and 6 (3.49%) grade V lesions. Twenty-nine patients (16.7%) had flow- related aneurysms. There were 9 hemorrhages over the period of follow-up. Nine (5.3%) patients were managed conservatively, and 163 patients underwent treatment – including 117 resections, 64 embolizations, and 61 stereotactic radiosurgery (SRS). Within the treated cohort, 75 (46%) patients underwent treatment with multiple modalities – including 49 embolization + resection, 12 volume staged SRS + resection, 6 SRS + embolization + resection, 5 resection + postoperative SRS. In those with angiographic follow-up (n=160), complete obliteration was achieved in 118 (73.8%). Peri-procedural strokes occurred in only 2 patients (1.2%). Mean pediatric mRS at last follow-up was 1.2 ± 1.2, and 164 (95.3%) patients neurologically improved or remained unchanged.

Table 1. Demographic, angiographic and clinical variables.

Variable	All Patients (n=172)
Demographics	
Mean Age at Diagnosis	11.7 ± 4.5 years
Gender	
Male	88 (51.2 %)
Female	84 (48.8 %)
Presentation	
Pre-treatment mRS	2.2 ± 1.5
Ruptured	108 (62.8 %)
Unruptured	64 (37.2 %)
Angiographic Features	
Mean Size of AVM Nidus	2.9 ± 1.5 cm
Eloquence	41 (23.8 %)
Deep Venous Drainage	48 (27.9 %)
Associated Aneurysms	29 (16.9 %)
Spetzler Martin Grade	
1	38 (22.4 %)
2	39 (22.9 %)
3	53 (31.2 %)
4	32 (18.8 %)
5	8 (4.7%)
Supplementary Grade	
1	72 (42.4 %)
2	70 (41.1 %)
3	28 (16.5 %)
4	0 (0 %)
5	0 (0 %)
Location	
Frontal	46 (27.1 %)
Parieto-Occipital	42 (24.7 %)
Temporal	21 (12.4 %)
Cerebellar	21 (12.4 %)
Ventricular/Peri-ventricular	16 (9.4 %)
Brainstem	5 (2.9 %)
Treatment	
Resection only	53 (30.8 %)
Embolization only	5 (2.9 %)
Radiosurgery only	33 (19.2 %)
Embolization + Resection	49 (28.5 %)
Volume Staged Radiosurgery + Resection	12 (7.0 %)
Resection + Postoperative Radiosurgery	5 (2.9 %)
Embolization + Resection + Radiosurgery	6 (3.5 %)
Conservative Management	9 (5.2%)

Table 2. Clinical outcomes following treatment of brain arteriovenous malformations.

Parameter	All patients
Mean length of follow-up	3.5 ± 4.0 years
Number of re-hemorrhage events	9 (9.9 %)
AVM obliteration (n =160)	
Complete	118 (73.8 %)
Incomplete	30 (18.7 %)
Unknown	12 (7.5 %)
Neurologic Outcome (n = 172)	
Mean mRS at last follow-up	1.2 ± 1.2
Neurological status improved or Unchanged	164 (95.3%)
Neurological status declined	8 (4.7 %)

Conclusions

Coordinated multi-disciplinary care utilizing multiple treatment modalities facilitates individualization of treatment planning on a case-by-case basis and results in safe and effective obliteration of pediatric AVMs. In lesions not amenable to surgery, close follow-up or volume staged radiosurgery and/or embolization may facilitate eventual resection.

Learning Objectives

By conclusion of this session, participants should be able to: 1) describe indications and mechanisms for coordinated multi-modal treatments of brain AVMs; 2) Identify basic treatment guidelines regarding individualization of optimal AVM treatment; 3) Understand the importance of creating interdisciplinary teams for AVM management.