

Eye On Imaging

CT ANGIOGRAPHY

Recent advances in Multidetector-Row Computed Tomography (MDCT) have resulted in the widespread clinical use of Computed Tomographic Angiography (CTA). Markedly improved acquisition speed along with improved spatial and temporal resolution have allowed CTA to rapidly progress and to effectively replace catheter angiography. Greater understanding of intravenous contrast dynamics and the ability to display the imaging information in two-dimensional (2D) and three-dimensional (3D) reformations (Figure 1) have further enhanced the utility of CTA. In the following brief review, we summarize some of the clinical applications of CTA.



Figure 1: 3D display of aorta, renal, and visceral arteries.

HEAD AND NECK

CTA of the head has become a primary modality for imaging intra-cranial arterial occlusive disease, aneurysms, arterial-venous malformations, and dural venous sinus thrombosis. The sensitivity of CTA for aneurysms is 93% to 99%. In patients with atherosclerotic disease, CTA identifies patients with intracranial stenosis who are at risk for stroke. In acute cerebral vascular occlusion, thrombus can be identified quickly and therapy can be initiated. (Fig. 2).

CTA of the neck has replaced Digital Subtraction Angiography (DSA) for carotid stenosis evaluation; studies show that the two techniques are comparable. With CTA one can evaluate the percent stenosis, ulceration, fibrous cap, lipid core and degree of calcified plaque. If there is enhancement of the arterial wall overlying a plaque there is a high correlation with frequent transient ischemic attacks and subsequent stroke.

Patients who have an "occluded" carotid by a duplex ultrasound may still have a small patient lumen, these patients should undergo CTA to see if any residual lumen is present. If the lumen is patent, these patients are at high risk for stroke, and are candidates for endarterectomy. (Fig. 3).

CTA of the head and neck has a higher sensitivity than MRA for the evaluation of vascular stenosis/occlusion and aneurysms. MRA, however, has two advantages over CTA; first, no contrast is needed to evaluate the intra-cranial circulation and second, there is no ionizing radiation. MRA of the neck is routinely performed with and without contrast; however, the study can be done without contrast when the patient has a significantly elevated creatinine. MRA is preferred for screening studies, younger patients, and those who cannot have iodinated contrast—either because of allergy or impaired renal function.

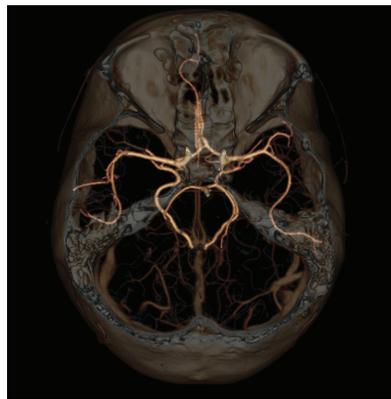


Figure 2: CT angiogram of the head with 3D modeling.



Figure 3: CT angiogram of occluded left carotid artery.

The studies are not mutually exclusive, for instance, if an MRA of the neck suggests an occluded internal carotid artery, CTA would then be performed to see if a small residual lumen exists.

CHEST

Pulmonary emboli Pulmonary embolism is a challenging diagnostic problem and the imaging literature contains many different diagnostic algorithms. CT pulmonary angiography (CTPA) is often the first test employed because of its high diagnostic accuracy and ready availability, as well as its ability to exclude other causes for the patient's symptoms. The presence of a filling defect within a contrast-filled pulmonary artery is diagnostic (Figure 4). CTPA is a highly sensitive and specific modality, and its clinical validity in excluding pulmonary embolism is comparable to standard catheter pulmonary angiography.

Aortic aneurysm A fusiform aneurysm is diagnosed when the diameter of the aorta exceeds 5 cm.

BIOGRAPHY

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Dr. Marshall Bein received his AB degree in biology from Boston University and his MD, MS from the University of Louisville School of Medicine. He completed internship and residency in Internal Medicine at the Hospital of the University of Pennsylvania, and residency in Diagnostic Radiology at UCLA. He remained in academic radiology at UCLA for nearly five years and then entered private practice radiology. Dr. Bein has special interest and expertise in all aspects of body imaging, especially CT and MR.

Dr. Rachael Gordon graduated with honors from University of Colorado Medical School. Following her diagnostic radiology residency at Cedars-Sinai Medical Center, she completed a two-year fellowship in Neuro-

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CT ANGIOGRAPHY

The location and size of the aneurysm and the potential involvement of the arch vessels can be precisely evaluated on CTA, and the aneurysm can be reliably followed when the patient is being treated medically. CTA is also used to evaluate any postsurgical complications.

Aortic Dissection Dissection is the most common of the acute aortic syndromes, which also include intramural hematoma, penetrating atherosclerotic ulcer, and unstable aortic aneurysm. Dissection results from an intimal tear with development of true and false lumens separated by an intimomedial flap. The false lumen may involve the entire thoracic aorta and extend into the abdominal aorta and extremity arteries. Type A involves the ascending aorta and is a surgical emergency. Type B occurs distal to the ascending aorta and arch and is more commonly treated medically. The diagnostic finding is demonstration of an intimomedial flap. CTA identifies the point of entry and length of the tear, size of the false lumen, and aortic side-branch involvement. CTA can reliably demonstrate any postoperative complications and persistence of the false lumen (Figure 5).

