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Seminars in
ULTRASOUND
CT and MRI

Computed Tomography Angiography in Head and Neck Emergencies

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Computed tomography angiography (CTA) offers a rapid means of evaluating the vasculature of the head and neck in patients presenting with acute onset of neurologic symptoms and blunt trauma to the head and neck. CTA is noninvasive, easy to acquire, and offers excellent detail in identifying site and nature of the lesion. The learning objectives of this article are to review normal anatomy and variants, recognize CTA appearance of vascular pathologies, describe typical parameters used for acquiring the study, and recognize common pitfalls.
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Introduction

Computed tomography angiography (CTA) of the head and neck is a valuable tool in the evaluation of patients presenting with acute neurologic symptoms. In patients presenting with symptoms of ischemic stroke, CTA has been shown to be effective in identifying the anatomical site of occlusion, length of occlusion, and in some cases the cause of occlusion.[1-4] Traumatic injuries sustained to the cerebrovascular system are termed blunt cerebrovascular injuries (BCVIs), defined as injuries to the carotid and vertebral arteries that result from blunt trauma. They are diagnosed in 0.01% of patient hospitalized for blunt trauma and in 2.7% of patients screened for asymptomatic blunt polytrauma. When unrecognized, it may result in severe morbidity and mortality. CTA serves as an effective and first-line tool for the evaluation of these patients as well.

The learning objectives of this article are as follows:

(1) Review of arterial anatomy of the head and neck, including common variants.
(2) Recognize common computed tomography (CT) angiographic appearance of various vascular injuries of the head and neck.
(3) Describe typical parameters used for the performance of CTA.
(4) Recognize common pitfalls.

Arterial Anatomy

Common Carotid Artery

Left common carotid is most commonly a branch off the aortic arch and the right common carotid artery off of the brachiocephalic trunk, although there are variations in these origins. Common carotid artery splits into the internal and external carotid arteries just superior to the thyroid cartilage.

Internal Carotid Artery

Starts at the bifurcation of the common carotid at the level of the thyroid cartilage and extends superiorly entering the cranium through the carotid canal located in the petrous portion of the temporal bone. The internal carotid artery (ICA) bifurcates intracranially to become the anterior cerebral artery (ACA) and the middle cerebral artery (MCA).

Circle of Willis

Named after English physician Thomas Willis, it is a circulatory vascular anastomosis located on the inferior aspect of the brain. The arteries included in the circle of Willis are the anterior cerebral arteries, anterior communicating artery (ACoA), ICAs, posterior communicating artery (PCoA), posterior cerebral arteries, and the basilar artery.

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The naming convention for the vessels contributing to and extending from the circle of Willis are described later.[5,6] A detailed discussion of the smaller branches arising from these vessels is beyond the scope of this article.

Internal carotid artery	Vertebrobasilar system
C1: Extracranial internal carotid artery.	*Vertebral artery*
C2: Petrous segment; attached to the dura and prone to shearing forces. Gives off the vidian artery and caroticotympanic artery, which supply the middle ear.	V1: Extraosseous segment; from the origin to the C6 vertebral transverse foramen. Supplies lower cervical spinal cord.
C3: Lacerum segment; lies adjacent to the trigeminal ganglia.	V2: Foraminal segment; inferior most transverse foramina to C2 vertebral body. Gives off the anterior meningeal artery.
C4: Cavernous segment; anastomoses with the external carotid artery branches and maybe a source of collaterals.	V3: Extra spinal segment; from C2, crossing the foramen magnum into the dura. Gives off the posterior meningeal artery.
C5: Clinoid segment.	V4: Intradural segment; gives off the anterior spinal artery, posterior spinal artery, posterior inferior cerebellar artery, and medullary perforating branches.
C6: Ophthalmic segment; lies within the subarachnoid space. Gives off ophthalmic artery (which anastomoses with external carotid artery branches) and superior hypophyseal artery.	Basilar artery: gives off basilar perforating arteries (supplies midbrain and pons), anterior-inferior cerebellar artery (AICA), and one or more superior cerebellar arteries (SCAs).
C7: Communicating segment; gives off the posterior communicating artery and anterior choroidal artery.	
Middle cerebral artery	*Posterior cerebral artery*
M1: Horizontal segment; gives off the lateral ventricular striate artery and the anterior temporal artery.	P1: Precommunicating segment; basilar artery bifurcation to junction of posterior cerebral artery with posterior communicating artery
M2: Insular segments; refers to the postbifurcation MCA segment, which undergoes a hairpin loop.	P2: Ambient segment; gives off anterior and posterior temporal arteries.
M3: Opercular segments; segments of MCA within the sylvian fissure.	P3: Quadrigeminal segment; begins behind the midbrain and ends at the calcarine fissure.
M4: Cortical segments; segments of MCA that exit the sylvian fissure and run along the cortical surface.	P4: Calcarine segment
Anterior cerebral artery	
A1: Horizontal segment; from the ICA bifurcation to anterior communicating artery (ACoA). Gives off medial lenticulostriate artery and the recurrent artery of Heubner(may also arise from A2).	
A2: Vertical segment; lies along the interhemispheric fissure up to the corpus callosum rostrum.	
A3: Callosal segment; terminal segment that divides into the pericallosal and callosomarginal branches.	

Variant Anatomy

Fenestrations

Division of the arterial lumen into distinctly separate channels, each with its own endothelial and muscularis layers while the adventitia may be shared (Fig. 1). Intracranial fenestrations may occur in the ACoA (12%-21%), basilar arteries (5%), vertebral arteries (0.3%-2.0%), MCA (0.2%-2.9%), or ACA (0%-4%). ICA, posterior cerebral artery (PCA), and PCoA fenestrations are very rare with only a few case reports.[7]

Azygous ACA

Derives from a persistent median artery of the corpus callosum. The ACA territories are supplied by a single A2 trunk (prevalence rate is 0.2%-4.0%, Fig. 2).[7]

Fetal Origin of the PCA

The PCoA is larger than the P1 segment of the PCA. The ICA thus, becomes the dominant blood supply to the occipital lobes as well. It can occur on the right side (10% of prevalence rate), the left side (10%), or bilaterally (8%), which results in a smaller than normal caliber basilar artery (Fig. 3).[7]

Arterial Duplications

Vary in prevalence, with ACoA duplications presenting fairly commonly (18%), and most other duplications having a prevalence rate between 0% and 3%.