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Successful treatment of symptomatic intracranial carotid artery stenosis using a 24 mm long bare metal coronary stent

Azeem A. Rehman, M.D.¹, Ryan C. Turner, M.D., Ph.D.¹, Brandon P. Lucke-Wold, Ph.D., MCTS¹, and SoHyun Boo, M.D.²

¹Department of Neurosurgery, West Virginia University School of Medicine, Morgantown, WV, USA

²Department of Interventional Neuroradiology, West Virginia University School of Medicine, Morgantown, WV, USA

Abstract

Background—Intracranial arterial atherosclerosis represents a common cause of stroke. Despite aggressive and optimal medical management, many patients will unfortunately suffer additional cerebrovascular events. The role of endovascular intervention for intracranial atherosclerotic disease continues to be uncertain, particularly in regard to extensive, symptomatic stenosis.

Case Description—We present a case of a 42-year-old male with a complex medical history who presented with recurrent ischemic stroke in the ipsilateral hemisphere despite optimal medical management. Given the length of stenosis and the luminal size of the intracranial cavernous and petrous segments of the ICA, we utilized a bare metal coronary stent (4.0 mm × 24 mm). This represents one of the longest stents deployed for intracranial disease reported in the literature.

Conclusion—This case illustrates that a long coronary stent might be successfully utilized to manage extensive intracranial lesions. We also review the efficacy of using one very long stent versus multiple overlapping stents, with reference to the coronary angiography literature.

Keywords

Cerebrovascular disease; intracranial artery stenosis; internal carotid artery; coronary stent; endovascular intervention

Corresponding Author: Brandon Lucke-Wold, Ph.D., West Virginia University School of Medicine, Department of Neurosurgery, Suite 4300, Health Sciences Center, PO Box 9183, Morgantown, West Virginia 26506-9183, (304)293-5041, Bwold@mix.wvu.edu.

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Introduction

Intracranial arterial stenosis secondary to atherosclerotic disease represents a common cause of stroke (4). Despite receiving optimal medical management, patients with a prior history of cerebrovascular accidents are particularly at risk (21, 22). Several randomized clinical trials have been conducted to evaluate therapeutic modalities to minimize the risk of stroke in patients with intracranial atherosclerosis (1, 5, 23), including symptomatic and asymptomatic cases. Despite initial optimism regarding endovascular intervention, the SAMMPRIS and VISSIT trials both demonstrated superiority in aggressive medical therapy alone when compared to angioplasty with stenting for symptomatic intracranial atherosclerosis (5, 23).

However, even with aggressive medical management, a subgroup of patients with symptomatic intracranial stenosis will invariably have subsequent ischemic events, raising the question of whether select patient cases might benefit from endovascular intervention. Per the FDA recommendations, the Wingspan stent system remains an option for patients aged 22–80 who experience recurrent stroke despite optimal medical therapy. It is especially useful in the context of having severe (70–99%) stenosis of a related intracranial artery. Patients must also have a modified Rankin score of less than 4 prior to the intervention, and treatment should be initiated after a week from the most recent stroke (FDA).

In this case report, we present a 42-year-old male with a complex medical history who presented with recurrent ischemic stroke in the ipsilateral hemisphere. This recurrent stroke occurred despite optimal medical management in the context of left ICA stenosis in the cavernous and petrous segments. Given the length of stenosis and luminal diameter, we utilized a bare metal coronary stent (4.0 mm × 24 mm), representing one of the longest stents deployed for intracranial disease. We discuss the advantages and disadvantages of using one very long stent versus multiple overlapping stents, with particular reference to the coronary angiography literature.

Case Description

A 42-year-old Caucasian male presented as a transfer to the Emergency Department with intermittent worsening right-sided arm and leg weakness and new onset right-sided facial droop (NIH Stroke Scale of 5) 7 hours after symptom onset. No other abnormalities were identified on the initial neurological exam. His past medical history is significant for HIV, Hepatitis C virus, coronary artery disease, congestive heart failure, chronic kidney disease, uncontrolled diabetes mellitus, hypertension, and a previous left MCA stroke. The patient's previous left MCA stroke occurred 4 months prior, during which time he underwent a diagnostic cerebral angiogram demonstrating left ICA stenosis in the cavernous (50%) and petrous (40%) portions. At that time, he received optimal medical management with aspirin 81 mg, clopidogrel 75 mg, and atorvastatin 10 mg daily.

