

# “Double-Barrel” Stent Reconstruction of a Symptomatic Fusiform Basilar Artery Aneurysm: Case Report

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**BACKGROUND AND IMPORTANCE:** Giant fusiform aneurysms of the basilar artery are associated with a high rate of morbidity and mortality. Treatment of these lesions can be difficult, especially when there are poor anatomic collaterals such as posterior communicating arteries. These lesions often have no acceptable treatment. The authors present a case of a patient with a symptomatic, fusiform basilar artery aneurysm successfully treated with a side-by-side (double-barrel), telescoping stent construct.

**CLINICAL PRESENTATION:** A 56-year-old man presented with chief concerns of dysarthria and left-sided hemiparesis. MRI and conventional catheter-based angiography revealed a dolichoectatic basilar artery with 3 large fusiform aneurysms throughout its length. Flow through the patient's aneurysm was successfully reduced with a side-by-side stent construct and coiling of the proximal aneurysm dilation. The patient experienced stabilization of his ischemic events and neurologic recovery. A total of 6 Neurform-2 4.5 × 30-mm stents were navigated and positioned from the proximal posterior cerebral arteries to the distal vertebral arteries in a side-by-side (double-barrel), telescoping manner. These were deployed simultaneously by 2 operators to oppose the stent struts as well as the arterial wall. Next, the proximal aneurysmal dilation was coiled to near occlusion. Successful flow redirection and aneurysm thrombosis was observed.

**CONCLUSION:** A novel, endovascular stenting technique for successfully treating symptomatic, giant basilar artery aneurysms is presented. This patient at 4 months was living independently with no further neurologic events or decline.

**KEY WORDS:** Basilar artery aneurysm, Endovascular treatment, Fusiform, Giant aneurysm, Stenting

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Fusiform basilar trunk aneurysms are associated with a high rate of morbidity and mortality, particularly if they manifest with ischemic stroke or rapid expansion.<sup>1,2</sup> Treatment options are limited and include surgical sacrifice of the vertebral arteries with concomitant bypass<sup>3,4</sup> and utilization of endovascular stent reconstruction.<sup>5-7</sup> More recently, the Pipeline stent (Chestnut Medical, Menlo Park, California) has been used to treat patients with this condition,<sup>8</sup> but currently the technology has been limited to a few centers. We report a patient who presented with clinically progressive deterioration in the setting of 3 fusiform aneurysms incorporating the entire basilar trunk treated with a “double-barrel” stent reconstruction endovascular approach.

## CASE REPORT

A 56-year-old man with a history of tobacco use, hypertension, and hyperlipidemia presented to an outside medical facility with concerns about dysarthria and left-sided hemiparesis 3 months earlier. The patient underwent a magnetic resonance imaging (MRI) of the brain that revealed an acute infarct in the right basis pontis and 3 fusiform aneurysms of the basilar artery. He subsequently underwent a catheter angiogram that confirmed the presence of a dolichoectatic basilar artery with 3 fusiform aneurysms. He was placed on aspirin and clopidogrel along with a high-dose statin and discharged to home. He presented 6 weeks later with profound dysphagia and worsening of his left hemiparesis. He was found to have a new infarct in the right pons and left medulla on MRI and was

discharged to rehabilitation on Coumadin therapy. Six weeks later he presented with profound dysarthria (mute), emotional lability, and right arm paresis. A repeat MRI of the brain confirmed a new ischemic stroke in the pons bilaterally, and a repeat cerebral angiogram confirmed significant expansion of the fusiform dilatation of the distal and proximal aneurysm. It was not clear if the aneurysm had truly enlarged or was related to recanalization of thrombus while the patient was on Coumadin therapy. Given the progression of ischemic injury, the patient was transferred to our institution for further evaluation.

