College of Health and Medical Technologies
Department of Radiology Technologies
Computed Tomography

CT scan of brain:
- Brain intravenous contrast medium
- CT venography
- CT scan for the Stroke

4 th stage

LECTUER 4

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MSc Radiographic Imaging

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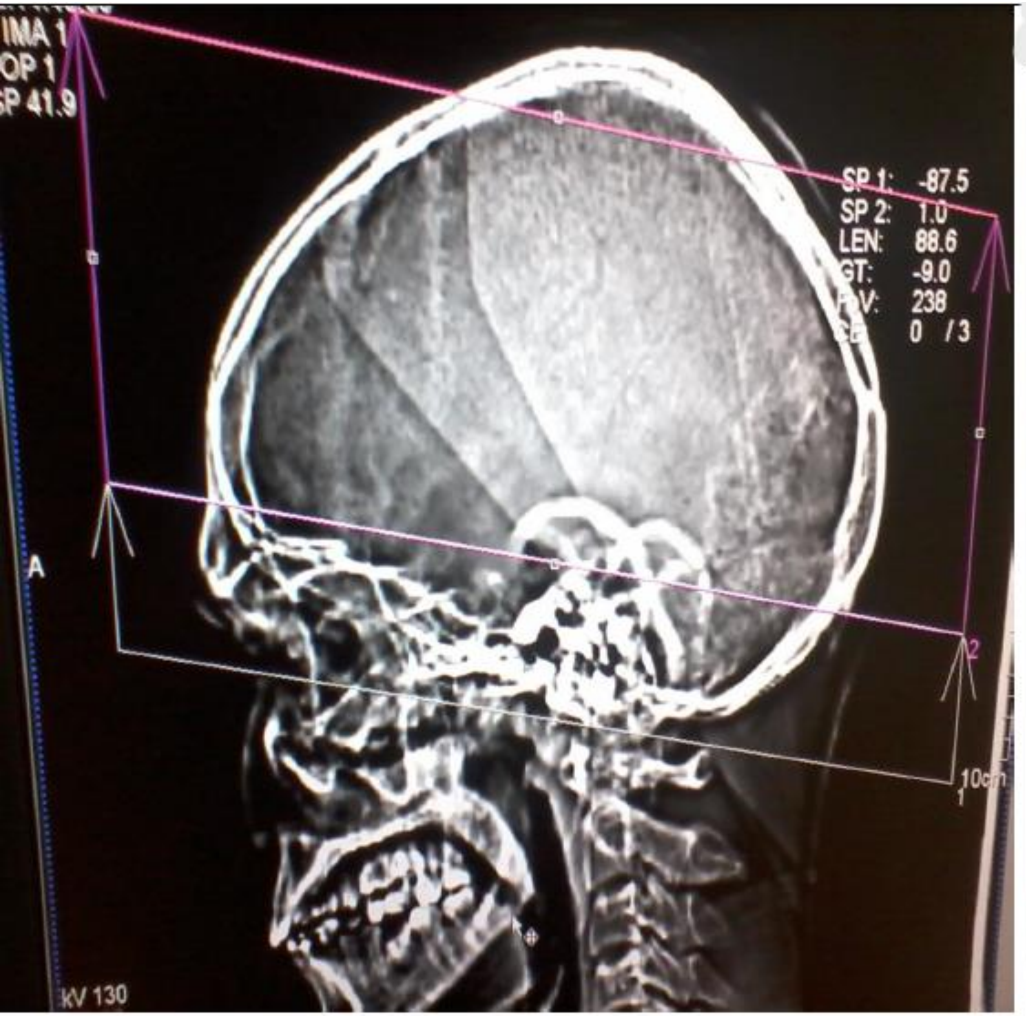
CT brain

CT head (sometimes termed **CT brain**), refers to a computed tomography examination of the brain and surrounding cranial structures. It is most commonly performed as a noncontrast study, but the addition of a contrast-enhanced phase is performed for some indications.


IMA 1
SP 1: -87.5
SP 2: 1.0
LEN: 88.6
-9.0
238
0 /3
A
10cm
kV 130

Preparing for the CT Scan

-Wear comfortable clothing to your exam. You may be given a gown to wear during the scan.

-Metal objects including jewelry, eyeglasses, dentures and hairpins may affect the CT images and should be removed prior to your exam.

-You may be asked not to eat or drink anything for several hours before your scan, especially if a contrast material will be used in your exam.

-You should inform your physician of any medications you are taking and if you have any allergies, especially to contrast materials.

-Also inform your doctor of any recent illnesses or medical conditions, and if you have a history of heart disease, asthma, diabetes, kidney disease or thyroid problems.

-Please bring a list of your current medications: prescriptions, over the counter medications, and vitamins.

-Women should always inform their physician or technologist if there is any possibility that they are pregnant.

-If your infant or young child is having a spiral CT, there are measures that can be taken to ensure that the test will not cause anxiety for either the child or pare

Indications

A. Primary Indications

1. Acute head trauma
2. Suspected acute intracranial hemorrhage
3. Follow-up for known intracranial hemorrhages
4. Detection or evaluation of calcification
5. Postoperative evaluation following intracranial surgery
6. Mental status change ,including drug toxicity
7. Headache
8. Acute neurologic deficits ,including cranial nerve dysfunction and ataxia
9. Intracranial infection
10. Hydrocephalus
11. Congenital skull and brain lesions
12. Suspected mass or tumor and increased intracranial pressure
13. Skull lesions (fibrous dysplasia, Paget disease, histiocytosis, osteolytic lesions, and skeletal tumors)
14. Seizures

B. Secondary Indications

(when MRI is unavailable or contraindicated, or if the supervising physician determines CT to be appropriate