The CT-head without contrast demonstrated no acute intracranial abnormalities, with no evidence of hemorrhage. In the emergency department, the patient's symptoms improved to baseline, which for him entailed residual weakness in his right lower extremity (NIH Stroke

Scale of 3) due to his prior left MCA stroke. The MR angiography reconstructions demonstrated multiple sites of worsening stenosis in the left intracranial ICA. In addition, the MRI revealed acute and remote infarcts throughout the left hemisphere along the MCA and ACA distributions. The case was presented to the endovascular team. Given the diffuse stenosis noted on MR angiography, the patient's failure on maximal medical management, as well as the patient's multiple comorbidities, the team discussed the option of percutaneous angioplasty with stenting with the patient. The patient agreed to undergo the intervention. Since the patient was already on appropriate anti-platelet therapy, no pre-medication prior to endovascular intervention was necessary.

Percutaneous access was obtained via the right common femoral artery using a modified Seldinger technique. A 6 French sheath was placed, through which a 071 guide catheter was navigated into the proximal petrous segment of the left ICA using fluoroscopy and the roadmap technique (Figure 1). Through this catheter, a 014 microwire was navigated across the stenosis. A balloon-mounted monorail system with a Rebel platinum chromium coronary stent system (Boston Scientific, Marlborough, MA), measuring 4.0 mm × 24.0 mm, was prepared and delivered over the microwire across the lesion. Intermittent angiograms were conducted, demonstrating appropriate positioning of the stent. The angioplasty balloon was slowly inflated over a period of 2 minutes to nominal pressure. The balloon was slowly deflated and withdrawn back into the guide catheter. An angiogram was performed demonstrating good apposition of the stent along the wall of the vessel as well as significantly improved caliber of the diseased segment with no residual stenosis (Figure 2). There was good flow intracranially without evidence of any large vessel occlusions or vascular pruning.

After the interventional procedure, the patient was transferred to the Intensive Care Unit. No neurologic events occurred during the procedure or in the post-operative period prior to discharge. He was started on aspirin 81 mg and Plavix 75 mg daily for 6 months. A 6-month follow-up cerebral angiogram was performed demonstrating patency of the previously placed intracranial left internal carotid artery stent involving the distal petrous and proximal cavernous segments (Figure 3). Minimal development of intra-luminal hyperplasia of the stent was also observed, however no stenosis was noted. At this time, the patient reported no worsening of his baseline neurologic symptoms.

Discussion

Multiple options exist for extracranial atherosclerotic lesions such as medical optimization, carotid endarterectomy, and carotid stenting. Intracranial stenosis management however continues to be ambiguous, particularly in regard to the role of endovascular intervention. Specifically, the smaller intracranial vessels are at greater risk of stenosis, resulting in greater adverse outcomes (15). As suggested by studies investigating coronary vessels and stenting, this restenosis might be related to the inability of small vessels to accommodate the lumen re-narrowing that invariably occurs with angioplasty and stenting (2, 8). This vessel discrepancy, in addition to the greater tortuosity and lack of peripheral tissue support, likely contributes to the higher restenosis and perioperative complications associated with intracranial compared to extracranial stenting.

One long stent versus multiple short stents

Longer stenotic intracranial lesions requiring long stents have been reported to be an important risk factor for in-stent restenosis during endovascular therapy (18, 24). However, other reports suggest no significant difference in adverse outcomes based on intracranial stenosis length (19). Nonetheless, this correlation is well supported in the coronary angiography literature with studies revealing increased periprocedural and long-term complications associated with longer stents (11–13). Appropriate endovascular management for long, stenotic intracranial lesions continues to be challenging, especially with regard whether to utilize one long stent versus multiple overlapping stents.