Figure 1 reveals the cerebral angiogram performed before transfer to our institution. We were unable to obtain the Pipeline device because of an ongoing clinical trial for which the patient did not qualify. The diameter of the basilar artery was 9.5 mm precluding placement of telescoping Enterprise (Cordis Corp., Miami Lakes, Florida) or Neuroform stents (Boston Scientific, Natick, Massachusetts). Thus, we opted for side-by-side telescoping stents (double-barrel technique) that has been previously reported to preserve side branches during aortic arch Endograft reconstruction.<sup>10</sup>

## TECHNIQUE

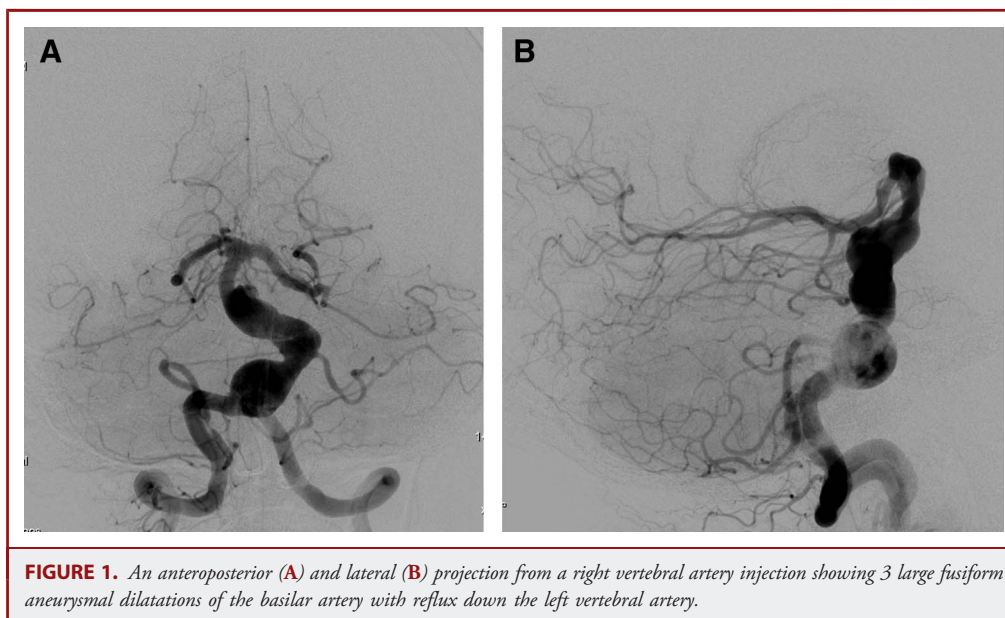
The patient was placed under general anesthesia with continuous hemodynamic monitoring through a radial arterial line. Before treatment the patient was given aspirin 325 mg for 3 days and clopidogrel 450 mg load followed by 75 mg daily for 3 days. We confirmed adequate inhibition of platelet function via aggregometry before proceeding with the procedure. The patient was given intermittent boluses of heparin to achieve an activated clotting time of 300 seconds or greater for the entire procedure.

