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Development and Validation of the MISTA Score for Predicting Rupture Risk in Brain Arteriovenous Malformations

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Purpose

Brain arteriovenous malformations (AVMs) are rare vascular anomalies with a high risk of rupture, leading to intracranial hemorrhage (ICH). Current predictive models, such as the R2eD score, have limitations due to small sample sizes and limited variable inclusions. This study aims to develop a more comprehensive scoring system, to better predict the rupture risk of AVMs.

Materials and Methods

We developed and validated the MISTA (Multicenter International Study for Treatment of Brain AVMs) Rupture Score using data from a total of 2,381 patients across 20 centers in North America and Europe. A generalized linear mixed-effects model identified factors associated with AVM rupture in a derivation cohort of 1,005 patients. Variables significant in univariable analysis or clinically relevant were included in a multivariable model. Model discrimination was assessed with ROC curves and 10-fold cross-validation. The score was externally validated in two independent cohorts (n=122 and n=1,254). Predictive performance was compared with the R2eD score using DeLong's test.

Results

Six factors were independently associated with AVM rupture: cerebellar location (OR, 2.16; 95% CI, 1.36–3.42), deep location (OR, 1.48; 95% CI, 1.04–2.11), monoarterial feeding (OR, 1.54; 95% CI, 1.05–2.28), single draining vein (OR, 1.50; 95% CI, 1.05–2.13), hypertension (OR, 2.02; 95% CI, 1.39–2.93), and frontal lobe location (protective; OR, 0.65; 95% CI, 0.45–0.96). The MISTA score demonstrated good discrimination (AUC, 0.70), outperforming the R2eD score (AUC, 0.54; P<0.001). External validation confirmed consistent performance (AUCs of 0.68 and 0.70). Annual rupture risk ranged from 0.68% in low-risk to 1.25% in very high-risk MISTA categories.

Conclusion

The MISTA Rupture Score is a validated, multicenter-derived tool that outperforms existing models in predicting AVM rupture. Its integration of anatomical and hemodynamic risk factors allows for individualized rupture risk stratification and more informed clinical decision-making.

References

List 1-5 references here using appropriate citation format.

Figures

Table-1: Baseline characteristics and demographics

Variable	**Overall**
	N = 1005
Age (years), Median (IQR)	42 (27 – 57)
Gender: Male, n (%)	506 (50)
Race, n (%)	
White	484 (61)
African American	122 (15)
Hispanic	140 (18)
Other	18 (2.3)
Asian	25 (3.2)
Hypertension, n (%)	217 (27)
Diabetes Mellitus, n (%)	78 (9.7)
Smoking Status, n (%)	
Never Smoked	596 (60)
Current Smoker	226 (23)
Former Smoker	170 (17)

Family History, n (%)	15 (1.9)
Cardiovascular Disease, n (%)	81 (10)
mRS at Presentation, Median (IQR)	1.00 (0.00 – 3.00)
Seizures, n (%)	237 (24)
Ruptured, n (%)	504 (50)
Rupture Time, n (%)	
24h	187 (41)
<7d	37 (8.2)
7-14d	26 (5.8)
≥14d	202 (45)