When comparing one long coronary stent as an alternative to the multiple short stents, De Scheerder et al. (6) did not observe any difference when analyzing in-hospital and 6-month outcomes, including restenosis occurrence. Of note, the authors did report that the use of one long, solitary stent was associated with a reduction in catheterization time, dye volume usage, and duration of radiation exposure. Similar findings were reported in a prospective, randomized trial (10) with further mention that placement of one long stent for extensive lesions is also more cost effective. In a separate investigation from Spain (17), patients with a long coronary lesion (>20 mm) treated with a single long stent had no significant difference in 2-year outcomes compared to management with multiple stents (overlapping and non-overlapping). Two additional reports cite no difference in managing long coronary lesions with one long stent versus multiple overlapping stents (3, 14), including a Chinese study that enrolled 2371 patients (3). Taken together, these findings suggest that although longer stenotic lesions are associated with higher restenosis rates, this complication is independent of whether one long versus multiple small stents are utilized. Moreover, the incorporation of one long stent might offer potential benefit in relation to procedural characteristics and overall cost. The complexity of intracranial stenting is often a result of the multiple exchanges that occur over a long microwire. As such, generally speaking, it is technically less challenging to place a single, balloon mounted monorail system stent versus multiple separate exchanges for angioplasty followed by stenting. For our case, it was decided to utilize one single long stent to cover the entire lesion. This was to minimize the number of device exchanges over the wire and to not have overlap of multiple shorter stents.

Coronary bare metal stent versus Wingspan stent system

In comparison to the Wingspan stent system, which also requires multiple exchanges, the coronary bare metal stent enables deployment of the stent in a single stage. Exchange techniques carry their own risk of morbidity, particularly vessel injury secondary to wire perforation. This acute hemorrhage can be devastating, given that the patient is likely therapeutic on dual anti-platelet agents. However, coronary stents are more rigid with higher inflation pressures, which must be considered during balloon dilation in order to avoid vessel dissection. In this case, we conducted a very slow balloon inflation to nominal pressure, and recommend that others may even inflate to sub-nominal levels if there is a higher concern for dissection. Also, the use of intermittent fluoroscopy as well as post-stenting visualization, both at the time of deployment and 15 minutes later, helps monitor for any dissection, thrombus formation, and distal thromboembolism that may occur.

Although off label, the utilization of a coronary stent to treat intracranial stenosis is not novel. Previous clinical studies, as outlined in Table 1, have been conducted. For example, Miao and colleagues treated 113 patients with symptomatic middle cerebral stenosis using balloon-mounted coronary stents, with a technical success rate of 96.46% and only a 4.42% rate of 30-day stroke and death. Compared to other studies, this case series demonstrated a very low complication rate and a low incidence of recurrent symptoms, despite a restenosis rate of over 20% (16). Separately, Fiorella et al. incorporated these stents in the management of vertebro-basilar intracranial stenosis, citing a high technical rate of success but a 26.1% rate of periprocedural morbidity and mortality (9).

Two additional smaller case series evaluated the use of stenting in various intracranial lesions, including those found in the internal carotid, middle cerebral artery, and vertebro-basilar system. The first study by Durst et al. utilized only balloon-mounted coronary stents, and had a relatively low incidence of periprocedural morbidity and mortality (7.1%) as well as long-term incidence of recurrent CVA (9.5%) (7). In contrast, Tarlov and colleagues demonstrated a much higher risk of intervention, both in increased morbidity and mortality in the periprocedural stage (22%) as well as long-term recurrent CVA (21.95%). Of note, this study did utilize both balloon-mounted coronary stents and the Wingspan stent system, with no differences noted between the two interventions (20).