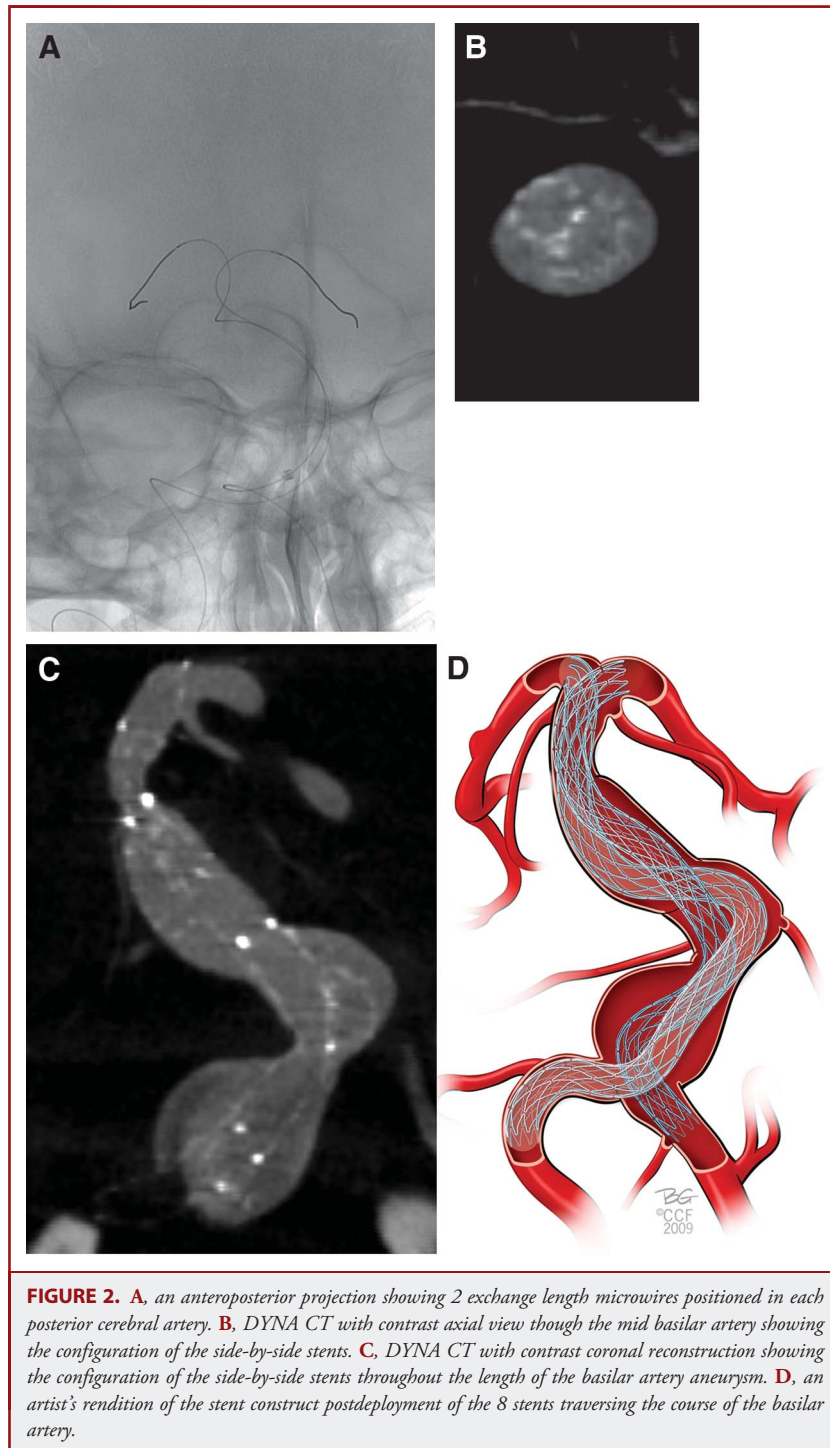
A 6F sheath was placed in the right common femoral artery and left common femoral artery using the Seldinger technique. A Neuron guide catheter (Penumbra Corp., Alameda, California) was placed in the left vertebral artery because of the extensive

proximal tortuosity of the extracranial vertebral artery. A 6F 80-cm Cook Shuttle sheath was placed in the right subclavian artery and a 6F 100-cm Envoy guide catheter was positioned in the extracranial right vertebral artery.

Under roadmapping guidance, a microcatheter and microwire were navigated into each posterior cerebral artery. The microcatheters were exchanged for 0.014-inch exchange length microwires (Figure 2). Two Neurform-2 4.5 × 30 mm stents were navigated and positioned in the proximal posterior cerebral artery side by side. These were deployed simultaneously by 2 operators to oppose the stent struts as well as the arterial wall. The stent catheters were removed and 4 more stents of the same size were placed in a telescoping manner overlapping the distal tines of the previously placed stents. A total of 6 stents were overlapped to the vertebrobasilar junction on each side. A Dyna CT was performed to confirm the positioning of the stents next to each other. We administered a total of 15 mg of eptifibatid at the end of the procedure for concerns of interval development of thromboembolic complications. Although the use of further antiplatelet therapy is unconventional, we felt that given the large amount of exposed metal surface area from the stents and turbulent blood flow through the stent construct of the aneurysm, administration of a glycoprotein IIb/IIIa antagonist might help in prevention of thromboembolic complications.

At this point, a microcatheter was placed in the proximal aneurysm through the stent struts and coil embolization was performed with GDC platinum coils. Sequential coil embolization was performed to partial occlusion of the aneurysm (Figure 3). The patient was then awoken from anesthesia and transferred to the intensive care unit on a heparin drip to achieve a partial thromboplastin time of 70 to 90 seconds. Aspirin 325 mg daily and clopidogrel 75 mg daily were maintained indefinitely.