1. Epilepsy
2. Neurodegenerative disease
3. Developmental delay
4. Evaluating psychiatric disorder

patient position

supine with their arms by their side

scout

C2 to vertex

scan extent C2 to vertex **scan direction**

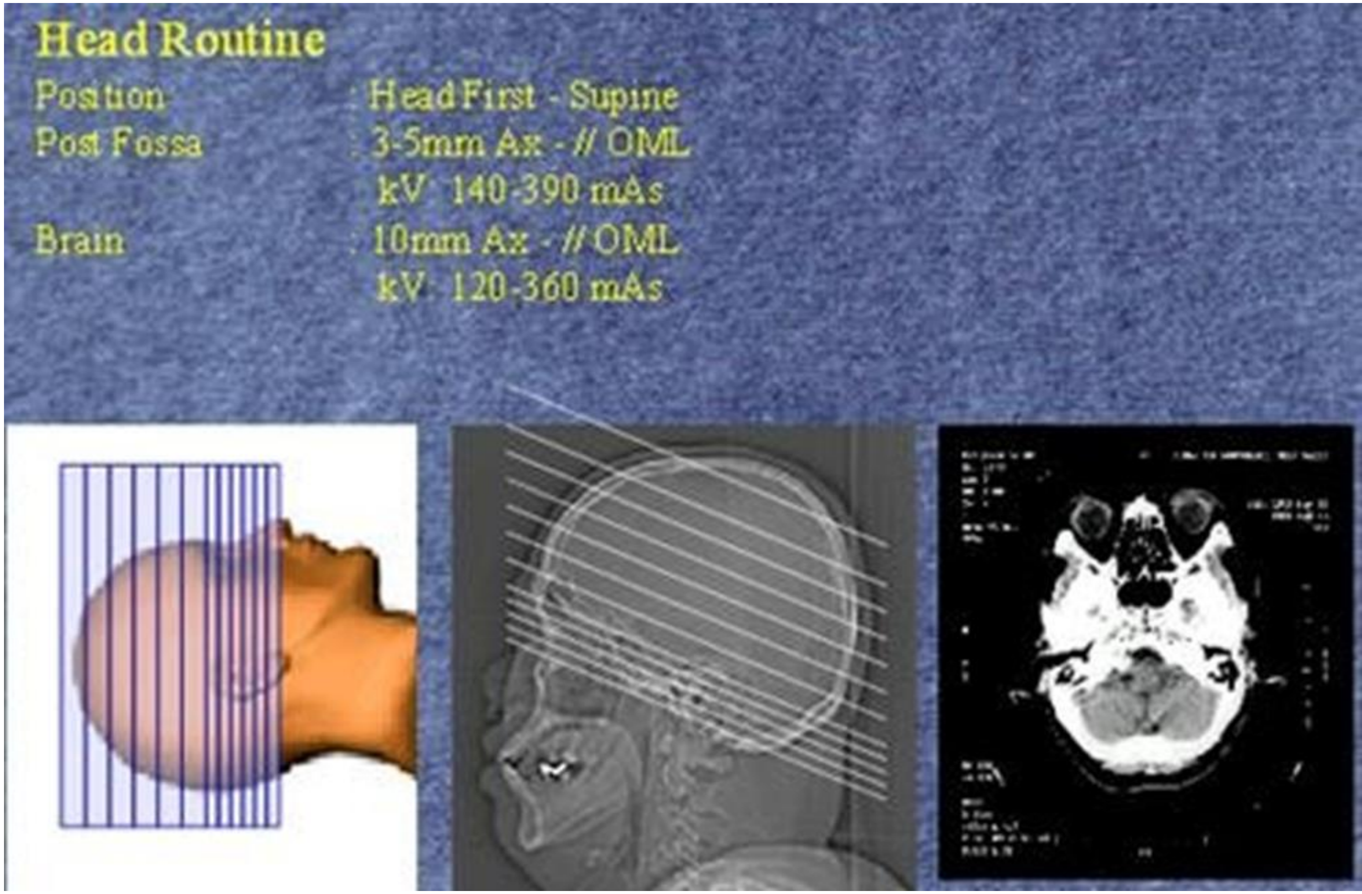
caudocranial

scan delay

minimal scan delay

respiration phase

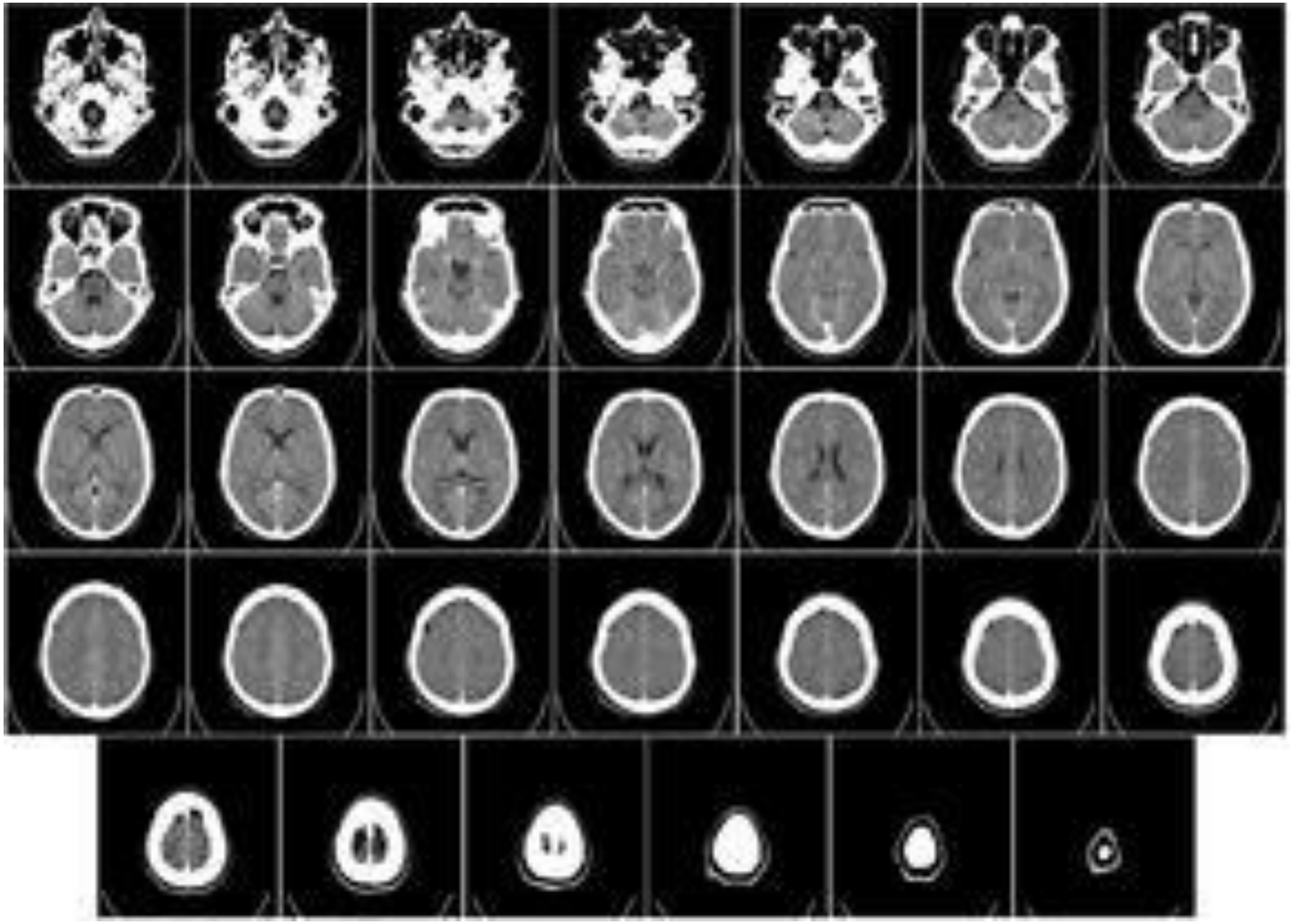
suspended



Brain Imaging

CT brain imaging may be performed with a sequential single- slice technique, multislice helical (spiral) protocol, or multidetector multislice algorithm

For CT of the brain, contiguous or overlapping axial slices should be acquired with a slice thickness of no greater than 5 mm (less for the posterior fossa). In addition to directly acquired axial images, reformatted images in coronal, sagittal, true axial, or other more complex planes may be constructed from the axial data set to answer specific clinical questions. Additionally, axial reconstructed images should be presented with at least two different windows, utilizing both a brain/soft tissue and bone window.



Intravenous contrast medium

A plain unenhanced study always should be performed first.

IV contrast enhancement shows areas of blood–brain barrier breakdown within the brain, common indications are:

(a)When plain CT is abnormal and there is a reasonable expectation that enhancement may improve diagnostic accuracy

(b)when lesions are suspected close to the skull base or in the posterior fossa (this includes pituitary and imaging for visual failure)

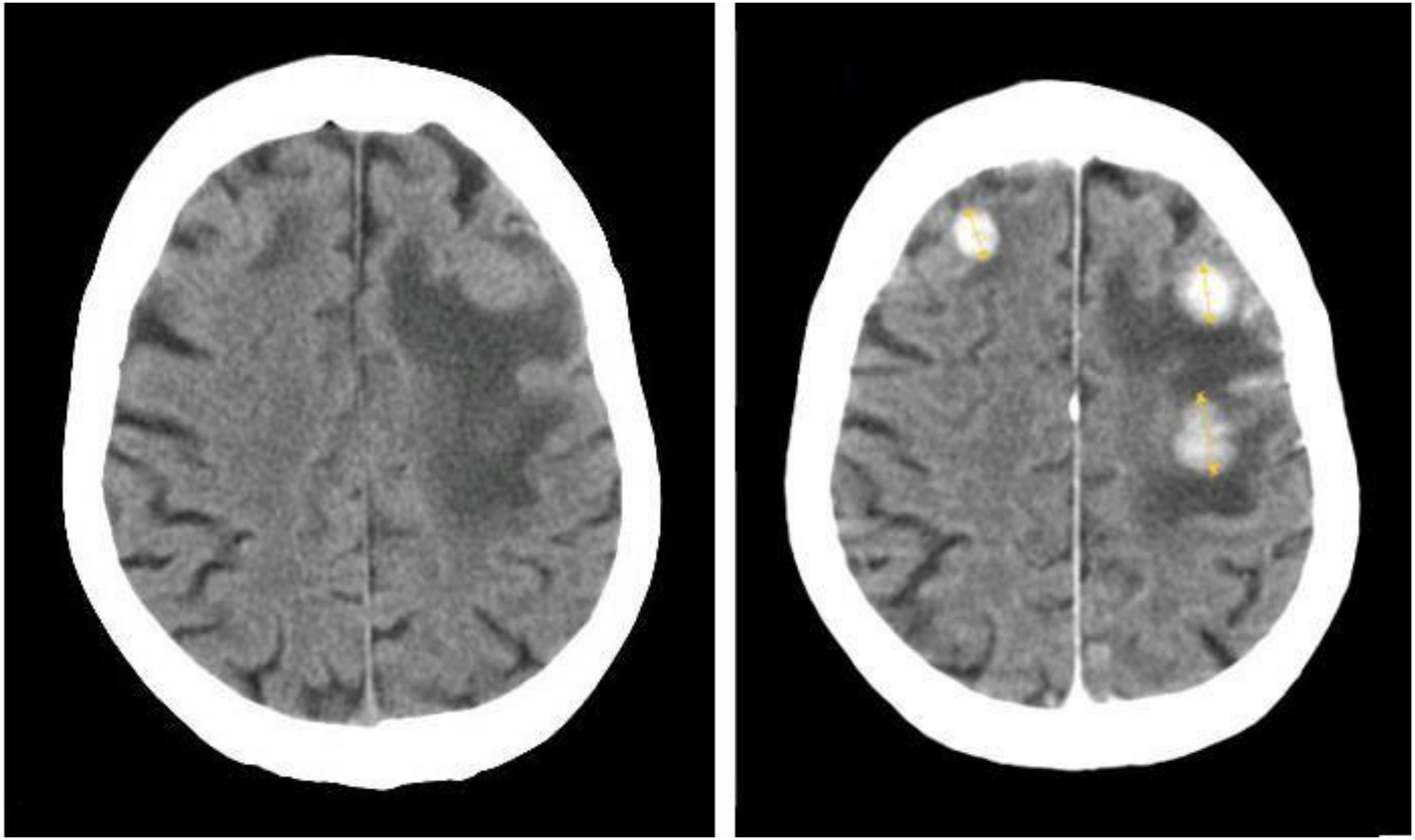
(c) When staging for carcinomas known frequently to metastasize to the brain

(d) When suspecting focal intracranial infections

(e) When meningeal disease is suspected such as may be caused by metastases.

