Vasospasm

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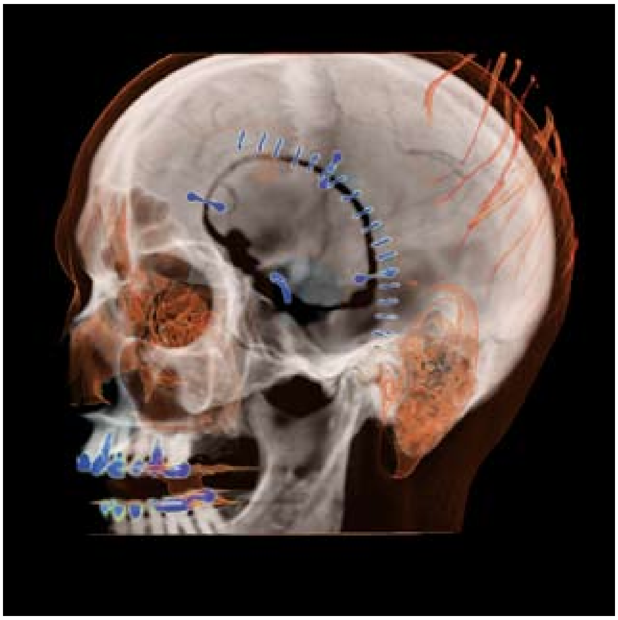
Introduction

Vasospasm is a delayed entity seen largely in patients who sustained subarachnoid hemorrhage (SAH) from an aneurysm rupture. Its manifestation results in the greatest morbidity and mortality in the recovery of those patients. Its onset occurs 3-5 days after initial SAH, and maximizes at 5-8 days. Early detection and neurointervention in the forms of intra-arterial drug infusion and/or angioplasty has promising results. [1,2] The advent of intra-arterial thrombolytic therapy has revolutionized how acute stroke and other stroke-like phenomenon (e.g. symptomatic vasospasm) are being treated. CT Perfusion (CTP) and CT Angiogram (CTA) [3-5] maintain their roles as primary imaging modality for evaluation of these patients. While MRI offers some advantages, the mainstay of CT in stroke evaluation exists largely because of its speed and availability in most academic and private medical centers. As an example, we will discuss the case of a female patient aged 39, who underwent a craniectomy for left middle cerebral aneurysm clipping (8 days prior presentation) and developed a progressive left pronator drift.



Methods

A CTP scan was obtained by using a Multidetector CT (MDCT) scanner (Volume Zoom; Siemens, Erlangen, Germany) at our institution as part of the protocol for acute stroke or vasospasm detection. After obtaining a non-contrast traditional 5 mm axial acquisition of the entire brain, a CT perfusion acquisition was performed by acquiring two 10 mm thick sections with continuous scanning adjacent to the center cut at the level of the basal ganglia.

The continuous scan utilizes the following technique: 80 kVp, 250 mAs, 2 x 10 mm sections, 1-sec/rotation, total scan duration of 40 seconds. An injection of 320 mg of iodine per milliliter for a total of 40 ml at a rate of 4 cc/sec was administered intravenously through a peripheral 16-22 gauge IV cannula. Data were reconstructed at 0.5 sec intervals by utilizing the available software module on the scanner console. CTA was then acquired in rapid sequence after CTP using CT techniques (KV 120, mA 270, slice 1mm, collimation 1mm, feed 2.7mm per revolution FOV 200mm). The contrast-enhanced dataset was acquired simultaneously with injection of contrast at the rate of 4 cc/sec for 100cc total volume from C2 through vertex.