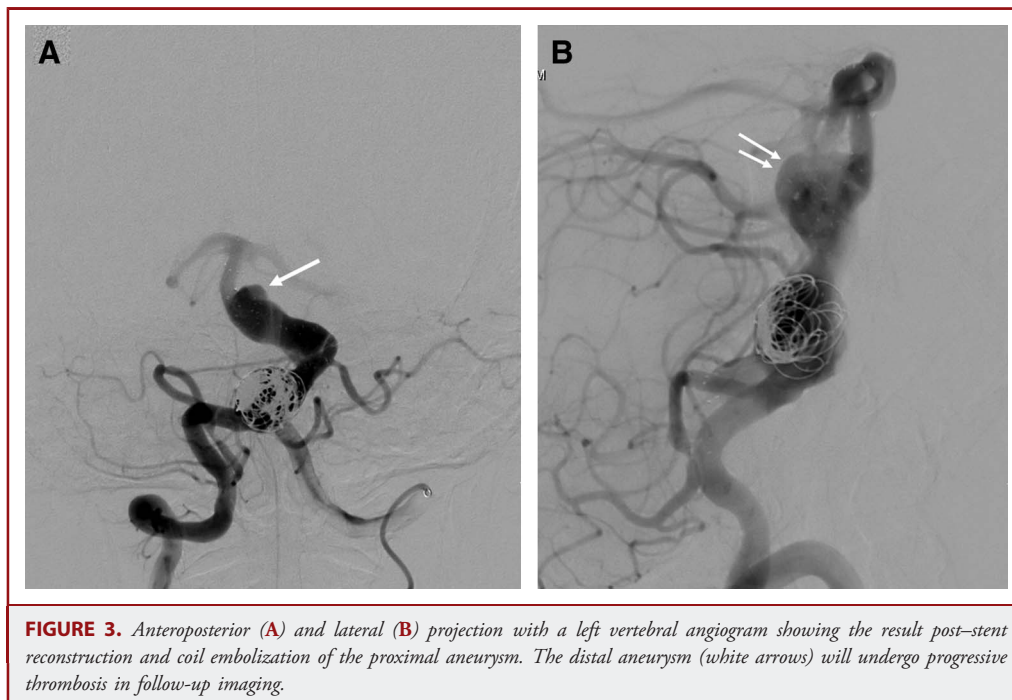




**FIGURE 2.** *A*, an anteroposterior projection showing 2 exchange length microwires positioned in each posterior cerebral artery. *B*, DYNACT with contrast axial view through the mid basilar artery showing the configuration of the side-by-side stents. *C*, DYNACT with contrast coronal reconstruction showing the configuration of the side-by-side stents throughout the length of the basilar artery aneurysm. *D*, an artist's rendition of the stent construct postdeployment of the 8 stents traversing the course of the basilar artery.

The patient required mechanical ventilation for 48 hours and then was extubated with an initial worsening of his left hemiparesis, but this returned to baseline 4 days postprocedure. He returned for follow-up at 4 months and was living

independently and did not have any further clinical deterioration. He underwent a cerebral angiogram and MRI of the brain (Figure 4) that showed progressive thrombosis of the proximal and distal aneurysms.



**FIGURE 3.** Anteroposterior (A) and lateral (B) projection with a left vertebral angiogram showing the result post-stent reconstruction and coil embolization of the proximal aneurysm. The distal aneurysm (white arrows) will undergo progressive thrombosis in follow-up imaging.