An IV injection of iodinated contrast medium, at dose equivalents of 15–30 g of iodine generally are given; some clinics use two or even three times that dosage.

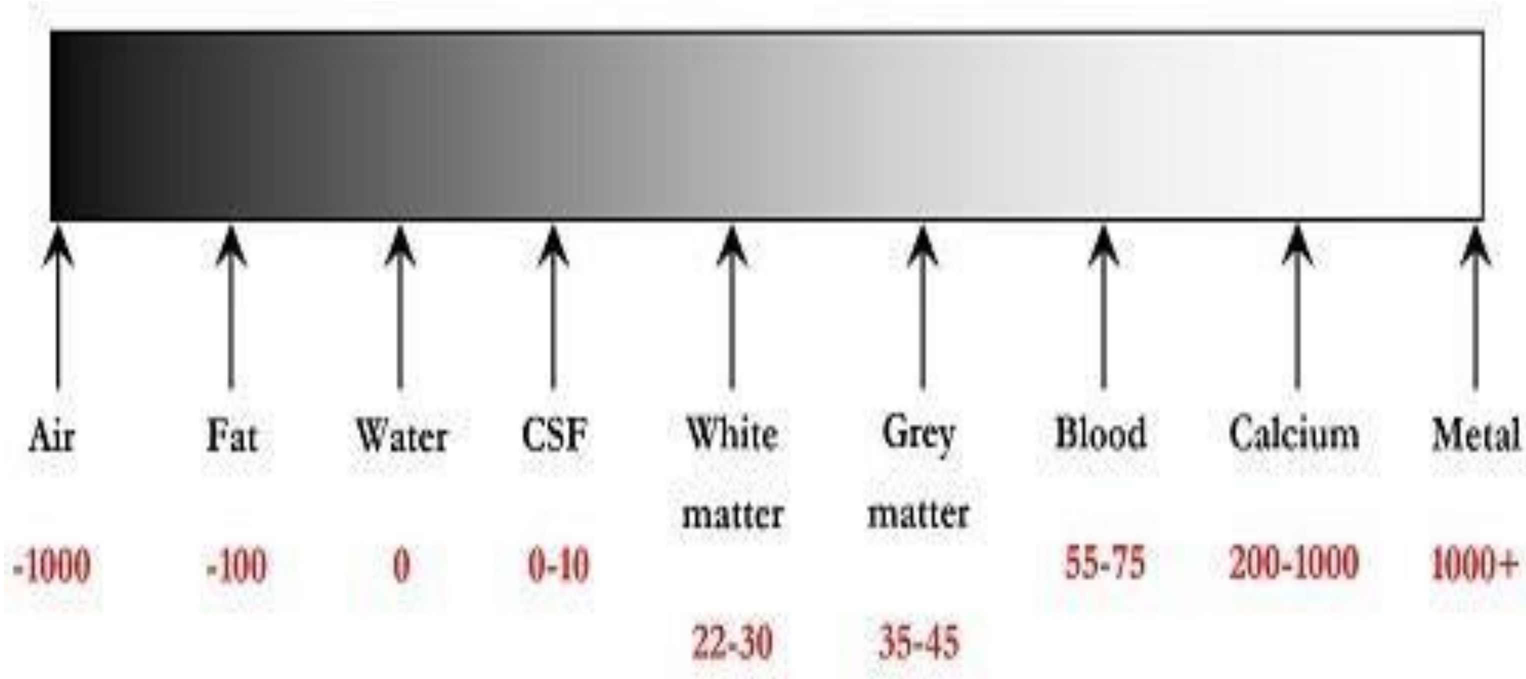
Most units now prefer to inject through indwelling cannulae rather than ordinary needles, so that IV access is assured in case an adverse reaction occur.



Interpreting CT images

CT images are displayed as varying shades of grey based on the characteristic absorption (or attenuation) patterns that different tissues exhibit when exposed to ionizing radiation.

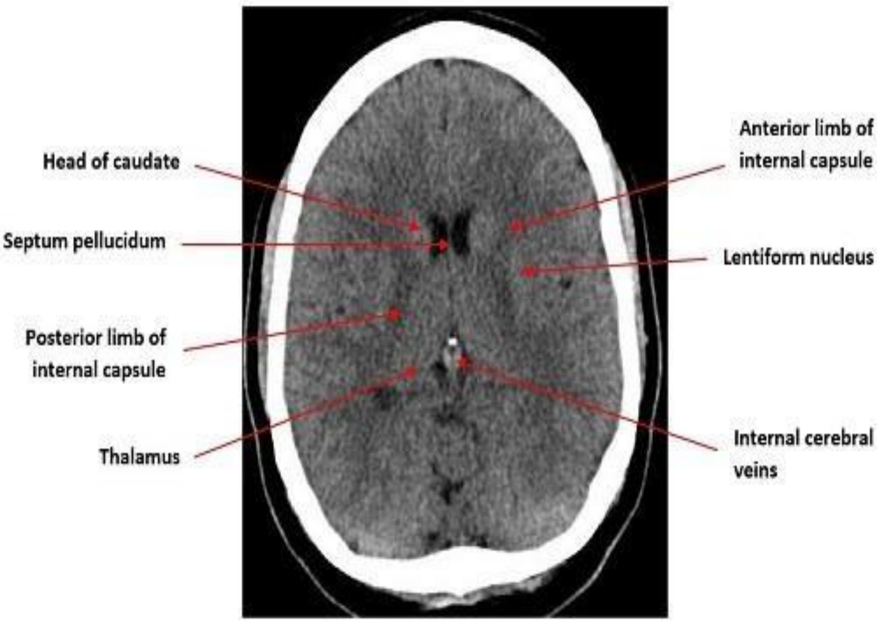
The Hounsfield Unit (HU) is an arbitrary scale which is used to display the range of tissue densities when viewing a CT scan. The scale ranges from –1000 to +1000 with water by convention designated the value of 0. The higher the HU, the brighter (or denser) the tissue displayed .

