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Stratification of Recanalization for Patients with Endovascular Treatment of Intracranial Aneurysms

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Introduction

With increasing utilization of endovascular techniques in the treatment of both ruptured and unruptured intracranial aneurysms, patients are in need of more comprehensive and accessible information about treatment efficacy. The goal of this study was to systematically develop a comprehensive model for predicting retreatment following various types of endovascular treatment using readily accessible predictors.

Methods

1. Retrospective chart review of 250 patients with intracranial aneurysms treated endovascularly at BIDMC from 2007 to 2013 and at least 6 months of radiographic follow-up

Aneurysm-specific factors:
Size
Neck width
Dome-to-neck ratio
Terminal or sidewall lesion
Intraluminal thrombus
Rupture

Treatment-related factors:
Immediate angiographic result
Stent assistance
Flow diversion

2. Identification of candidate predictors of retreatment by univariable screening analysis
3. Identification of independent predictors of retreatment by multivariable logistic regression
4. Construction of the Aneurysm Recanalization Stratification Scale (ARSS) based on the proportional contribution of each independent predictor to the multivariable model

In view of increasing clinical evidence that a majority of aneurysm recurrences are stable and unlikely to enlarge and/or rebleed, all-cause retreatment was chosen as our primary endpoint as it reflects clinically significant aneurysm recanalization and is more meaningful for patients and providers.
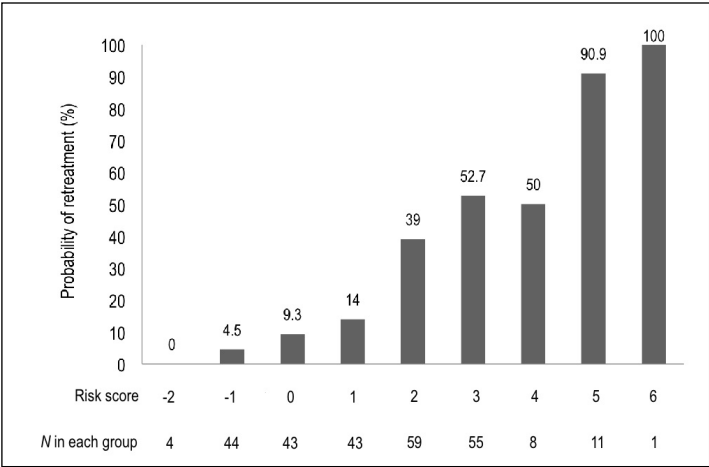
Results

Aneurysm-specific and treatment-related factors in our cohort

Characteristic	Total n = 268	Retreatment n = 79	No retreatment n = 189	P value
Aneurysm-specific factors				
Size				
>10 mm	70 (26.1%)	30 (38.0%)	40 (21.2%)	<0.0005
≤10 mm	198 (73.9%)	49 (62.0%)	149 (78.8%)	
Neck width				
>4 mm	84 (31.3%)	30 (38.0%)	54 (28.6%)	0.130
≤4 mm	184 (68.7%)	49 (62.0%)	135 (71.4%)	
Dome-to-neck ratio				
>1.5	133 (49.6%)	42 (53.2%)	91 (48.1%)	0.454
≤1.5	135 (50.4%)	37 (46.8%)	98 (51.9%)	
Ruptured	102 (38.1%)	51 (64.6%)	51 (27.0%)	<0.0001
Unruptured	166 (61.9%)	28 (35.4%)	138 (73.0%)	
Location				
End-on	118 (44.0%)	37 (46.8%)	81 (42.9%)	0.550
Sidewall	150 (56.0%)	42 (53.2%)	108 (57.1%)	
Thrombus	3 (1.1%)	2 (2.5%)	1 (0.5%)	0.155
No thrombus	265 (98.9%)	77 (97.5%)	188 (99.5%)	
Treatment-related factors				
Coils only	147 (54.9%)	61 (77.2%)	86 (45.5%)	
Stent-assistance	107 (39.9%)	17 (21.5%)	90 (47.6%)	<0.0001
Flow diversion	14 (5.2%)	1 (1.3%)	13 (6.9%)	
Initial treatment result				
Raymond Roy 1	126 (47.0%)	22 (27.8%)	104 (55.0%)	
Raymond Roy 2	132 (49.3%)	52 (65.8%)	80 (42.3%)	<0.0005
Raymond Roy 3	10 (3.7%)	5 (6.3%)	5 (2.6%)	

Independent predictors of aneurysm retreatment identified by multivariable logistic regression

Predictor	Multivariate coefficient	Odds ratio	P value	Points assigned
Aneurysm-specific factors				
Size (>10 mm)	1.589	4.90 (2.29-10.5)	<0.0001	2
Rupture	1.485	4.41 (2.08-9.36)	<0.0005	2
Thrombus	2.258	9.56 (0.496-185)	0.135	2
Treatment-related factors				
Stent assistance	-0.853	0.426 (0.188-0.994)	0.0481	-1
Flow diversion	-2.106	0.122 (0.0103-1.44)	0.0948	-2
Neck remnant	0.977	2.66 (1.37-5.16)	<0.005	1
Residual aneurysm	1.608	4.99 (1.13-22.0)	0.0335	2

Probability of retreatment stratified by risk score

Risk score	-2	-1	0	1	2	3	4	5	6
(Probability %)	0	4.5	9.3	14	39	52.7	50	90.9	100
N in each group	4	44	43	43	59	55	8	11	1

Size (>10 mm), rupture, stent assistance, and immediate angiographic result were identified as independent predictors of retreatment whereas flow diversion and intraluminal thrombus trended toward significance, possibly due to inadequate statistical power.

The ARSS demonstrated good predictive value with a C-statistic of 0.799. This was significantly superior to prediction using only the Raymond Roy Occlusion Classification (C-statistic = 0.641), which supports a multifactorial approach.

Conclusions

The ARSS is the first comprehensive model that has been developed to quantitatively predict the risk of retreatment following endovascular therapy.

Retreatment is a semi-subjective endpoint which reflects the objective presence of recanalization and a subjective assessment by the neurosurgical team of the risk of hemorrhage. However, due to the widely recognized clinical significance of our predictor variables, we are hopeful that our model will produce useful stratification in other centers. We are in the process of validating our stratification system on independent cohorts from other neurovascular centers.