## DISCUSSION

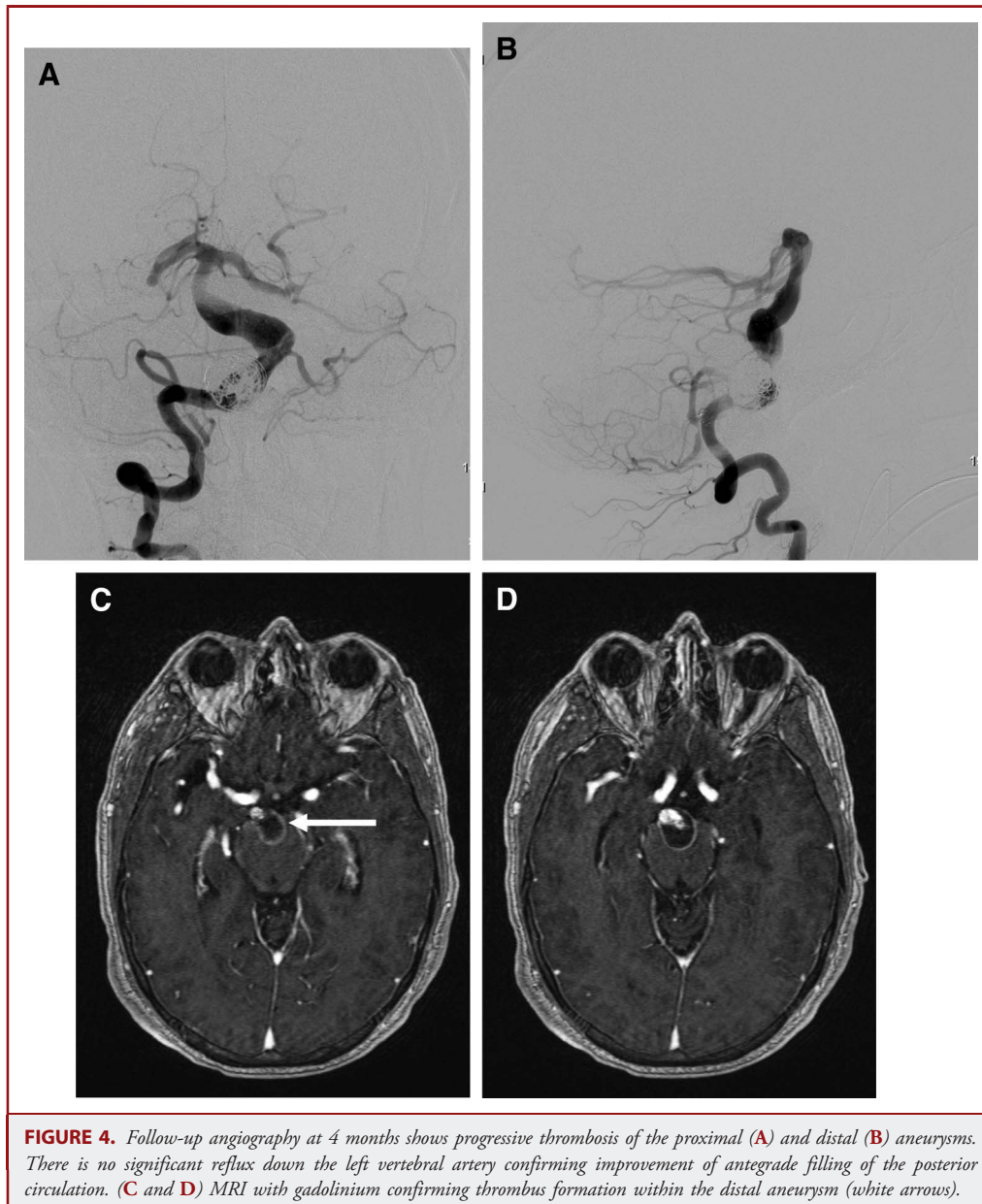
Fusiform basilar artery aneurysms are associated with a high rate of mortality and disability.<sup>1,2</sup> The mortality rate appears to be proportional to the size of the dilatation with rates of mortality as high as 30% per year when the diameter of the vessel is larger than 7 mm.<sup>1</sup> These lesions cause mass effect on the brainstem leading to cranial nerve dysfunction along with ischemic strokes due to formation of thrombus that may impede flow to the perforator branches.<sup>2</sup> The treatment of these lesions is often challenging and associated with a high degree of morbidity.