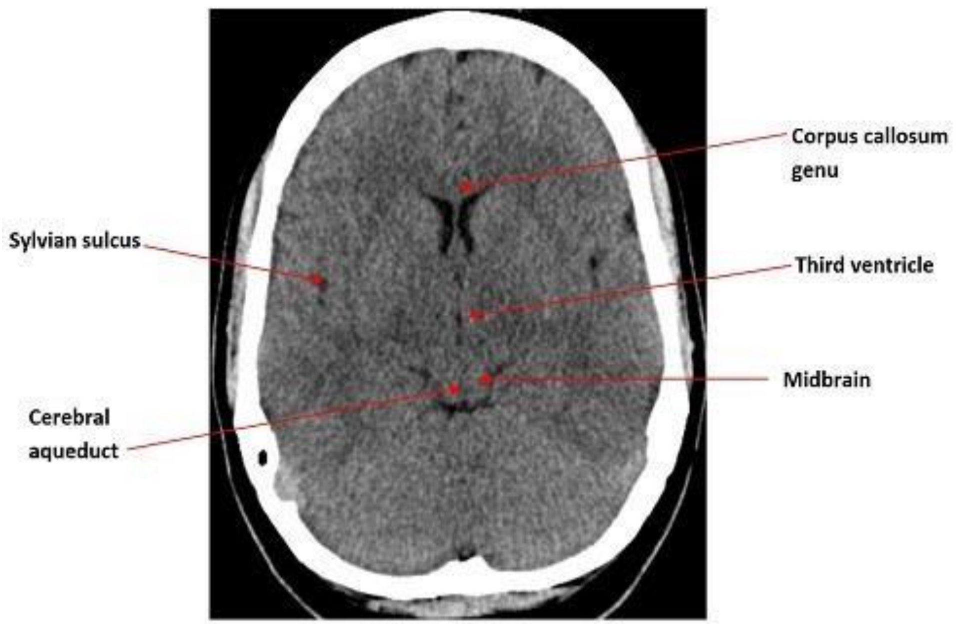


Neuroanatomy

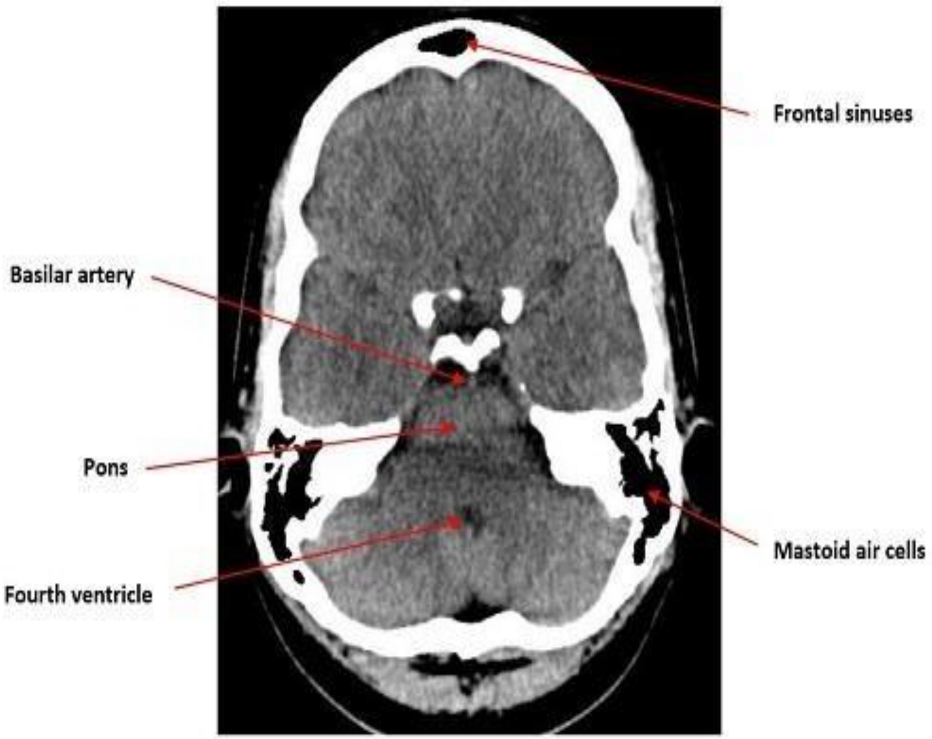
The below CT axial slices highlight common anatomical structures which are helpful to know when interpreting a CT Brain scan. The following images are representative axial slices through the normal brain proceeding inferiorly from the most superior
axial slice

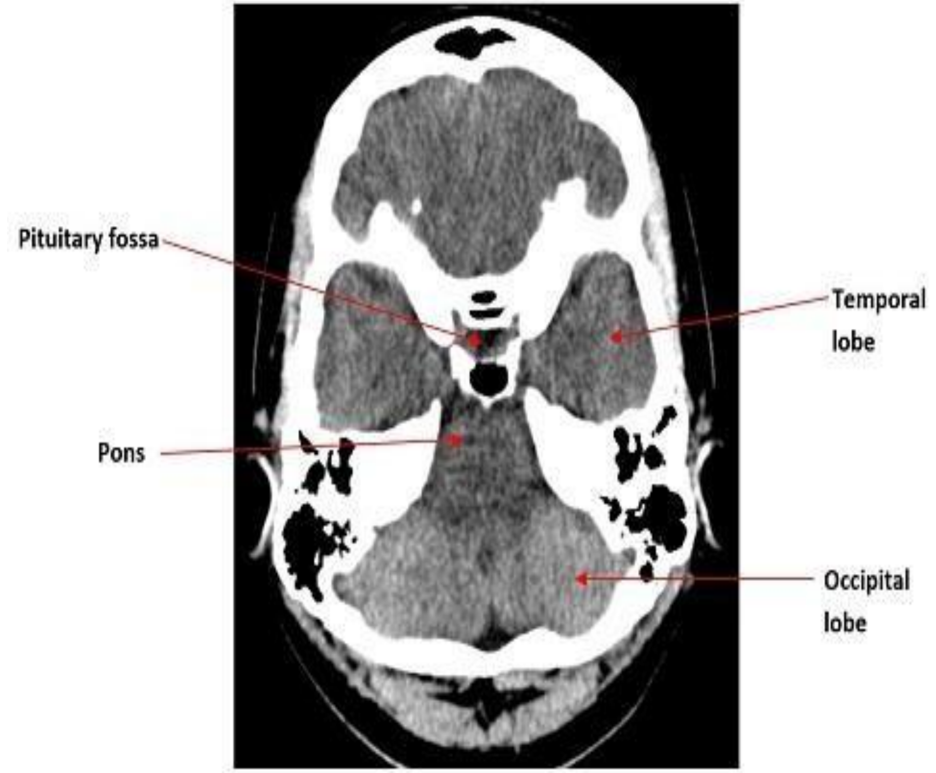
Axial CT slice at the level of the lateral ventricles





Axial CT slice at the level of the pituitary fossa





The importance of windowing

W indow settings are used to aid detection of pathologies involving the brain substance (e.g. infarcts), skull vault (e.g. fractures) or soft tissues (e.g. haematomas).

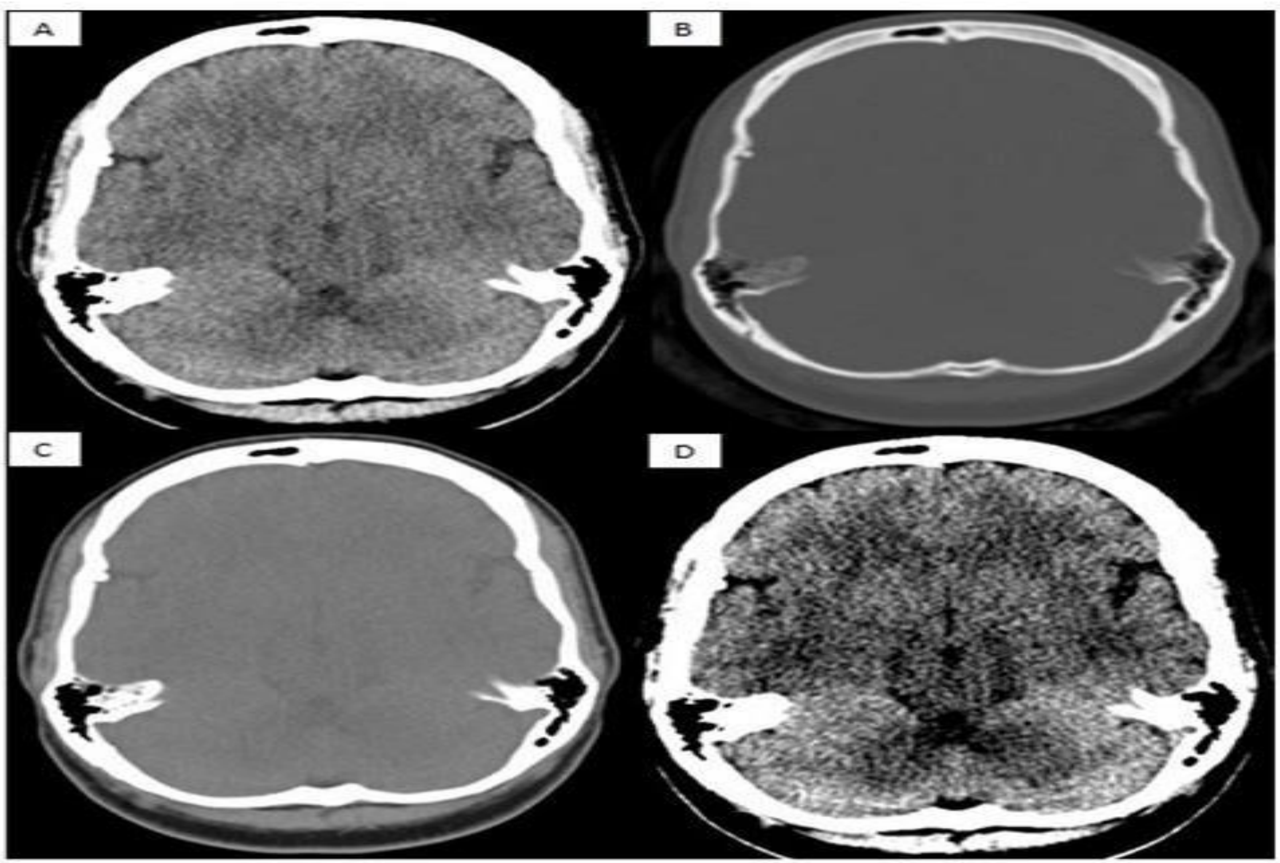
W indow settings are described in terms of window width (WW) and window level (W L). These values are typically displayed on the computer screen.

WW is the range of HU displayed and WL is the HU in the centre of the window width.

Let’s take an example: A typical stroke window setting is WW 40 and WL 40. This means that a total range of 40 HU is displayed, centred on a density of 40 HU. Therefore, the actual range of HU displayed is 20 to 60 HU).