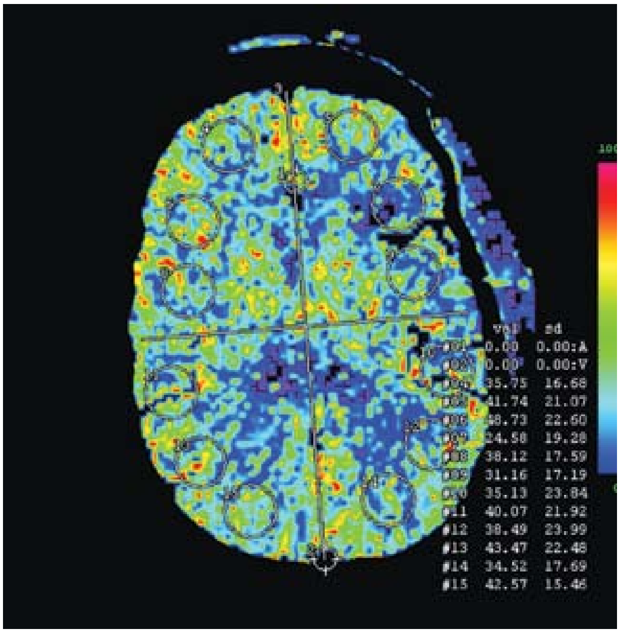


Figure 1 Abnormal CBF within the left cortical hemisphere

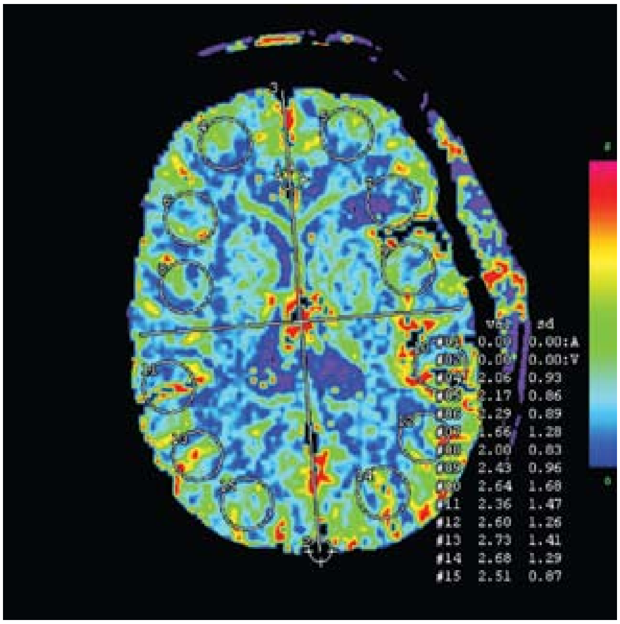


Figure 2 Abnormal CBV within the left cortical hemisphere

The processed data were then imported to the Aquarius Workstation from TeraRecon, Inc. The Aquarius Workstation has an advanced Time-Density-Analysis (TDA) package and 3D capabilities for CT Perfusion and CTA analysis, respectively. Processing for CTP included placing regions of interest sequentially on the input artery (anterior cerebral or middle cerebral artery) on the normal side and on an appropriate venous structure (torcula) for generation of Cerebral Blood Flow (CBF), Cerebral Blood Volume (CBV), and Mean Transit Time (MTT) color maps. ROIs were then placed at the periphery of the brain parenchyma in symmetrical fashion for comparative quantitative analysis. CTA images were visualized using a Maximal Intensity Projection (MIP) in coronal and axial views.

Results

The initial CTP color maps showed abnormal findings, especially abnormal CBF, CBV, and MTT within the left cortical hemisphere (Figures 1- 3) as compared to the contralateral side. This corresponds to the left MCA territories.

