**CTA Appearance of In-Stent Restenosis of Intracranial Arteries Treated with Wingspan Stent**

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**SUMMARY**

Four patients underwent angioplasty and stenting (PTAS) of medically refractory symptomatic intracranial atherosclerosis with the new Wingspan stent system. On all 4 patients, CTA showed an abnormality within the stented segment that was suggestive of non-occlusive in-stent thrombus. However, subsequent conventional angiography was typical for in-stent restenosis (ISR). The CTA imaging features of ISR are important to recognize and the misinterpretation of ISR as in stent thrombus may result in inappropriate management.

**INTRODUCTION**

Intracranial atherosclerosis (ICA) accounts for up to 10% of the 700,000 new strokes that occur in the US each year.¹ Medical therapy has a poor prognosis and endovascular therapy of this disease has previously been limited due to device technology.² Recently the Gateway balloon and Wingspan stent have been released for treatment of medically refractory significant intracranial stenosis.² Little is known about the non invasive imaging appearance of this device in follow up after treatment.

Computed tomography angiography (CTA) appears promising as a non invasive tool for evaluating the status of intracranial stents, but limited literature on this topic exists. Extensive case series are beginning to appear in the coronary literature.³ We report the CTA appearance of in-stent stenosis in four patients who have undergone Wingspan placement.

**CASE REPORT**

All studies were reviewed under an IRB approved protocol. CT studies were performed on either a 16 or 64 slice GE LightSpeed CT scanner (GE Healthcare, Waukesha, WI). Post processing was done on a GE Advantage Windows Workstation utilizing CT perfusion software version 3.0.

CTA data were acquired with a helical acquisition using a 0.5 second rotation speed and a collimation of 2.5 mm with 50% overlap. The data were prospectively reconstructed to 1.35 collimation with a 625 interval. For technique we used a kV of 120 and auto MA, setting the highest MA value at 440 using 12 as a noise factor (220 MAs). A pitch of 1.35 and a table speed of 13.75 allow tracking the contrast bolus in the arterial phase. CTA was performed with a 100 cc bolus of 370 mgl/dl nonionic contrast media at an injection rate of 3cc/second followed by a 50 cc saline flush. The timing bolus requires an additional 20 cc of contrast. Axial, sagittal and coronal overlapping thick slab 2-D MPR reformations were made using 10mm slices with 2.5mm overlap. Additional magnified curved planar images (MPR's) were done focusing on the stented vessel segment utilizing 0.625mm slab thickness.

**DISCUSSION**

There is little literature describing the CTA appearance of in stent restenosis associated with the Wingspan stent. In our early experience with this device we have encountered 4 patients who, at the time of follow-up with CTA, were found to have an intra-luminal filling defect suggestive of thrombus. However, on further DSA evaluation these filling defects were found to represent in stent restenosis.

The ability of CTA to image the lumen within cerebrovascular stents is primarily limited by CT related artifacts. Blurring effects result in stent struts appearing thicker and is exaggerated by any adjacent vascular calcification.⁴ The stent composition and design can also play a role in the blurring effect and overall degree of artifact.⁵ The Wingspan stent is composed of Nitinol, has an open cell design, thin struts and a relatively low metal surface area coverage which results in less beam hardening and scatter artifacts compared to conventional coronary stents (Figure 5). Optimal intraluminal contrast enhancement is also important for reducing intra-stent artifact and accurately imaging the intrastent lumen. A final limitation of CTA lies with partial volume averaging due to the small size of the cerebral vessels. To minimize volume averaging effects all CTA scans utilized 0.625mm isotropic voxels with additional thin slice curved MPR’s from either a 16 or 64 slice CT scanner.

Since CTA is increasingly used as a modality for evaluation and follow up of patients who have undergone intracranial stenting, it is important that the possibility of false positive studies indicating intra-luminal thrombus be appreciated. Because of the management implications when a finding suggestive of an intra-luminal thrombus is seen on a CTA in these patients, confirmation with DSA should be strongly considered. Further studies are required to determine both the cause and the frequency of this CTA finding.

