Quantitative assessment of in-stent stenosis following Pipeline embolization device treatment of intracranial aneurysms: a single institution series and systematic review

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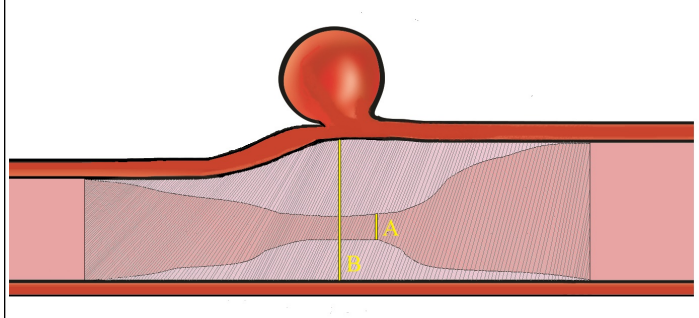
Introduction

Very little is known on the incidence of in-stent stenosis following Pipeline embolization device (PED) treatment of intracranial aneurysms. The objective of this study was to evaluate the incidence and clinical significance through quantification of the degree of in stent stenosis at angiographic follow-up after PED placement. The secondary objective was to analyze literature reported rates of in stent stenosis following flow diverter treatment.

Methods

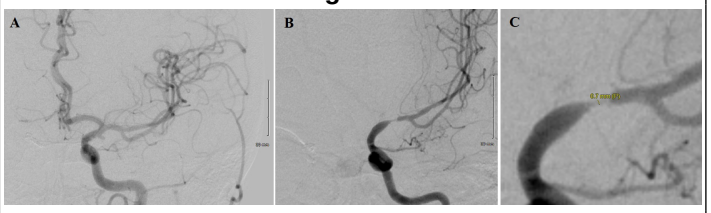
Clinical and radiological records from all patients undergoing PED treatment of intracranial aneurysms at a major US academic center from 2013 until 2017 were retrospectively reviewed. A modified version of the North American Symptomatic Carotid Endarterectomy (NASCET) criteria was used to quantify the degree of stenosis on most-recent post-procedural angiograms. A search of PubMED, MEDLINE, EMBASE and Web of Science electronic databases was furthermore conducted in accordance with PRISMA guidelines.

Figure 1



Pictorial depiction of stenosis measurement with flow diverter in situ

Figure 2



In-stent stenosis: illustrative case. Antero-posterior digital subtraction angiographs pre-procedurally (A) demonstrates an aneurysm in the C7 segment of the ICA. Following treatment with a single PED post-procedurally, complete aneurysm obliteration at 6 month follow-up angiogram is seen as well as in stent stenosis measuring 70% (B and C).

Results

Between March 2013 and July 2017, 168 patients (mean age=58.3 years, 30 men) harbouring 168 aneurysms underwent treatment with the Pipeline Embolization Device (Medtronic Inc, Dublin, Ireland) at our institution. In stent stenosis was detected in 12 patients (7.1%) at a median angiographic follow-up of 6 months. Mean percentage of stenosis was 39% (standard deviation 19%). Only one case was symptomatic. Aneurysm occlusion rates were comparable between the stenosis and non-stenosis cohorts (76.9% and 71.6%, respectively). No significant differences between either clopidogrel responder status, or subsequent post-procedural anti-platelet regimen were detected between the stenosis and non-stenosis cohorts. Following systematic review, 44 papers met the inclusion criteria. The mean literature-reported in stent stenosis rate was 6.34%

Table 1

Parameters	All patients (n=155)	In-stent stenosis (n=12)	No stenosis (n=143)	p-value
Age, years, mean ± SD	57.1 ±11.6	57.2 ±12.0	56.8 ±11.9	0.259
Male, n (%)	29 (18.7)	2 (16.7)	27 (18.9)	0.850
Smoking, n (%)	41 (26.5)	4 (33.3)	37 (25.6)	0.574
Platelet function tests performed	112 (72.2)	10 (83.3)	102 (71.3)	
Clopidogrel non-responder	34 (21.9)	5 (41.7)	29 (20.3)	0.085
Patients switched to another regimen	33 (97.1)	4 (80)	29 (100)	0.289
Antiplatelet regimen post-procedure				
ASA 325 mg + clopidogrel 75 mg	93 (60)	7 (58.3)	86 (60.1)	
ASA + ticagrelor	60 (38.7)	5 (41.7)	55 (38.4)	
ASA + prasugrel	1 (0.6)	0 (0)	1 (0.6)	
ASA 81mg + clopidogrel 75 mg	1 (0.6)	0 (0)	1 (0.6)	

Baseline characteristics

Table 2

Parameter	All patients (n=155)	In-stent stenosis (n=12)	No stenosis (n=143)	p-value
Mean follow-up, months, mean (range)	12.48 (5-41)	12.42 (6-36)	12.49 (5-41)	
Complete occlusion rate	116 (71.6)	9 (75)	107 (71.3)	0.989
Retreatment with PED	11 (6.5)	1 (7.7)	10 (6.5)	0.060
Pre-treatment mRS				
0	70(45)	2 (16.7)	68 (47.6)	0.039
1	66 (42.6)	7 (58.3)	59 (41.2)	
2-5	19 (12.4)	3 (25)	16 (11.1)	
Post-treatment mRS				
0	89 (57.4)	6 (50)	83 (58)	0.588
1	46 (29.7)	3 (25)	43 (30)	
2-5	19 (12.2)	3 (25)	16 (11.1)	
Mortality	1 (0.6)	0	1 (0.9)	0.771
Thromboembolic complications	9 (5.8)	2 (16.7)	7 (4.9)	0.179

Angiographic and clinical outcomes

Conclusions

In stent stenosis following treatment of intracranial aneurysms remains a rare phenomenon. Further studies with longer follow-up durations are needed to ascertain the effect of anti-platelet regimens on the development of in stent stenosis.

References

1. Randomised trial of endarterectomy for recently symptomatic carotid stenosis: final results of the MRC European Carotid Surgery Trial (ECST). Lancet 351:1379-1387, 1998

2. John S, Bain MD, Hui FK, Hussain MS, Masaryk TJ, Rasmussen PA, et al: Long-term Follow-up of In-stent Stenosis After Pipeline Flow Diversion Treatment of Intracranial Aneurysms. Neurosurgery 78:862-867, 2016