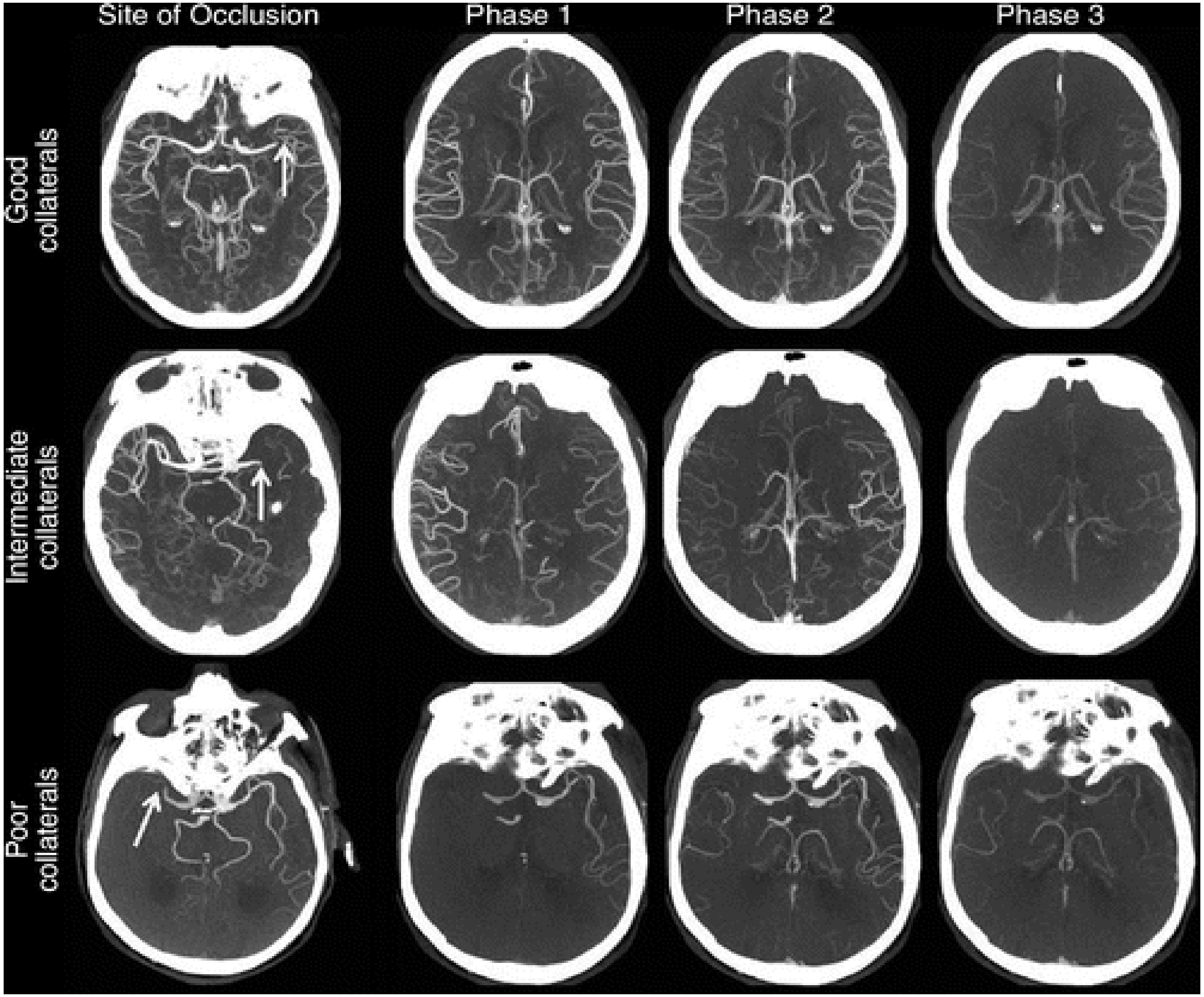
Altering the window settings helps reduce the range of HU displayed. This in turn helps to maximise the pickup rate of different pathologies

Common window settings used when interpreting a normal CT Brain scan.
A: Brain window (WW 80, WL 40); **B**: Bone window (WW 3000, WL 500);
C: Soft tissue window (WW 260, WL 80); **D**: Stroke window (WW 40, WL 40).



CT angiography of the cerebral arteries

CT angiography of the cerebral arteries (also known as a **CTA carotids** or an **arch to vertex angiogram**) is a noninvasive technique allows visualization of the internal and external carotid arteries and vertebral arteries and can include just the intracranial compartment or also extend down to the arch of the aorta. The overarching goal of this examination is an optimal enhancement of the carotid arteries with little to no venous component; the technical aspect of the examination will vary from site to site.


Site of Occlusion
Phase 1
Phase 2
Phase 3
Good collaterals
Intermediate collaterals
Poor collaterals

Indications

CTA of the cerebral arteries is indicated in a wide variety of clinical scenarios including:

1 ischemic stroke to detect occlusion and thrombosis

2 transient ischemic attack to detect carotid artery stenosis

3 subarachnoid hemorrhage for detection of aneurysms

4 cerebral parenchymal hemorrhage to assess for the presence of a vascular malformation or ongoing bleeding

The CTA of the cerebral arteries is performed to demonstrate the full patency of the cerebral arteries via contrast enhancement. It is important to time the scan as accurately as possible to ensure maximal opacification and decrease venous contamination

Technique

patient position

supine with their arms by their side

scout

mid-chest to vertex

scan extent

aortic arch to vertex

scan direction

caudocranial

contrast injection considerations / monitoring slice (region of interest)
descending aorta, **threshold** 100 HU, **injection** 50-75 ml of non-ionic iodinated contrast with a 100 ml saline chaser at 4.5/5 ml/s

scan delay

minimal scan delay

respiration phase

suspended

Post-processing

CTA images are usually presented as axial and coronal and/or sagittal multiplanar reformat of a variety of thicknesses depending on local preference.

Additional post-processing techniques include:

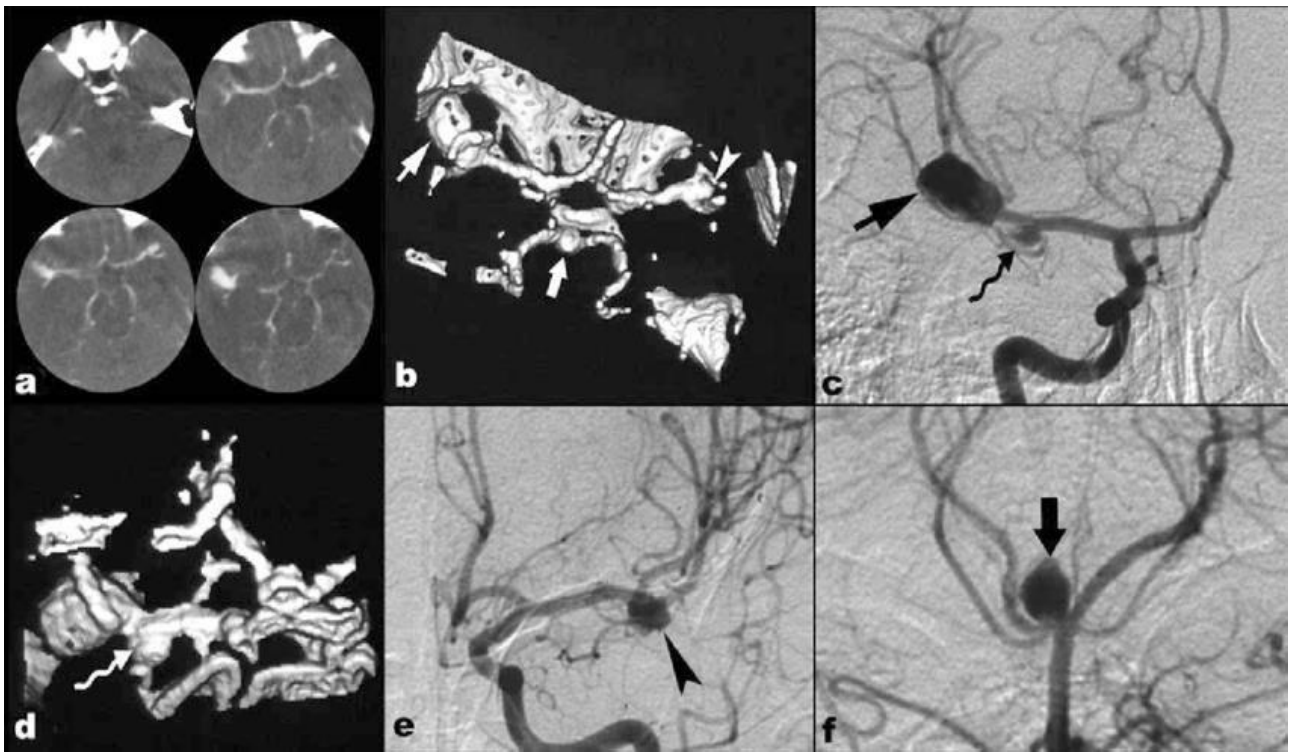
maximum intensity projection MIP: displays pixels with higher CT value

curved planar reformats: delineates the entire course of the vessel and can be used when the vessel is tortuous

shaded surface display volume rendering (SS-VRT): only the pixels above a user-defined threshold value are displayed as a 3D. It is used mainly for pre-operative planning

CT angiography of the cerebral arteries

a CľA souíce images. b Supeíioí SSD CľA íeconstíuction. d Posteíioí-infeíioí SSD CľA íeconstíuction. c,e,f DSA. Ruptuíed 15 mm iííegulaí aneuíysm (thin aííows on b, c, d) of the íight MCA M2 segment. Incidental aneuíysms aíe noted at the tip of the basilaí aíteíy (thick aííows on b, f), M2 segment of the left MCA (aííowheads on b,e) and at the distal paít of M1 segment of the íight MCA (wavy aííows on c, d



CT cerebral venography

(also known as a **CTV head** or **CT venogram**) is a contrast-enhanced examination with an acquisition delay providing an accurate detailed depiction of the cerebral venous system.

