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Long-Term Functional Outcomes and Predictors of Shunt Dependent Hydrocephalus after Treatment of Ruptured Intracranial Aneurysms in the BRAT Trial: Another piece in the Clip versus Coil Puzzle

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Introduction

Acute Hydrocephalus is a well-known sequela of aneurysmal subarachnoid hemorrhage (SAH). Controversy exists on whether open microsurgical methods serve to reduce shunt dependency when compared to endovascular techniques. Furthermore, long-term functional outcomes of shunt dependent patients are unknown.

Methods

Four hundred seventy one patients who were part of a prospective randomized controlled trial from 2003-2007 were retrospectively reviewed. All variables including demographic data, medical history, treatment, imaging and functional outcomes were included as part of the prospective randomized controlled trial. No additional variables were retrospectively collected.

Table 1. Patient and Aneurysm Characteristics. Univariate Analysis

	Total	No-Shunt	Shunt	p-value
No. of Patients	471	324 (68.8)	147 (31.2)	-
Mean Age	53.72 +/- 12.43	52.9 +/- 12.6	55.4 +/- 12.0	0.043*
Male (%)	139 (29.5)	96 (29.6)	43 (29.3)	NS
Medical History (%)				
History of Aneurysm	12 (2.5)	6 (1.9)	6 (4.1)	NS
CHF	6 (1.27)	3 (0.9)	3 (2.0)	NS
Arrhythmia	21 (4.5)	11 (3.4)	10 (6.8)	NS
Diabetes	37 (7.9)	25 (7.7)	12 (8.2)	NS
HTN	207 (44.0)	136 (42.0)	71 (48.3)	NS
Lung Disease	37 (7.9)	28 (8.6)	9 (6.1)	NS
CA	26 (5.5)	21 (6.5)	5 (3.4)	NS
CVA	17 (3.6)	12 (3.7)	5 (3.4)	NS
Social History (%)				
Left Hand Dominant	47 (10.0)	33 (10.2)	14 (9.5)	NS
Illicit Drug Use	91 (19.3)	63 (19.4)	28 (19.0)	NS
Smoking History	292 (62.0)	202 (62.3)	90 (61.2)	NS
Years Smoked	25.6 +/- 16.6	25.8 +/-13.2	27.1 +/- 14.0	NS
Aneurysm Characteristics (%)				
Left Sided	121 (25.7)	79 (24.3)	42 (28.6)	NS
Midline	155 (32.7)	104 (32.0)	51 (34.7)	NS
Angiogram Negative	57 (12.3)	52 (16.0)	5 (3.4)	0.001*
Blister	6 (1.3)	4 (1.2)	2 (1.4)	NS
Dissecting	45 (9.5)	23 (7.1)	22 (15.0)	0.011*
Fusiform	4 (0.9)	2 (0.6)	2 (1.4)	NS
Saccular	358 (76.0)	242 (74.7)	116 (78.9)	NS
Aneurysm Size, mm	6.68 +/- 4.4	6.51 +/- 4.1	6.9 +/- 4.0	NS
Aneurysm Location (%)				
ACA	152 (32.3)	100 (30.9)	52 (35.4)	NS
MCA	62 (22.9)	44 (13.6)	18 (12.2)	NS
ICA	128 (27.2)	88 (27.2)	41 (27.9)	NS
PCA	4 (0.9)	3 (0.9)	1 (0.7)	NS
Vertebral A./Basilar A.	37 (7.9)	36 (54.5)	30 (20.4)	0.01*

Results

147 (31.2%) patients ultimately required a Ventriculoperitoneal Shunt (VPS) in our series. Age, dissecting aneurysm type, ruptured vertebrobasilar aneurysm, Fisher Grade, Hunt-Hess Grade, admission Intraventricular Hemorrhage (IVH), admission Intraparenchymal Hemorrhage (IPH), admission fourth-ventricular blood, perioperative ventriculostomy and hemicraniectomy were significant risk factors ($P < 0.05$) associated with shunt dependent hydrocephalus on univariate analysis. On multivariate analysis, IVH and IPH were independent risk factors for shunt dependency ($P < 0.05$). Clipping versus coiling treatment was not statistically associated with VPS after SAH on both univariate or multivariate analysis. At 6-years, 17% of shunted patients experienced at least one shunt infection/failure. Patients who did not received a VPS at discharge had a higher Glasgow Outcome Scale (GOS) Score and Barthel Index at 3-years, and were more likely to be independent at home and returned to work at 6-, 12-, 36-, 72-months after surgery ($P < 0.05$).