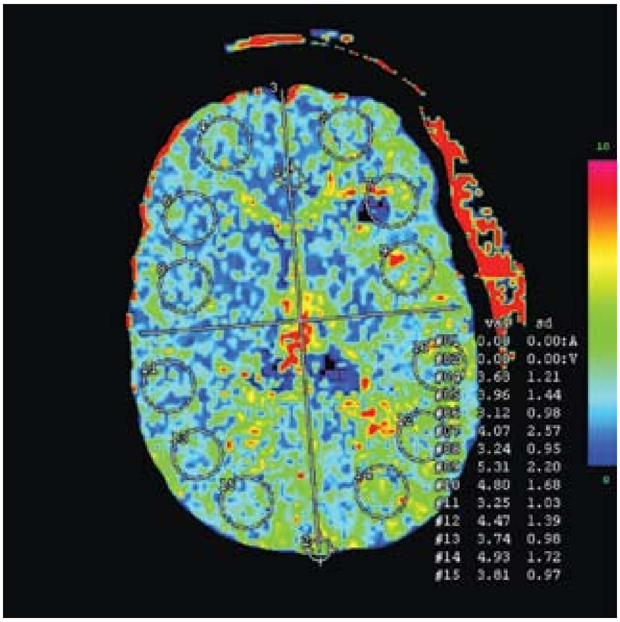


Figure 3 Abnormal MTT within the left cortical hemisphere

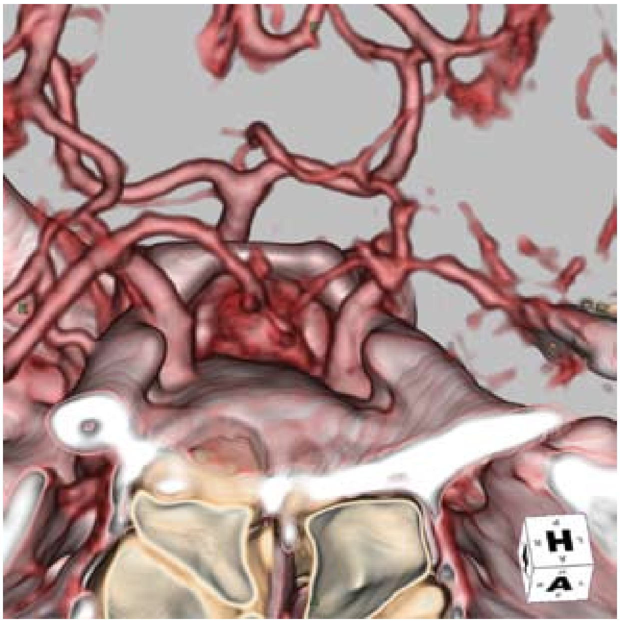


Figure 5 Volume rendering shows the moderate vasospasm between left ICA and left middle MCA

CTA revealed moderate vasospasm within the left distal internal carotid artery (ICA) and proximal M1 and M2 segments of the left middle cerebral artery (MCA) (Figures 6, 8, and 10).

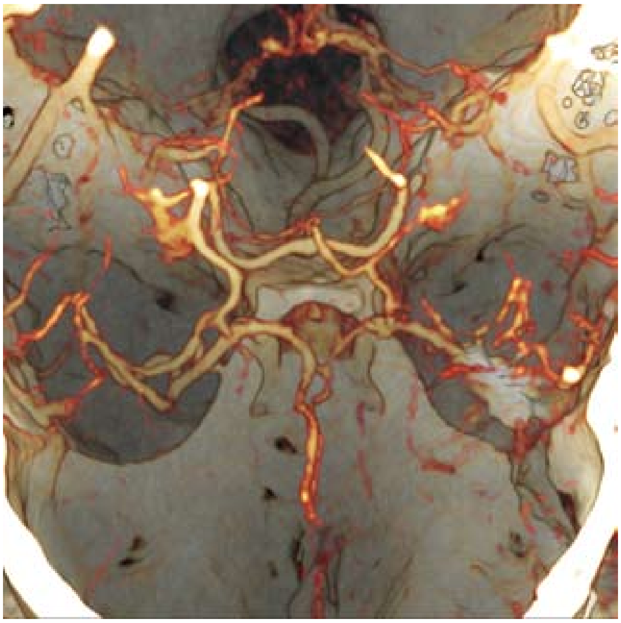


Figure 4 Volume rendering shows the moderate vasospasm between left ICA and left middle MCA

