# Head CT Scan Interpretation:
# A Five-Step Approach to Seeing Inside the Head

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**Five Step Approach**

1. Adequate study
2. Bone windows
3. Ventricles
4. Quadrigeminal cistern
5. Parenchyma

**Step 1: Assuring an Adequate Study**

- Correct patient/scan
- Square in the scanner
- Contrast or not
- Correct slice thickness
- Correct number of slices

**Step 2: Bone Window interpretation**

- Soft tissue swelling or lacerations
- Fractures
- Pneumocephalus
- Sinuses
- Scout film

**Step 3: Assessment of the Ventricles**

- Size
- Shape
- Spatial relationship
- Symmetry
- Blood

**Step 3: Assessment of the Ventricles**

- Lateral ventricles – frontal horns
- Lateral ventricles – occipital horns
- Lateral ventricles – temporal horns
- Third ventricle
- Fourth ventricle

**Step 4: Quadrigeminal cistern**

- Location
- Identification
- Significance
- Effacement
- Blood

**Step 5: Parenchyma**

- Midline shift
- Symmetry
- Blood
- Edema
- Ischemia
- Tumor

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**Step 1: Assuring an adequate study**

- Correct patient/scan
  - Make correct decisions on correct information
  - Looking at the wrong scan happens when you are busy or complacent
  - Every slice should have demographic information
- Square in the scanner
  - Symmetry is important in the evaluation of ventricles and parenchyma
  - A head tilted in the scanner may cause structures to appear asymmetric
  - Ocular lenses are 10mm in size and should be in the same cut
- Contrast or not
  - Contrast does not cross intact blood brain barrier
  - Appears white (radiodense)…so does acute bleeding
  - Rarely given in Emergency Department patients
  - If administered, the type and amount will be indicated on every slice
- Correct slice thickness

    - The thinner the slice, the less artifact, particularly in small spaces
    - No more than 5mm thick for entire scan in children
    - No more than 5mm thick in the posterior fossa in adults
    - No more than 10mm thick above the tentorium in adults
- Correct number of slides
    - Foramen magnum to apex of skull
    - Most superior cut should be only bone
    - Apical subdural hematoma

**Step 2: Bone Window interpretation**

- Important in trauma patients
- Performed often in 2.5mm cuts
- Soft tissue swelling or lacerations
    - May see underlying brain injury on corresponding parenchymal windows
    - May see underlying skull fracture
- Fractures
    - Linear
    - Depressed
    - Diastatic
    - Basilar
    - Comminuted
    - Open
    - May see underlying brain injury on corresponding parenchymal windows
- Pneumocephalus
    - Best seen on bone windows
    - Air appears black
- Sinuses
    - Evaluate paranasal sinuses for air-fluid levels or masses
    - Evaluate the mastoid air cells for fluid
    - A "free" sinus series
- Scout film
    - Used to align the CT gantry – hard palate is reference structure at VUMC
    - Look for linear fractures
    - Look for foreign bodies
    - Look for post-surgical defects

**Step 3: Assessment of the Ventricles**

- Size
    - Focal enlargement due to encephalomalacia
    - Diffuse enlargement
        - Hydrocephalus – effacement of sulci
        - Atrophy – prominence of gyri and sulci
    - Effacement (compression) may be due to edema, bleeding, or mass
- Shape
    - May be affected by edema, bleeding, mass or increased ICP
- Spatial relationship

    - Should be in correct relationship to the midline
    - May be affected by edema, bleeding, mass, or increased ICP
- Symmetry
    - Affected by head position in scanner
    - Affected by edema, bleeding, mass, increased ICP
- Blood
    - Most often from rupture of subependymal veins
    - May be from reflux of aneurysmal subarachnoid bleeding
    - May be from extension of an intraparenchymal bleed
    - Intraventricular blood increases risk of developing hydrocephalus
    - Do not confuse choroid plexus with blood

**Step 3: Assessment of the Ventricles**

CSF spaces within the brain

- Lateral ventricles – *frontal horns*
    - Located above tentorium
    - Shaped like backward parentheses “)(“
- Lateral ventricles – *occipital horns*
    - Located above tentorium
    - Contains choroid plexus
    - Dependent position when patient is supine – may collect blood
- Lateral ventricles – *temporal horns*
    - Located within the temporal lobes
    - Narrow “L-shaped” structures
    - Sensitive for detecting hydrocephalus
- Third ventricle
    - Located at the level of the pineal gland
    - Single, midline, slit-like structure
    - Makes and exclamation point “!” with the pineal gland
    - Effacement is sensitive finding for early edema, or small bleed
- Fourth ventricle
    - Located below the level of the tentorium in the posterior fossa
    - Oval or “pith-helmet” shaped
    - Infrequently has blood
    - Infrequently is effaced or displaced from midline

