A New Scoring System For Angiographic Assessment of Embolotherapy Outcome of Peripheral Arteriovenous Malformations

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Introduction

Previous studies have evaluated the angiographic response following Embolotherapy of peripheral arteriovenous malformations (AVM) based on the degree of AVM devascularization (i.e., 100%, 76–99%, 50-75%, or <50% resolution).[1-4] However, in the few studies that reported detailed data, the percentage of the angiographic response did not consistently correlate with the clinical outcome. These studies showed that the overall therapeutic outcome was more dependent on clinical outcome assessment than on angiographic response. For example, one study demonstrated a discrepancy between the percentage of devascularization and clinical outcome in 50% of their cohort.[3] Also, AVM show variable degrees of arteriovenous shunting (AVS) depending on different pathophysiologic factors e.g., size of nidus, flow velocity, and vascular steal. In addition, in some AVM, the degree of nidus and AVS change following embolization may appear angiographically-unrelated to each other. Therefore, we believe that precise evaluation of each structural component of the AVM (i.e., the nidus and the AVS) can provide more accurate assessment of the AVM angiographic response that may predict and correlate accurately with the clinical outcome.

Objectives

We propose a new scoring system to predict the therapeutic outcome after embolization based both on the degree of change in nidus occlusion and AVS resolution.

Materials and Methods

With IRB approval, we retrospectively reviewed a cohort of 17 patients with peripheral AVM who underwent Embolotherapy between 2012 and 2021. The baseline angiogram from the first embolization session and the final (completion) angiogram from the last embolization session were reviewed for changes in occlusion of the nidus and resolution of AVS. The observed changes were scored by two independent reviewers using a 7-point scale for each of the nidus and AVS (Table 1). The final categorization of the therapeutic response was based on the cumulative scores of both components (Table 1).

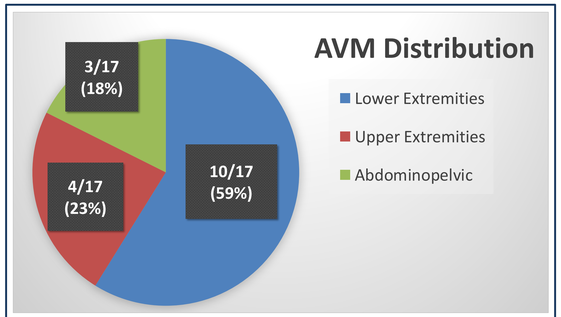
Patient-reported average pain intensity before and after treatment was scored on a 0–10 scale with 0 is no pain and 10 is the maximum improvement. Patients were also asked to categorize their pain improvement at end of treatment as improved, no change, or worse. Interobserver reliability was calculated using weighted the Cohen's kappa coefficient. For measures of effect, Pearson correlation coefficient (R^2) and Kruskal-Wallis rank sum test were used.

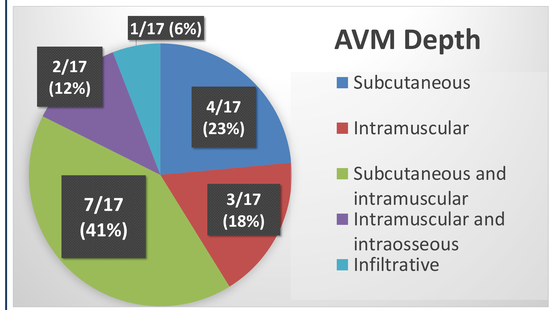
Table 1. Angiographic Scoring System

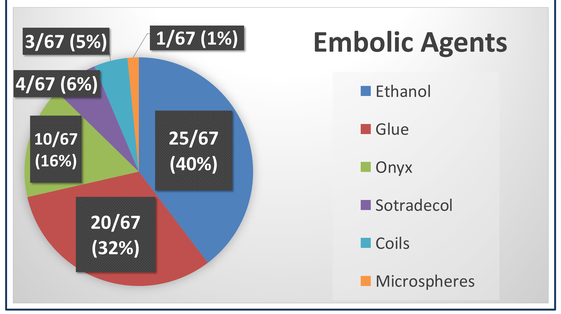
Nidus		Score	Shunt		Score	Angiographic Response (Baseline vs. Final Angiogram)	
Worse		-1	Worse		-1	-1 – -2	Aggravating
No change		0	No change		0	0	No Change
Residual	> 75%	1	Occlusion	< 25%	1	1–4	Poor
	50–75%	2		25–49%	2	5–7	Good
	25–49%	3		50–75%	3		
	< 25%	4		> 75%	4	8–9	Excellent
Complete Resolution		5	Complete Occlusion		5	10	Cure

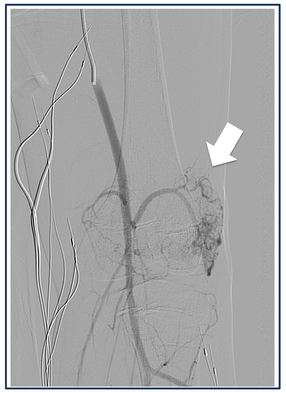
Results

Seventeen patients with a mean age of 30.7 years (range: 2–65 years; 11 males) underwent a total of 67 embolization sessions for 17 different AVMs. The mean clinical follow-up time was 27.9 months (range: 4.5–78.7 months). 53 (79.1%) and 14 (20.8%) sessions were performed via an endovascular and percutaneous approach, respectively. Correlation (R^2) values between changes in the nidus and AVS were significant for both reviewers (0.93 and 0.86; p<0.001). Cohen's Kappa values for the nidus, shunt and final AVM numeric scores between both reviewers were (0.66, 0.41 and 0.40, respectively; p<0.01). Interobserver reliability for the categorical final score was 84% (p=0.0002). There was a moderate correlation between each of the nidus, shunt and final AVM scores, and the pain scores (n=12), with R^2 values of 0.50 (p=0.1), 0.54 (p=0.07), and 0.52 (p=0.08), respectively. Kruskal-Wallis rank sum values between the average nidus, shunt and final AVM scores, and the categorical pain (n=14) scores were 1.29 (p=0.53), 1.21 (p=0.54) and 1.43 (p=0.49), respectively.

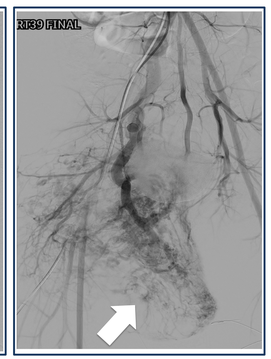








A 9-year-old boy with left knee subcutaneous AVM who had 4 sessions of trans-arterial embolization using ethanol and glue. The angiographic improvement of the AVM nidus was scored 5 by reviewer 1 (i.e. 100% resolution) and 4 by reviewer 2 (i.e. <25% residual). The improvement of AVS was scored 4 by both reviewers (i.e. >75% occlusion). Final score was 9 (reviewer 1) and 8 (reviewer 2) representing excellent improvement.



A 2-year-old girl with right pelvic AVM who had 8 sessions of trans-arterial embolization using ethanol and sotradecol. The nidus improvement was scored -1 by both reviewers (i.e. worse). The improvement of AVS was scored -1 by reviewer 1 (i.e. worse) and 0 by reviewer 2 (i.e. no change). Final score was -2 (reviewer 1) and -1 (reviewer 2) representing aggravation of AVM.

Conclusion

Our proposed scoring system implements a more meticulous assessment of the AVM structural details, including changes in both the nidus and arteriovenous shunting. Although our cohort was limited, the correlation between average AVM scores and pain scores was moderate and trended towards significance. Further testing and correlation with clinical outcomes are necessary to validate this scoring system.

References