**REFERENCES**

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**Example Case 1**

A 38 year old female with history of diabetes, hypertension, and hypercholesterolemia presented with recurrent paraphasia, refractory to medical management. Angioplasty of a middle cerebral artery (MCA) stenosis was not durable; symptomatic restenosis occurred within weeks. She was then referred to our institution for intracranial stenting. CTA showed a critical stenosis of the right M1 segment of the MCA and was verified with DSA (Figure 1a). She was continued on Clopidrogel and aspirin and underwent angioplasty and stenting (3mm x 9mm Gateway balloon and a 3.5mm x 15mm Wingspan stent) with good result (Figure 1b). CTA follow up at one month showed the stented segment to be widely patent (Figure 1c). Three month follow up CTA showed an abnormality within the stented segment that was suggestive of non-occlusive in-stent thrombus (Figure 1d). DSA demonstrated a significant smooth tapering in-stent restenosis (Figure 1e). Because of concern of the risk of distal emboli associated with an attempt at repeat angioplasty, the patient was converted to Coumadin and Aspirin and followed for an additional four months. CTA again showed an irregular, non-occlusive, filling defect within the stent. DSA demonstrated a significant smooth tapering in-stent restenosis (Figure 1f). Balloon angioplasty (3mm x 9mm Gateway balloon) resulted in resolution of the stenosis and symptoms (Figure 1g).

**Example Case 2**

A 38 year old female with history of diabetes, hypertension, and hypercholesterolemia presented with recurrent TIAs vs complicated migraine headaches. Turner syndrome which predisposes to early onset of atherosomatic disease, hypertetiesis, hypertension, episodic non-physiologic speech ‘arrest’ events. The patient presents with symptomatic progressive right A1 stenosis refractory to medical therapy who underwent angioplasty and Wingspan stent placement. Serial DSA and CTA imaging detail occlusion of the patient’s right A1 Wingspan stent at follow up.

## Figure 1a-g

1a. 38 year old female with right MCA stenosis refractory to medical therapy and prior angioplasty.
1b. Serial imaging detailing restenosis and eventual angioplasty. See Case example text for full details.
1c. CTA Appearance of In-Stent Restenosis of Intracranial Arteries Treated with Wingspan Stent
1d. CTA Appearance of In-Stent Restenosis of Intracranial Arteries Treated with Wingspan Stent
1e. CTA Appearance of In-Stent Restenosis of Intracranial Arteries Treated with Wingspan Stent
1f. CTA Appearance of In-Stent Restenosis of Intracranial Arteries Treated with Wingspan Stent
1g. CTA Appearance of In-Stent Restenosis of Intracranial Arteries Treated with Wingspan Stent

## Figure 2

Axial and coronal thick slab reformations (left) and thin slice curved MPR images (right) focusing on the stented segment at 3 months follow up (upper row) and then at 6 months follow up (lower row) show abnormal linear filling defect within the stent which is most apparent on the MPR images.

**Figure 3**

Axial and coronal thick slab reformations (left) and thin slice curved MPR images (right) focusing on the stented segment to be widely patent (Figure 1c). Three month follow up CTA done because of recurrent symptoms showed a filling defect within the stent (Figure 1d). Curved thin slice MPR’s focusing on the stented segment revealed the filling defect along the caudal aspect of the stent with contrast seen circumferentially around the filling defect suggestive of a thrombus (Figure 1e).

**Figure 4**

Image on the left demonstrates a critical stenosis (arrow) involving the left A1 anterior cerebral artery that is treated with angioplasty and Wingspan stent with resolution of stenosis.

**Figure 5**

MCA in stent restenosis with correlating CTA and DSA. The patient previously required a coronary stent for critical supra-aortic stenosis proximal to the Wingspan stent (*) in the adjacent MCA. Note the extensive blooming effect related to coronary stent in comparison to the adjacent Wingspan stent.

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