Conclusions

There is no difference in shunt dependency after SAH among patients treated by endovascular or

Table 2. Imaging findings, Treatment, Complications and Disposition, Univariate Analysis

	Total	No-Shunt	Shunt	p-value
Mean HH Grade	2.59 +/- 1.07	2.4 +/- 1.0	3.02 +/- 1.0	<0.005*
Mean Fisher Grade	2.67 +/- 0.64	2.40 +/- 1.0	2.88 +/- 0.3	<0.005*
CT Scan Findings (%)				
IVH	264 (56.1)	155 (47.8)	109 (74.1)	<0.005*
IPH	98 (20.8)	54 (16.7)	44 (29.9)	0.001*
4th Ventricular Blood	126 (26.8)	66 (20.4)	60 (40.8)	<0.005*
Treatment (%)				
Clipping	280 (59.4)	176 (54.3)	104 (70.7)	NS
Coiling	128 (27.2)	90 (27.8)	38 (25.9)	NS
Not Treated	63 (13.4)	58 (17.9)	5 (3.4)	<0.005*
Other Procedures				
Ventriculostomv	372 (79.0)	225 (69.4)	147 (100)	<0.005*
Hemicraniectomv	18 (3.8)	8 (2.5)	10 (6.8)	0.035*
Subdural Drain	2 (0.4)	0 (0.0)	2 (1.4)	NS
Complications (%)				
Intraprocedural Rupture	58 (12.3)	37 (11.4)	21 (14.3)	NS
In-hospital Death	20 (4.2)	19 (5.9)	1 (0.7)	<0.005*
Postoperative CVA	44 (9.3)	29 (9.0)	15 (10.2)	NS
Disposition				
Total Hospital Stay, Days	17.1 +/- 7.2	11.3 +/- 5.50	22.1 +/- 6.43	<0.005*
Home (%)	215 (45.7)	173 (53.4)	42 (28.6)	<0.005*
Rehab/SNF (%)	223 (47.3)	122 (37.7)	101 (68.7)	<0.005*

Learning Objectives

1. Open microsurgical techniques do not reduce the incidence of postoperative shunt dependent hydrocephalus

2. Shunt dependent patients after aneurysmal Subarachnoid Hemorrhage have worse functional outcomes when compared to patients without shunt dependency.

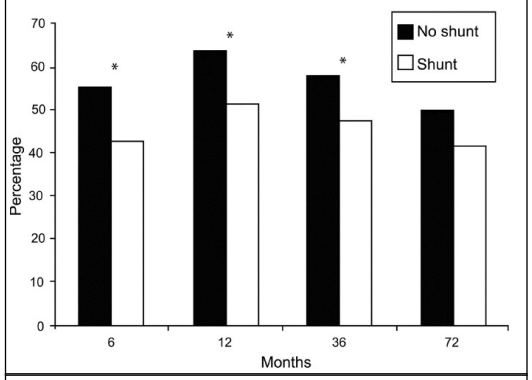
References

1.Auer, L.M., M. Mokry. Disturbed Cerebrospinal Fluid Circulation After Subarachnoid Hemorrhage and Acute Aneurysm Surgery. Neurosurgery, 1990. 26: p.804-09. 2.Black, P.M. Hydrocephalus and Vasospasm After Subarachnoid Hemorrhage from Ruptured Intracranial Aneurysms. Neurosurgery, 1986.18: p.12-16.3. De Oliveira, J.G., J. Beck, M. Setzer, et al. Risk of Shunt-Dependent Hydrocephalus After Occlusion of Ruptured Intracranial Aneurysms by Surgical Clipping or Endovascular Coiling: A Single-Institution Series and Meta-Analysis. Neurosurgery, 2007. 65(5): p.924-34.

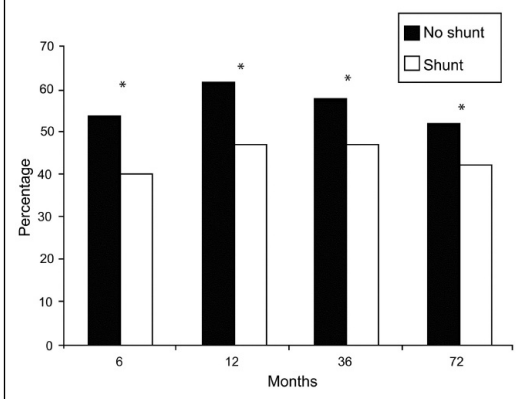
Table 3. Multivariate Analysis

	Beta	OR	LCI	UCI	p-value
Age	0.008	1.008	0.991	1.026	NS
IVH	0.768	2.156	1.285	3.616	0.004*
IPH	0.541	1.718	1.051	2.808	0.031*
Fourth Ventricular Blood	0.426	1.532	0.828	2.834	NS
Clipping	0.432	1.385	0.771	2.638	NS
Intraoperative Rupture	0.55	1.733	0.828	3.627	NS
Dissecting Aneurysm	0.328	1.388	0.73	2.639	NS
Vertebral Aneurysm	0.415	1.515	0.908	2.527	NS

Percent of SAH patients that were "self-care" status at various time intervals after discharge.



Percent of SAH patients that had returned to work at various time intervals after discharge.



*Statistically significant, p-value <0.05.