Indications

A CT venogram is obtained where anatomy and patency of the cerebral veins is required. It is an alternative to MR venography.

Indications include the diagnosis of cerebral venous thrombosis and preoperative anatomy particularly for posterior fossa surgery where the sigmoid sinuses may be compressed (e.g. retrosigmoid craniotomies)

The purpose of this exam is to visualize the cerebral veins and venous sinuses filled with contrast opacified blood, allowing their anatomy and patency to be assessed.

Technique

patient position

supine with their arms by their side

scout

CT to the vertex

scan extent

CT to the vertex

scan direction

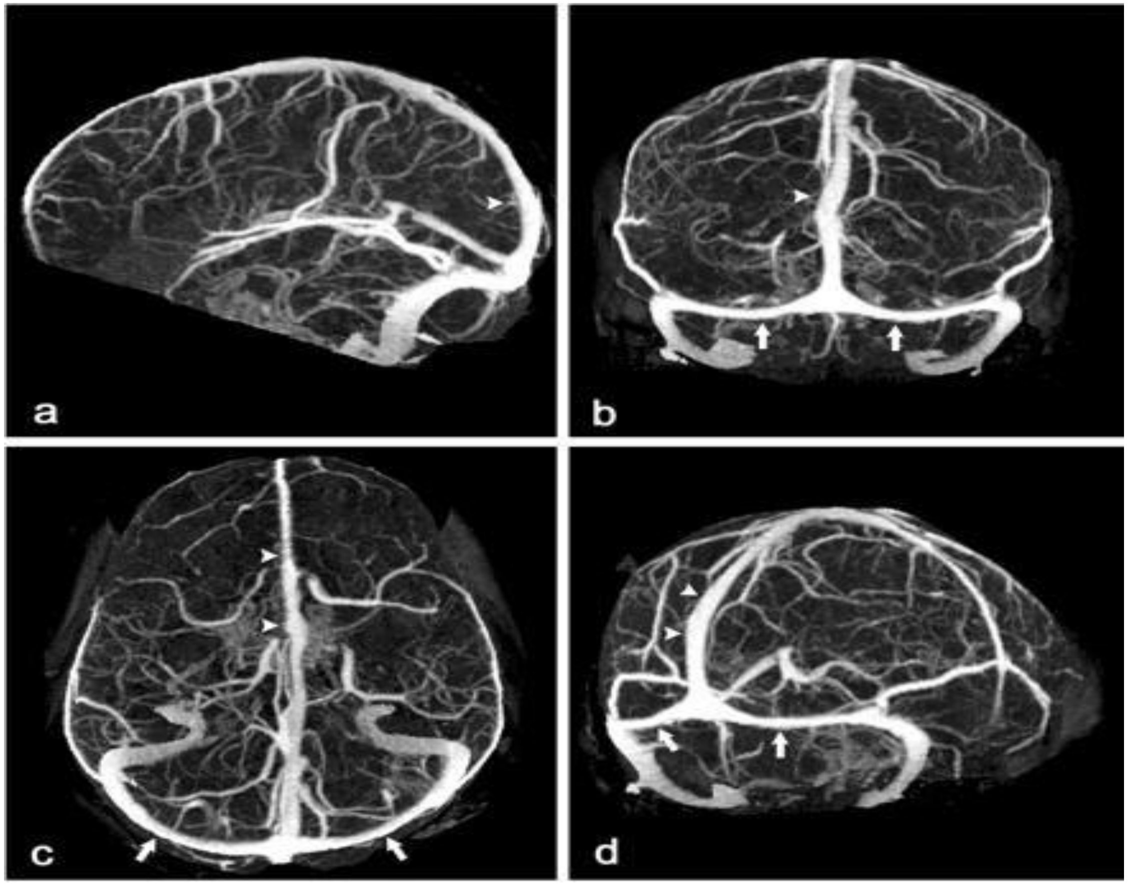
caudocranial

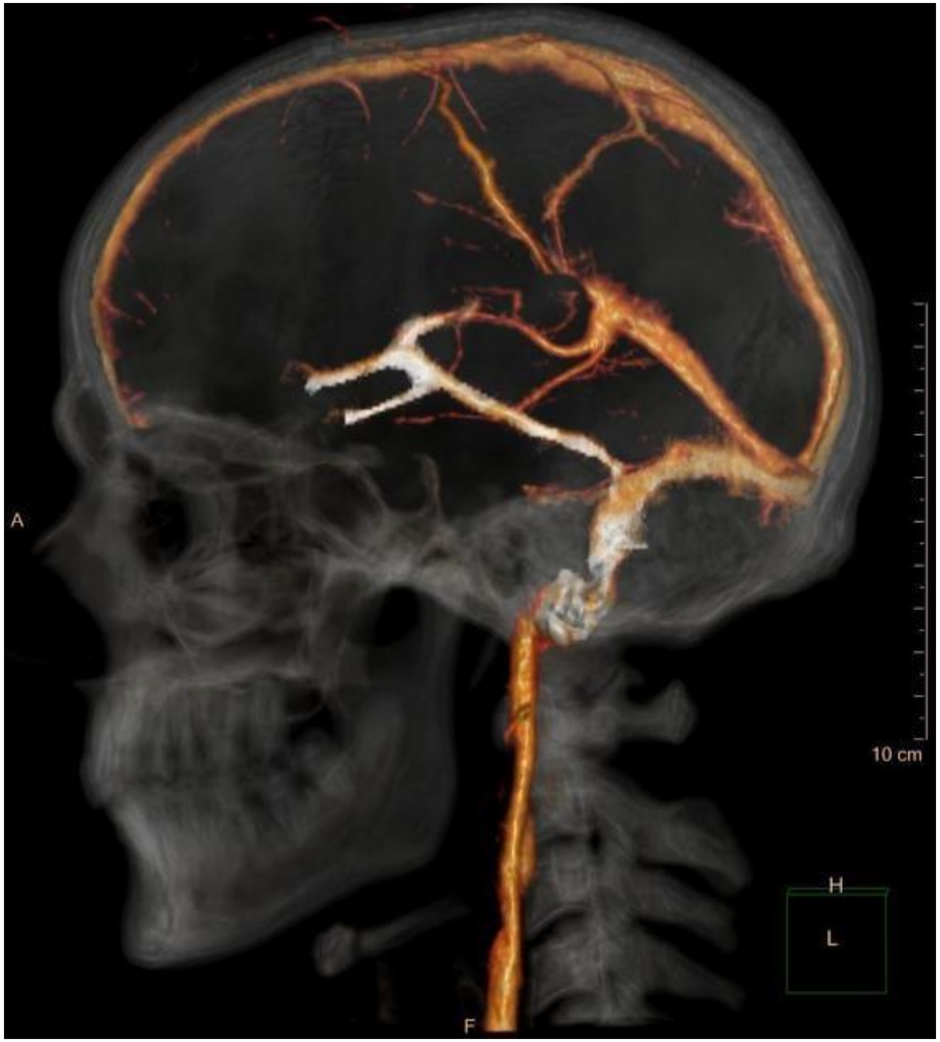
contrast injection considerations injection

75-100 ml of non-ionic iodinated contrast

scan delay
45 seconds
respiration phase
suspended

MR venography.




A
10 cm
H
L
F

Ischemic stroke

Non-contrast CT of the brain remains the mainstay of imaging in the setting of an acute stroke. It is fast, inexpensive and readily available. Its main limitation, however, is the limited sensitivity in the acute setting.

The goals of CT in the acute setting are:

1 exclude intracranial hemorrhage, which would preclude thrombolysis

2 look for any "early" features of ischemia

3 exclude other intracranial pathologies that may mimic a stroke, such as a tumor

CT Stroke Stages

Immediate

The earliest CT sign visible is a hyperdense segment of a vessel, representing direct visualization of the intravascular thrombus/embolus and as such is visible immediately . Although this can be seen in any vessel, it is most often observed in the middle cerebral artery (hyperdense middle cerebral artery sign.