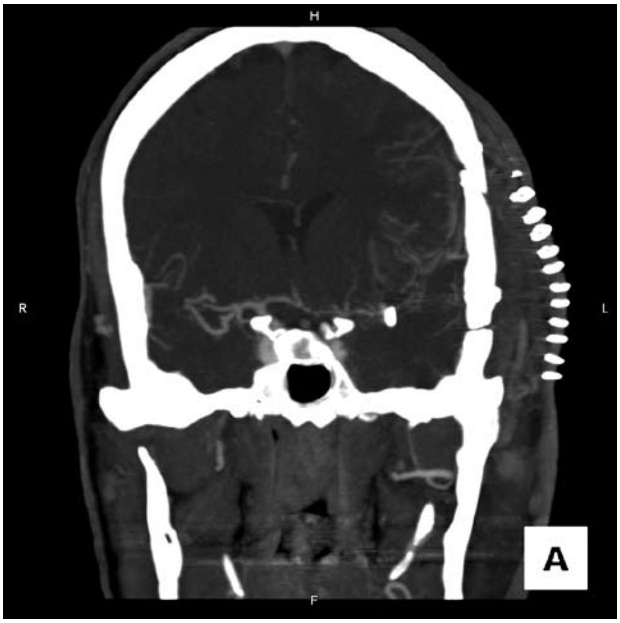


Figure 6 Left middle cerebral artery

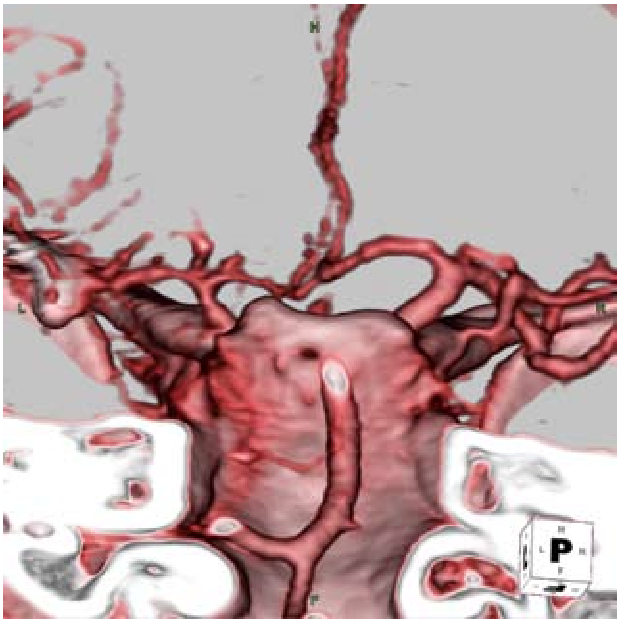


Figure 7 With easy thin slab function applied to dataset, volume rendering shows the moderate vasospasm from posterior view

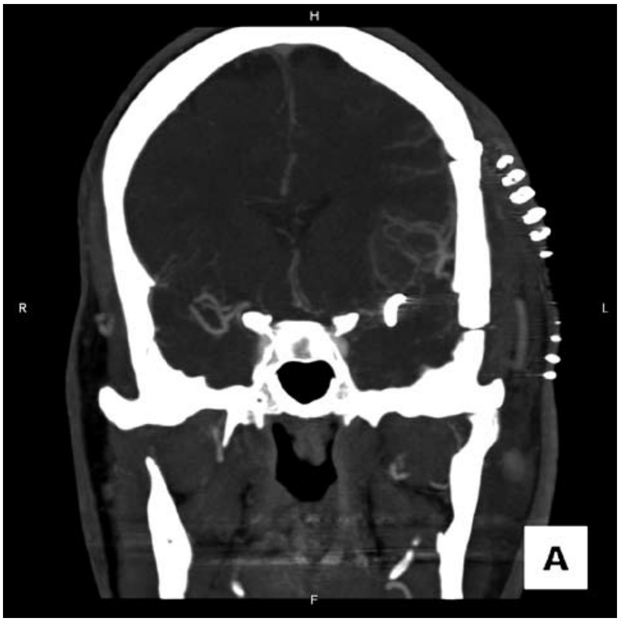


Figure 8 The left middle cerebral artery

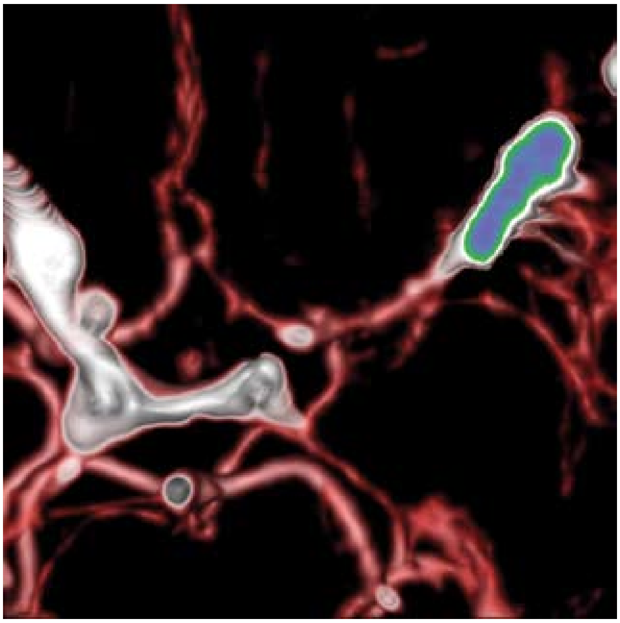


Figure 9 Enlarged view of volume rendering shows the moderate vasospasm and surgical clip from inferior projection