Surgical treatment with occlusion of the vertebral arteries or the basilar artery has been previously reported.<sup>3,4</sup> This technique was not believed to be suitable for our patient because the aneurysmal dilatation involved the length of the basilar artery and the patient had little anatomic collaterals such as posterior communicating arteries on angiography. Other studies have shown that aneurysms that extend along the length of basilar artery or are distal in nature have higher rates of ischemic complications with this occlusion technique.<sup>11,12</sup> From an endovascular perspective, the Pipeline embolization device was considered given the reports of recent success, but unfortunately this was not available because the device was being tested in a clinical trial for which our patient did not qualify. Prior studies have shown that utilization of stent monotherapy may occlude basilar trunk aneurysms.<sup>5,8</sup> The mechanism for this is likely due to the condition being a dissecting pseudoaneurysm with stents inducing healing along the dissection, thereby inducing thrombosis of the aneurysm. Alternatively, minor redirection of flow

through the stent, as opposed to the dome of the aneurysm, may induce thrombosis of the aneurysm. The etiology of these lesions is often unknown, although atherosclerosis has been postulated as a potential mechanism because there is disruption of the internal elastic lamina on histopathology.<sup>13</sup>

In our patient, the vessel diameter of the nonaneurysmal portions of the artery measured 9.5 mm in diameter and, thus, it was felt that a single stent would not be opposed to the vessel wall and thereby risk becoming dislodged from the original position during placement of subsequent telescoping stents. We thus utilized the side-by-side stent delivery technique to allow sections of the stent to heal along the arterial wall. The concern with this technique was leaving a septum of 2 stents in the middle of the basilar artery, thereby potentially increasing thromboembolic complications. Prior operators have described the “kissing stent” technique intracranially without reported incidence of thromboembolic complications.<sup>6</sup> In addition, the kink at the level of the anterior inferior cerebellar artery was felt to be contributory to the aneurysmal dilatation distally, and, by placing stents, the hope was to change the configuration of the kink. Although we did not see a significant change in the curvature of the basilar artery, progressive thrombosis occurred within the distal aneurysm.

Giant aneurysms throughout the intracranial vasculature usually contain some evidence of thrombosis and slow or turbulent blood flow. It has been postulated that thrombus formation in these aneurysms is dynamic, and, consequently, the amount and direction of blood flow in the aneurysm changes. We also postulate that large aneurysms, because of stagnant and turbulent blood flow, are prone to thrombosis; therefore, slight



manipulation or redirection of flow may induce dramatic changes in the aneurysm's overall characteristics. The placement of stents inside of these large aneurysms, regardless of metal surface area, may provide flow redirection to induce varying levels of thrombosis. In our case, we also elected to place coils in the proximal aneurysmal dilation. It was felt that this might also promote laminar flow through the stent construct by reducing turbulence through the proximal aneurysm. Follow-up angiography and MRI studies showed progressive thrombosis of the distal aneurysm.

This case describes an endovascular technique for treating giant fusiform vertebrobasilar aneurysms. This technique is off-label

and may be considered in select cases when no other therapeutic option is available. A more in-depth knowledge of large fusiform posterior circulation aneurysms elucidating etiology and the effects/outcomes of endovascular treatment of these lesions is required. It also illustrates the morbid natural history of these lesions, and the etiology of stent-induced thrombus formation within aneurysms. The double-barrel technique can be considered an option for patients with progressive neurologic decline. This technique, or variations of this technique, can be considered in patients who may not be candidates for current flow-diversion technologies.

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## COMMENT

The authors present an interesting approach to treating a fusiform aneurysm of the basilar artery by incorporating a technique published in the treatment of abdominal aortic aneurysms. By employing the double-barrel technique, the authors provide the necessary support for each portion of the stent system across regions of aneurysm that are much broader than the maximum diameter of the aneurysm. At 4-month follow-up the authors report no further symptomatology and a significant improvement in the patient's neurological condition. They thus conclude that this technique should be considered in situations where the traditional techniques are not applicable.

There are several important observations that can be made as a result of this and other similar techniques, the most important of which is the tremendous amount of remodeling that can occur when flow through vessels is modified. The concept of flow diversion and how to successfully "tame" it to predictably alter the biology of vessels, though discussed for many years, still eludes us. However, clinical vignettes such as this may certainly serve to help investigators from many disciplines better understand the key combination of biology and flow that contribute to healing in this setting.

The technical aspects of this procedure can certainly be challenging, and should be carefully considered as one adds this technique to the endovascular armamentarium in the treatment of previously untreatable lesions.

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