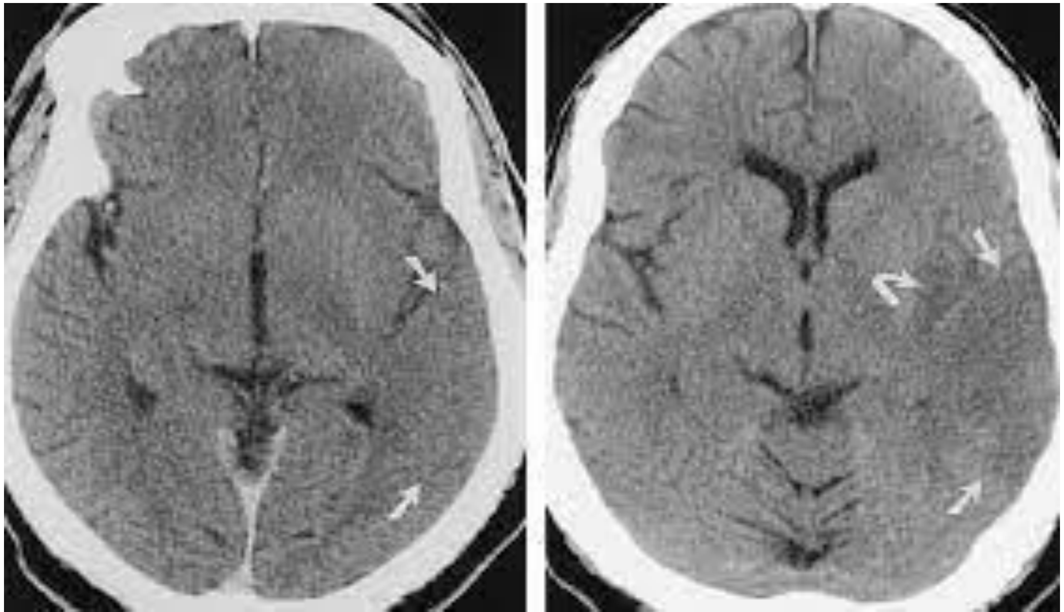
Early hyperacute

Within the first few hours, a number of signs are visible depending on the site of occlusion and the presence of collateral flow. **Early features include**:

loss of grey-white matter differentiation, and hypoattenuation of deep nuclei.

cortical hypodensity with associated parenchymal swelling with resultant gyral effacement

Visualization of loss of grey-white matter differentiation is aided by the use of a stroke window

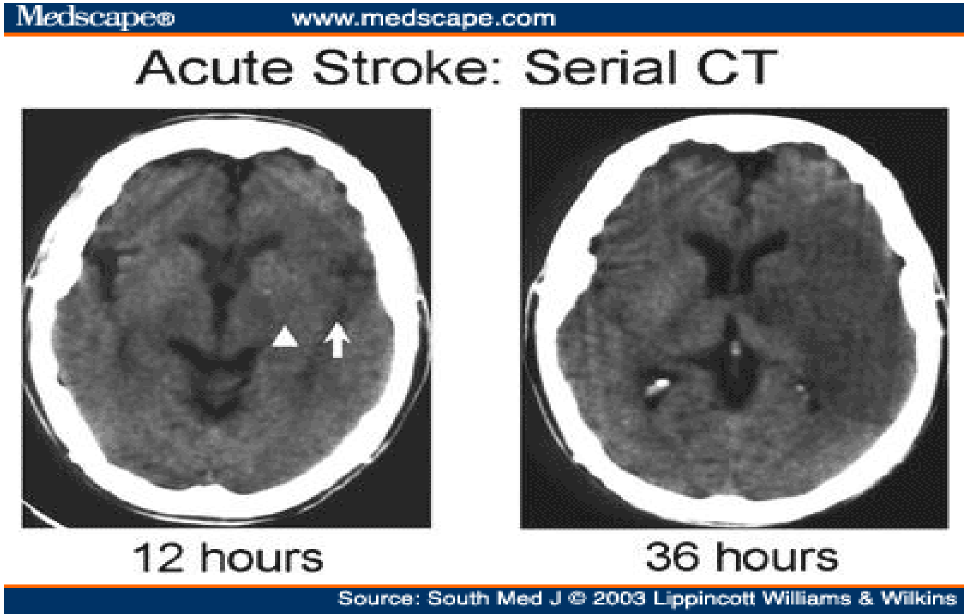


Acute

With time the hypoattenuation and swelling become more marked resulting in a significant mass effect. This is a major cause of secondary damage in large infarcts.

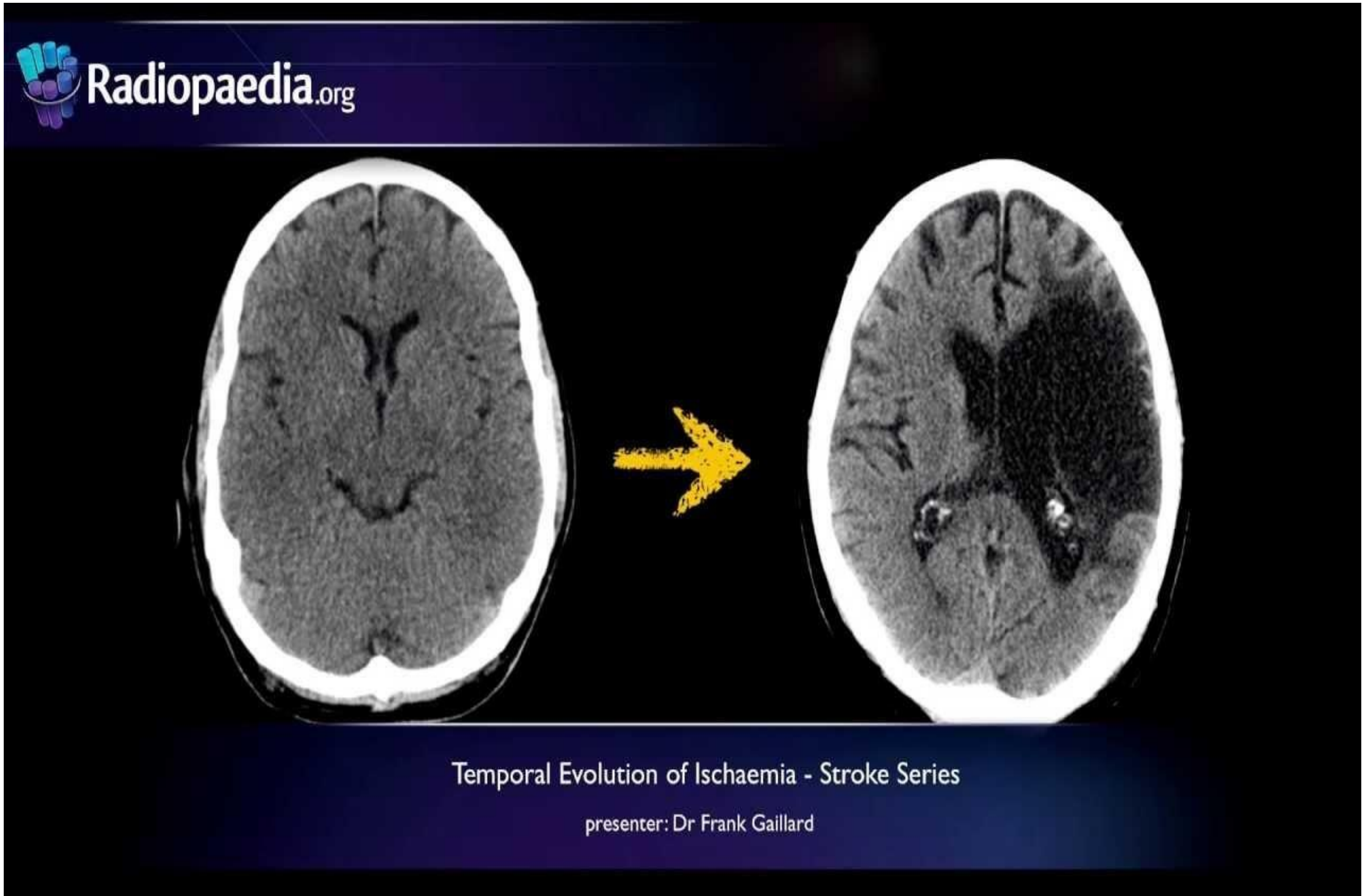
Subacute

As time goes on the swelling starts to subside and small amounts of cortical petechial hemorrhages (not to be confused with hemorrhagic transformation) result in elevation of the attenuation of the cortex.



Chronic

Later still the residual swelling passes,and gliosis sets in eventually appearing as a region of low density with negative mass effect.