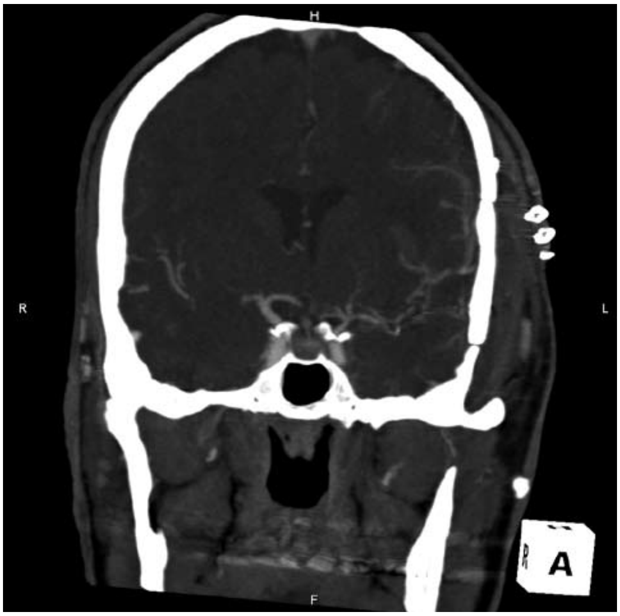


Figure 10 The left middle cerebral artery

Figure 11 Axial MIP image

Figure 13 Axial MIP image

These were also confirmed on the Axial MIP images (Figures 11 and 13). These abnormal findings on both CTP and CTA correlate with the patient's clinical neurological deficit in a presumed symptomatic vasospasm.

The patient then underwent initial cerebral Diagnostic Subtraction Angiogram (DSA) for anticipated intra-arterial intervention therapy (Figures 14 & 15).

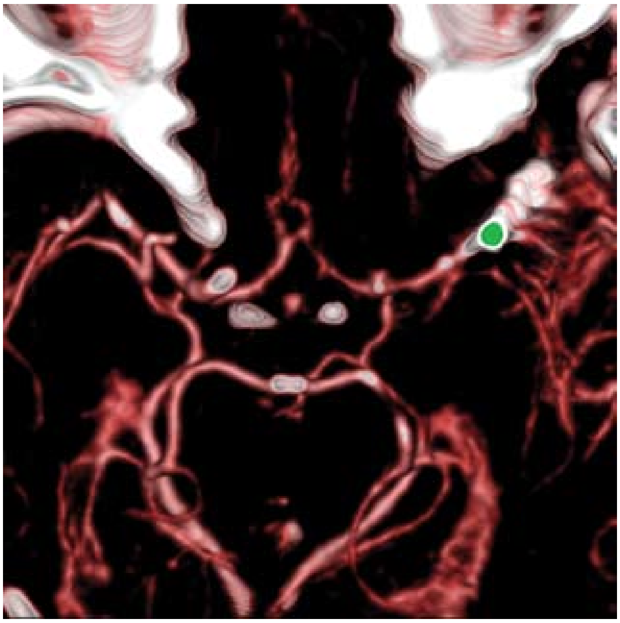


Figure 12 Volume rendering of COW from inferior view

Figure 14 AP view of a cerebral Diagnostic Subtraction Angiogram

Figure 15 Lateral view of a cerebral Diagnostic Subtraction Angiogram

The findings on CTA correlate well with the DSA findings. Given the matched findings of CTA, CTP, and DSA, intra-arterial infusion was then initiated for vasospasm relief. The highly efficient Time-Density module from the Aquarius Workstation was instrumental in the superb images and accurate diagnosis of this case.

Conclusion

CT Angiogram and CT Perfusion continue to have greater role in intra-cerebral vascular ischemic initial evaluation. The techniques are non-invasive, fast, and available at most top-notch medical centers. Post-processing of these dataset is convenient with the use of devices like the Aquarius Workstation.

References

1. Rabinstein, A.A., et al., Predictors of outcome after endovascular treatment of cerebral vasospasm. AJNR Am J Neuroradiol, 2004. 25(10): p. 1778-82.

2. Wu, C.T., et al., Treatment of cerebral vasospasm after subarachnoid hemorrhage--a review. Acta Anaesthesiol Taiwan, 2004. 42(4): p. 215-22.

3. Anderson, G.B., et al., CT angiography for the detection of cerebral vasospasm in patients with acute subarachnoid hemorrhage. AJNR Am J Neuroradiol, 2000. 21(6): p. 1011-5.

4. Takagi, R., et al., Three-dimensional CT angiography of intracranial vasospasm following subarachnoid haemorrhage. Neuroradiology, 1998. 40(10): p. 631-5.

5. Takagi, R., et al., [Evaluation of three-dimensional CT angiography (3D-CTA) for the diagnosis of cerebral vasospasm]. Nippon Igaku Hoshasen Gakkai Zasshi, 1997. 57(1): p. 64-6.