**Step 4: Quadrigeminal cistern**

- Location
    - Located within 2 cuts superiorly of the dorsum sella
- Identification
    - Find dorsum sella and count superiorly 2 cuts
    - Quadrigeminal cistern should be found within 2 cuts
    - If not seen, suspect effacement
- Significance
    - Located at the level of the tentorium
        - Effacement suggests herniation syndrome

        - Sensitive to clinical presentation
    - Located in proximity of the Circle of Willis
        - 80% of spontaneous SAH are due to aneurysm
        - Aneurysmal hemorrhage will fill cistern with blood
- Effacement
    - May be effaced by mass, increased ICP, blood, edema
- Blood
    - Sudden onset of headache with blood in the quadrigeminal cistern suggests aneurysmal bleeding
    - Blood in the quadrigeminal cistern and subsequently other ventricles may result in hydrocephalus

**Step 5: Parenchyma**

- Midline shift
    - May occur from edema, mass, blood, intracranial pressure, infarction
    - Midline shift should prompt careful examination for serious disease or injury
    - Midline structures
        - Falx cerebri
        - Septum pellucidum
        - Third ventricle
        - Pineal gland
        - Fourth Ventricle
- Symmetry
    - Correspondence in size, form, and arrangement of parts on opposite sides of a plane
    - Normal hemispheres should be relatively symmetric
    - Asymmetry should prompt careful examination for serious disease or injury
- Blood
    - Extra-axial: Does not arise from the brain itself
        - Epidural hematoma
            - Typically due to arterial injury
            - Middle meningeal artery
            - Biconvex or “lens” shaped
            - Usually acute or hyperdense (white) in appearance
            - Will cross midline
            - Will not cross suture lines
        - Subdural hematoma
            - Typically due to injury of bridging veins
            - May be spontaneous in elderly
            - Crescent shaped
            - Will cross suture lines
            - Will not cross mid line except in the posterior fossa
            - Radiographic density depends on age

        - Acute (0-24 hours) – white
        - Subacute (4-6 days) – gray
        - Chronic (11-14 days) – black
    - Location
        - Typically along convexities
        - May be trans-falcine
        - May be trans-tentorial
- Subarachnoid hemorrhage
    - Spontaneous
        - Aneurysmal – quadrigeminal cistern
        - Sylvian fissure
        - "Crab of death"
        - AV malformation
    - Traumatic
        - Often seen adjacent to SDH or EDH
        - Along convexities
        - Interdigitates into sulci
- Intraparenchymal
    - Contusion
        - Ill-defined areas of petechial hemorrhage
        - Superficial cortex
        - Underlying white-matter is spared
        - May be coup or contracoup
        - Seen in frontal and temporal areas
        - Temporal lobe contusions may cause herniation
    - Shear hemorrhage
        - Seen at the gray-white matter interface
        - Due to rotational acceleration-deceleration injuries
        - Sign of axonal injury
        - Frontal and temporal lobes
        - Usually a few millimeters to a centimeter in size
    - Parenchymal bleed
        - Rupture of deep perforating vessels
        - Hypertension – in area of basal ganglia
        - Tumor
        - Infarction
        - Coagulopathy
        - Illicit substance related

- Edema
    - Localized
        - Vasogenic
            - Ill-defined hypodensity of white matter
            - Spares gray matter
            - Disruption of blood brain barrier
            - Surrounds tumors

                - Surrounds infection
                - Surrounds late-stage infarctions
                - Surrounds bleeds
            - Cytotoxic
                - Occurs within minutes after onset of ischemia
                - Due to disruption of cellular function
                - Cellular edema
        - Diffuse
            - Loss of gray-white matter differentiation
            - Effacement of basilar cisterns
            - Loss of prominence of gyri
- Ischemia
    - Seen on CT in only 20-30% of patients
    - Earliest findings at 6-12 hours after insult
    - CT done to exclude ICB
    - MRI may see findings with 2 hours after insult
    - Findings
        - Hyperdense artery
        - Insular ribbon
            - Between Sylvian fissure and
            - Lentiform nucleus
        - Loss of in insular stripe due to cellular edema
        - Loss of gray-white differentiation
- Tumor
    - Ill-defined low-density appearance
    - Surrounding edema
    - Better defined by MRI