



Impact of Coil Packing Density and Coiling Technique on Occlusion Rates for Aneurysms Treated with Stent-Assisted Coil Embolization

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■ **BACKGROUND AND OBJECTIVE:** Stent-assisted coil embolization is an established endovascular technique for wide-necked intracranial aneurysms. Although recanalization after coil embolization is reduced with the use of a stent, the impact of aneurysm packing density is less clear in stent-coiled aneurysms. The purpose of the present study was to assess packing density in stent-coiled aneurysms and evaluate its effect on recanalization and retreatment.

■ **METHODS:** A retrospective analysis of consecutive aneurysms treated with stent-assisted coiling was performed at 2 academic institutions between 2007 and 2015. Aneurysm occlusion was assessed using digital subtraction angiography. Packing density was calculated using the AngioCalc app.

■ **RESULTS:** Two hundred fifty-three aneurysms were identified (median age, 59 years). The median packing density was 35.3%. At last follow-up, 72.7% of aneurysms were completely obliterated and 19.4% had a neck remnant. Complete occlusion was associated with smaller aneurysms and coiling through stent interstices. A higher packing density was associated with increased rate of complete occlusion when analyzed as continuous variable. After adjustment for confounding variables, packing density was no longer predictive of complete occlusion (odds ratio = 1.018, $P = 0.122$). Similarly, there was no significant association between aneurysm occlusion, retreatment, and packing density when assessed by categories of high (>22%), moderate (12%–22%), and low (<12%) packing density.

■ **CONCLUSIONS:** Aneurysm size remains the most important predictor of aneurysm recanalization and retreatment after stent-assisted coiling. Although higher packing densities were associated with increased rates of aneurysm occlusion in unadjusted statistical comparisons, this finding was no longer significant after adjusting for confounders.

INTRODUCTION

Stent-assisted coil embolization is an established endovascular technique for wide-necked intracranial aneurysms. Although questioned in early reports,¹⁻³ safety and efficacy of stent-assisted coiling has been demonstrated in several large studies⁴⁻⁶ in recent years. The role of coil packing density, however, has not been addressed in these studies. To our knowledge, only one other large cohort study⁷ assessed the effects of packing density on aneurysm occlusion in stent-coiled aneurysms. In that study packing density was found to be a significant predictor of complete occlusion upon follow-up. Although complete occlusion rate was lowest with low (<12%) packing density, there was no additional gain in aneurysm occlusion when packing density was increased from moderate (12%–22%) to high (>22%).⁷ The purpose of the present study was to assess the findings of that study and evaluate the effect of packing density on recanalization and retreatment of stent-coiled aneurysms.

METHODS

A retrospective analysis of prospectively maintained databases of consecutive aneurysms treated with stent-assisted coiling was performed at 2 academic institutions in North and South America

Key words

- Aneurysm
- Coiling
- Occlusion
- Packing density
- Stent

Abbreviations and Acronyms

aSAH: Aneurysmal subarachnoid hemorrhage

CI: Confidence interval

OR: Odds ratio

RR: Raymond Roy

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Citation: *World Neurosurg.* (2016) 94:157-166.

<http://dx.doi.org/10.1016/j.wneu.2016.06.127>

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

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Table 1. Baseline Characteristics

Parameter	Number
No. of aneurysms	253
Gender	
Females	195 (77.1%)
Male	58 (22.9%)
Age range (years; median, range)	59 (19–85)
Smoking	105 (41.5%)
Hypertension	84 (33.2%)
Family history*	18 (10.5%)*
Symptomatic	58 (22.9%)
Multiple aneurysms	93 (36.8%)
Location	
ICA	111 (43.8%)
Cervical	3 (1.2%)
Cavernous	3 (1.2%)
Paraophthalmic	40 (15.8%)
Superior hypophyseal	17 (6.7%)
Posterior communicating	32 (12.6%)
Anterior choroidal	3 (1.2%)
Carotid bifurcation	13 (5.1%)
Anterior communicating	48 (19%)
ACA	6 (2.4%)
MCA	50 (19.8%)
Vertebral	6 (2.4%)
Basilar trunk	6 (2.4%)
Basilar tip	26 (10.2%)
Relation to parent vessel	
Sidewall	156 (61.7%)
Bifurcation	97 (38.3%)
Shape	
Saccular	248 (98%)
Fusiform	5 (2%)
Daughter sac	36 (14.2%)
Measurements (mm; median, range)	
Maximal diameter	5 (1.5–31.8)
Neck size†	5.1 (1.4–19)
Height‡	6.6 (2–31.8)
Width‡	6.6 (1.6–27.3)
Subarachnoid hemorrhage	60 (23.7%)
Immediate (<2 weeks)	28 (11.1%)
Remote (>2 weeks)	33 (13%)
Continues	

Table 1. Continued

Parameter	Number
Hunt and Hess	
1–2	13 (5.1%)
3–5	15 (5.9%)
Modified Fisher scale	
1–2	8 (3.2%)
3–4	20 (7.9%)
Prior treatment	60 (23.7%)
Endovascular	53 (20.9%)
Surgery	5 (2%)
Both	2 (0.8%)
Pretreatment mRS	
0–2	225 (88.9%)
3–5	28 (11.1%)
ICA, internal carotid artery; ACA, anterior cerebral artery; MCA, middle cerebral artery; mRS, modified Rankin scale. *Data were not available for 81 aneurysms. †Data were not available for 2 aneurysms. ‡Data were not available for 1 aneurysm.	

between 2007 and 2015. The decision to treat an aneurysm with stent-assisted coiling was at the discretion of the operator. Institutional Review Board approval was obtained at both centers. The following information was collected: demographics and risk factors (e.g., gender, age, active smoking status, hypertension status, family history, symptomatic aneurysms, multiple aneurysms), aneurysm and treatment features (e.g., location, relation to parent vessel, shape, daughter sac, size measurements, history of subarachnoid hemorrhage, history of prior treatment, stent type, coiling technique, packing density), procedural complications, and angiographic and functional outcome. Packing density was calculated using the AngioCalc app based on the shape and size of the aneurysm, as well as the type and size of coils. This was analyzed as a continuous and categorical variable.⁸ Packing density as a categorical variable was grouped into low (<12%), moderate (12%–22%), and high (>22%) as previously described.⁷ Angiographic outcome was assessed using digital subtraction angiography. Magnetic resonance angiography was not considered for angiographic follow-up to standardize assessment of angiographic outcome. Aneurysm occlusion after stent-coiling was categorized according to the Raymond Roy (RR) occlusion classification.⁹ Functional outcome was recorded as modified Rankin scale at last follow-up.

Embolization Procedure

Patients received aspirin (325 mg daily) and clopidogrel (75 mg daily) for 7–14 days before the intervention. Platelet function assays were not routinely performed. Patients undergoing treatment of a ruptured aneurysm received a loading dose of aspirin (650 mg

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