Medical optimization in the patient

We acknowledge that optimal medical therapy does not only include dual-antiplatelet agents, but also extends to other co-morbidities, including glucose management, cholesterol control, and in this particular patient, anti-retroviral therapy. At the time of the patient's initial stroke, hemoglobin A1c was 14.7, triglycerides were 1193, and HIV viral load was 126357. Education regarding the need to control these factors and the importance of smoking cessation were provided to the patient. Regarding the patient's diabetes, 80 units nightly insulin glargine (Lantus) was prescribed in addition to 12 units insulin lispro (Humalog) for meal coverage. For hyperlipidemia, the patient was continued on atorvastatin 10 mg nightly. The patient was also maintained on anti-retroviral therapy, per infectious disease recommendations.

When the patient presented with a recurrent stroke 4 months later, at the time of stent placement, hemoglobin A1c levels had reduced to 12.3, triglycerides had increased to 1296, and HIV viral load had decreased to 111682. No changes were made to the patient's medication regimen, however, additional reinforcement, especially due to the importance of dual anti-platelet therapy in maintaining stent patency was provided. Pre-procedural platelet reactivity assay was checked using the VerifyNow Aspirin and P2Y12 tests (Accriva diagnostics), confirming therapeutic values. Following the 6-month post-procedural angiogram, lab work was redrawn, demonstrating a notable reduction in hemoglobin A1c to 6.4, triglycerides to 260, and the HIV viral load to 25673 (Table 2).

Although our team proceeded with intracranial stenting due to recurrent ischemic events when the patient was on aggressive medical intervention, we did not implement the risk factor management and lifestyle adjustments as stringently in other studies, most notably in the SAMMPRIS trial.

Conclusions

The favorable outcome for this particular patient should be contrasted with the notable periprocedural complications associated with stenting, as noted in the SAMMPRIS and VISSIT trials (5, 23). Nonetheless, this case report reveals that endovascular intervention remains a reasonable alternative in a select population of patients with intracranial atherosclerosis who experience recurrent stroke, despite being on optimal medical therapy. Moreover, a long coronary stent might be successfully utilized to manage extensive intracranial lesions. Whether to utilize a long stent versus multiple smaller stents to manage extensive intracranial stenosis continues to be debatable, warranting further investigation. A long-term pilot study is also necessary to assess the durability of utilizing a long stent over time.

Abbreviations

FDA	Food and Drug Administration
MCA	middle cerebral artery
ICA	internal carotid artery

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Highlights

1. Stenosis of intracranial cavernous and petrous segments of carotid artery
2. Application of a long bare metal coronary stent (4.0 mm × 24 mm)
3. Long coronary stents might be a successful option for intracranial lesions

Figure 1.
Left carotid angiogram, AP view, demonstrating intracranial ICA stenosis, particularly in the cavernous and petrous portions.

Figure 2.
Left carotid angiogram, AP view, after delivery of a coronary bare metal stent, measuring 4.0 mm × 24.0 mm.

Figure 3.
Left carotid angiogram, AP view, at the 6-month follow-up demonstrating patency of the previously placed intracranial left internal carotid artery stent involving the distal petrous and proximal cavernous segments

Table 1

Overview of clinical studies involving the use of balloon-mounted coronary stents to treat intracranial arterial atherosclerosis.

	Miao <i>et al.</i> (2009)	Fiorella <i>et al.</i> (2007)	Tarlov <i>et al.</i> (2012) *	Durst <i>et al.</i> (2015)
Patient sample size	113	44	41	39
Lesion location	MCA	VBS	ICA, MCA, VBS	ICA, MCA, VBS
Technical success rate	96.46%	95.7%	100%	98%
Peri-procedural morbidity	4.42%	26.1%	22%	7.1%
Recurrent stroke/TIA	6.74%	15%	21.95%	9.5%
Average follow-up (mts)	29	43.5	13.55	35.1
Restenosis rate	20.25%	12.5%	NA	20%

* Involved both balloon-mounted coronary stents and Wingspan stents

Table 2

Changes in patient's HbA1c, triglycerides, and HIV viral load over the course of intervention.

	Initial stroke Time 0 months	Recurrent stroke Time 4 months	Follow-up angiogram Time 10 months
HbA1c	14.7	12.3	6.4
Triglycerides	1193	1296	260
HIV viral load	126357	111682	25673