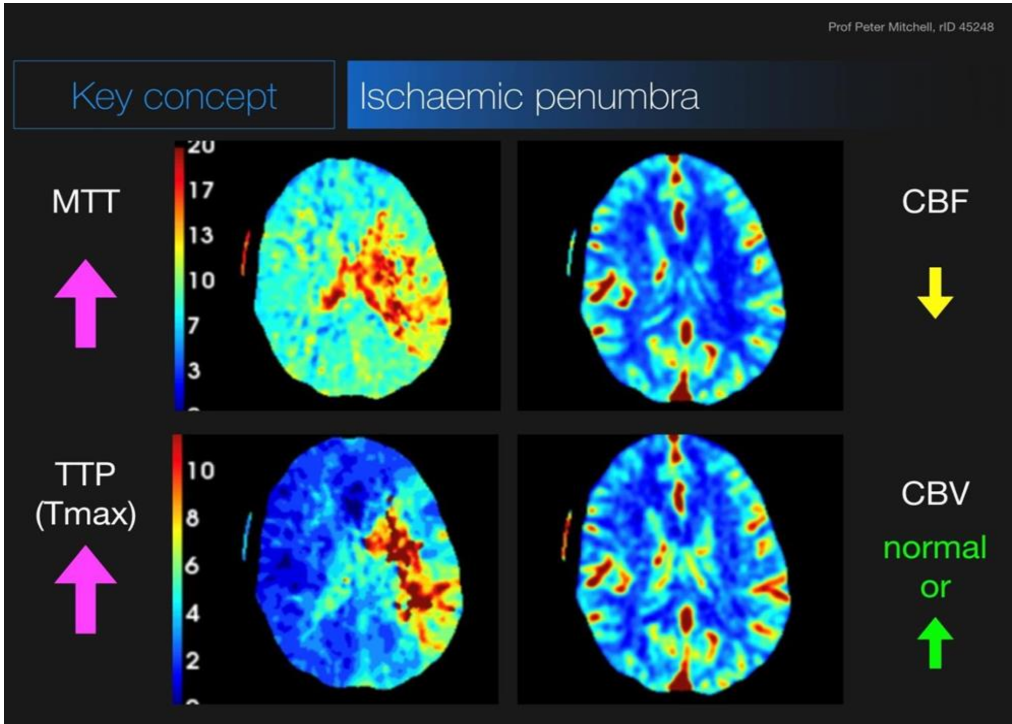
CT perfusion in ischemic stroke

It enables differentiation of salvageable ischemic brain tissue (the penumbra) from the irreversible damaged infarcted brain (the infarct core). This is useful when assessing a patient for treatment (thrombolysis or clot retrieval).

The key to interpreting CT perfusion in the setting of acute ischemic stroke is understanding and identifying the infarct core and the ischemic penumbra, as a patient with a small core and a large penumbra is most likely to benefit from reperfusion therapies

The infarct core is the part of the ischemic brain which has already infarcted or is going to infarct regardless of therapy.

. The ischemic penumbra, which in most cases surrounds the infarct core



CTangiography

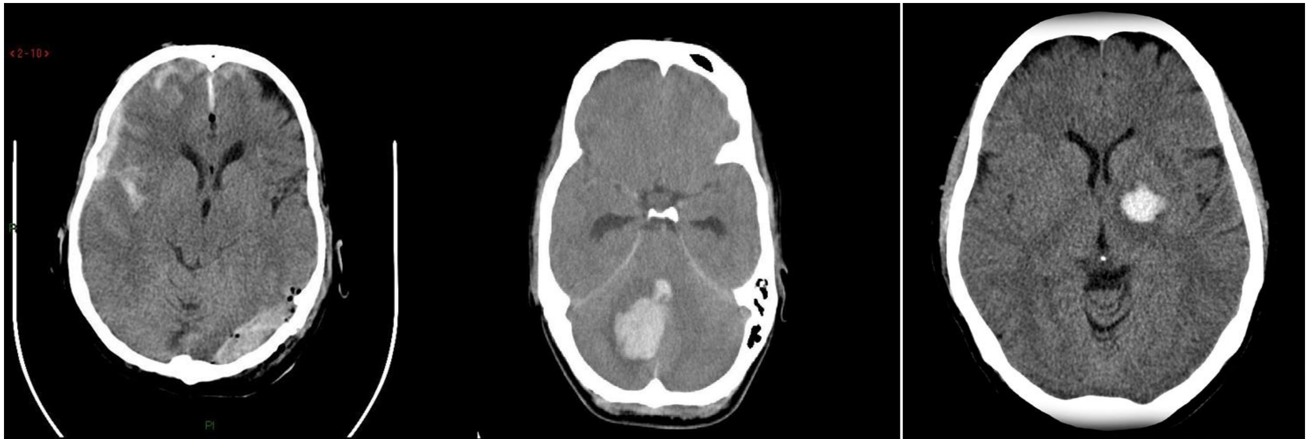
1 may identify thrombus within an intracranial vessel, and may guide intra-arterial thrombolysis or clot retrieval

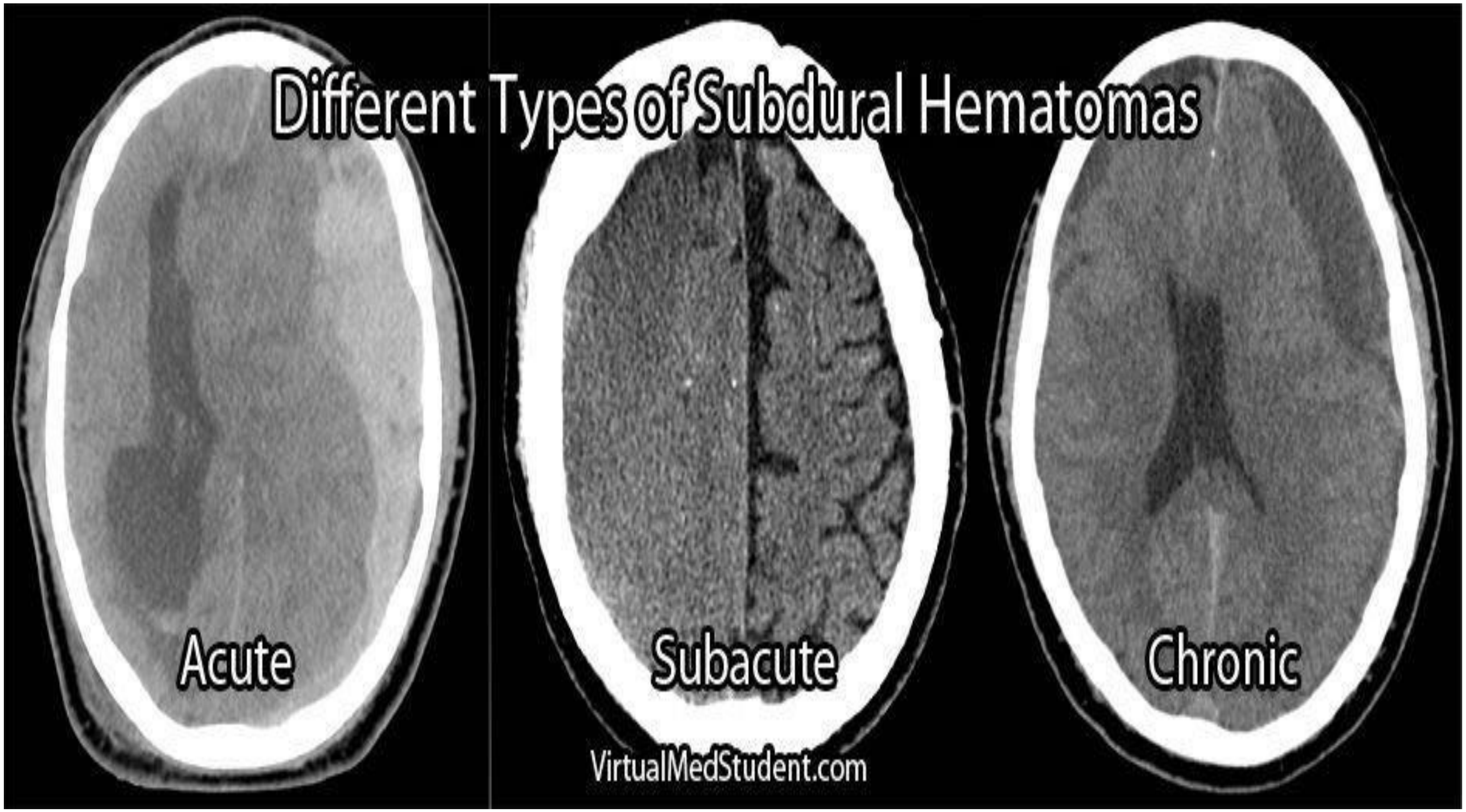
2 evaluation of the carotid and vertebral arteries in the neck to establishing stroke etiology or assess endovascular access

3 maybe necessary prior to thrombolysis in pediatric stroke cases

Intracranial hemorrhage

- **CT** scan is almost always the first imaging modality used to assess patients with suspected intracranial hemorrhage. Fortunately, acute blood is markedly hyperdense compared to brain parenchyma, and as such usually poses little difficulty in diagnosis (provided the amount of blood is large enough, and the scan is performed early).
- CT angiography (CTA) is increasingly used to assess for a vascular underlying cause, particularly in cases of subarachnoid hemorrhage, or intraparenchymal hemorrhage where something in the presentation, demographics of the patient, or location/appearance of bleed make a primary hemorrhage less likely.
- Similarly, CT venogram (CTV) can be used to reliably assess for patency of the dural venous sinuses.




Different Types of Subdural Hematomas
Acute
Subacute
Chronic
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