ABDOMEN

Renal artery stenosis Systemic hypertension is most often idiopathic. Renal artery stenosis is a rare treatable cause of hypertension and CTA plays a critical role in its screening. Atherosclerosis is the most common cause with stenosis usually occurring at the vessel origin or within the proximal 2 cm. Fibromuscular dysplasia is the next most common cause with stenosis occurring in the mid to distal renal artery. CTA accurately demonstrates hemodynamically significant renal artery stenosis.

Mesenteric ischemia One of the many causes of obscure abdominal pain is compromise of the mesenteric circulation. Either arterial or venous abnormalities may occur and may be acute or chronic. CTA visualizes the arterial circulation including the vasa recta, the venous circulation, and the bowel wall. The most common cause of acute mesenteric ischemia is superior mesenteric artery (SMA) embolus which usually presents as a filling defect within the proximal vessel although smaller emboli may occur distally. SMA thrombosis is the second most common cause and usually occurs secondary to atherosclerotic disease; this typically occurs at the vessel origin or within the proximal 2 cm. Nonocclusive ischemia is an additional cause that occurs as a complication of hypotension with resultant vasoconstriction of all the mesenteric arteries. The final cause of acute ischemia is mesenteric vein thrombosis which is usually seen in patients with a coagulopathy. Chronic mesenteric ischemia is almost always due to severe and widespread atherosclerotic disease with two of the three mesenteric vessels involved (Figure 6).

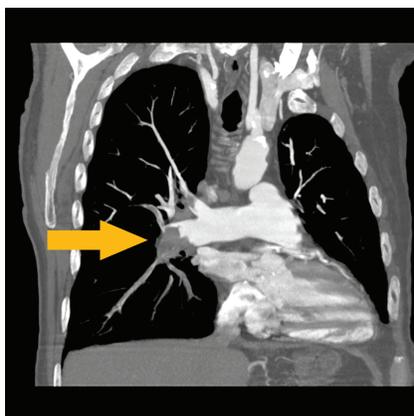


Figure 4: Multiple pulmonary emboli, the largest in the proximal right descending artery.

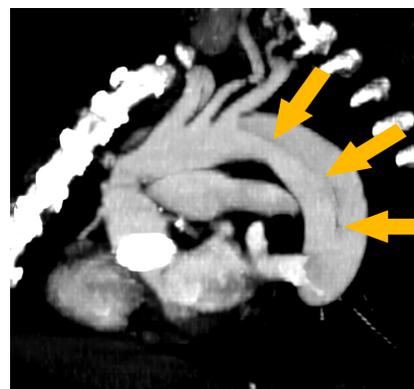


Figure 5: Persistent intimomedial flap and false lumen after repair of Type A dissection.

Aortic aneurysm An abdominal aortic aneurysm is defined as dilatation greater than 3 cm and the majority occur distal to the level of the renal arteries. Ultrasound may be used for screening, but detection is often limited by technical factors; ultrasound may also be limited in defining the level of the renal arteries and determining extension into the iliac bifurcation. CTA has replaced digital subtraction angiography for definitive diagnosis because it is less invasive and can evaluate both the aortic wall and intraluminal thrombus. The threshold size for intervention is usually 5.5 cm. CTA evaluation includes size and length of the aneurysm, location of the neck, relation to the renal arteries, status of mesenteric and iliofemoral vessels, and findings of rupture or impending rupture. Treatment may be with open surgical repair or less invasively by endovascular aneurysm repair with endoluminal stent graft. CTA plays a pivotal role in the evaluation of complications post stent placement which include vessel occlusion, aneurysm or pseudoaneurysm at the anastomotic site, graft limb occlusion, and endoleak.

LOWER EXTREMITIES

Peripheral arterial disease This type of arterial disease is secondary to stenotic or occlusive atherosclerosis, and claudication is the dominant presenting symptom. Patients with symptoms and positive noninvasive test results who are potential candidates for intervention are referred for CTA. The location and severity of stenosis, and the length of any occluded segments are critical determinants in determining endovascular versus surgical bypass treatment.

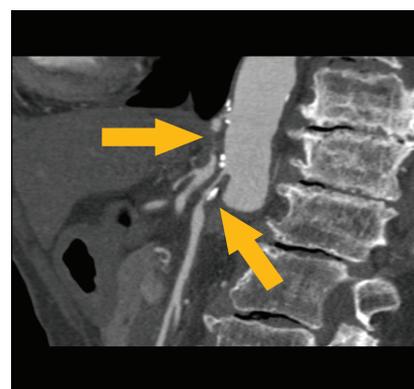


Figure 6: Stenosis of celiac axis and superior mesenteric artery.

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2. Bashe, et al. Intracranial Vascular Stenosis and Occlusive Disease: Evaluation with CT Angiography, MR Angiography, and Digital Subtraction Angiography. American Journal of Neuroradiology. 2005;26:1012-1021.