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Head CT Interpretation in the ED: The Complete Primer

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Case Presentation

67 y/o female who complains of intermittent headaches and dizziness over the past few months. Headaches previously controlled with Tylenol PRN, recently required several times/day. The patient presents today for an acute worsening of the headache two hours prior to arrival and difficulty walking without assistance.

On exam, BP176/94, P 65, RR 16, T 98.8, and pulse ox 93% saturation on RA. The patient was alert and conversive, slightly uncomfortable appearing. She had no abnormalities on physical exam with the exception that she was unable to ambulate without significant assistance secondary to an unstable gait, although the patient had no discrete weakness on extremity strength testing.

What, if any, imaging tests are indicated in the ED?

What things should be sought on an initial non-contrast head CT?

Key Clinical Questions and Learning Points

1. **When is a head CT scan deemed adequate for interpretation?**

   A scan is adequate if all structures necessary are seen to the best ability of the imaging equipment. The scan must be assessed for artifact, such as the scatter from dental hardware, aneurysm clips, bullets or other metal foreign bodies. All of these can obscure small areas of hemorrhage or ischemia. Motion must be minimized or slices repeated if possible. Motion can make it difficult to visualize acute ischemic changes and isodense structures such as subacute subdural hematoma. Significant artifact or motion results in an inconclusive reading.

2. **What findings can be present in acute ischemia?**

   Acute ischemia, such as that seen in acute stroke, often presents as an entirely normal head CT. Changes that may be present include loss or blurring of the gray-white interface, seen in the basal ganglia, thalamus or internal capsule. Loss of the “insular ribbon” in the temporal lobe is an early finding of cortical infarct in the MCA distribution, and is really another example of blurring of the grey-white interface by edema. Localized mass effect, seen as effacement of the sulci or asymmetry of the lateral ventricles can result as edema progresses and can finally develop to generalized mass effect and herniation, although this finding is typically later in progression. A hyperdense middle cerebral artery secondary to thrombus within the MCA can be seen at any point during acute ischemia, and this finding is usually reaffirmed by comparison of one side to the other.

3. **When assessing a CT with hemorrhage, what findings should be relayed to neurosurgery/neurology that may affect treatment and outcome?**

   The main things to assess for on the initial head CT that your neurosurgery/neurology colleagues will want to know and that affect the patient's treatment and outcome are location of hemorrhage, volume of hemorrhage, presence of intraventricular hemorrhage, mass effect or midline shift, evidence of herniation, and the presence of hydrocephalus.

4. **How is the quantity of ICH determined?**

   A simple method for determining the quantity of ICH is to multiply the largest perpendicular diameters of the hemorrhage by the total number of slices by the slice thickness, all divided by two (AxBxC/2). For example, a hemorrhage that measures 5 cm x 5 cm in a single axial slice and covers 6 consecutive 5 mm slices would be (5x5x3)/2, or 37.5 cc. Supratentorial volumes of less than 30 cc generally have better outcomes than volumes larger than this. Volumes greater than 60 cc are generally associated with a poor outcome.

5. **How does the appearance of a SDH change over time?**

   A hyperacute (<6 hrs) subdural hematoma can be either hypodense or hyperdense on CT, although acute (6 hrs – 3 days) subdural hematoma is generally hyperdense due to the presence of dense, clotted blood. Subacute subdural hematoma is generally isodense with brain, while chronic subdural is typically hypodense and may have septae present. In general, density by CT decreases with the age of the subdural.

6. **Describe the use of Hounsfield units and acute hemorrhage?**

   Hounsfield units (HU) describe relative densities of structures by CT. Water, by convention, is 0 HU, dense bone is 1000 HU and air is -1000 HU. Blood is 50 – 100 HU, averaging around 80 HU. Many CT software programs have the ability to determine the HU of specific small areas, and therefore support or help to refute suspicion for acute hemorrhage.

References

Barber PA DA, Zhang J, Buchan AM. Validity and reliability of a quantitative computed tomography score in predicting outcome of hyperacute stroke before thrombolytic therapy. Lancet 2000;355(9216):1670-4.

Sarkarati D, Reisdorff EJ. Emergent CT Evaluation of Stroke. Emergency Medicine Clinics of North America 2002;20:553-81.

Kothari RU, Brott T, Broderick JP, et al. The ABCs of Measuring Intracerebral Hemorrhage Volumes. Stroke 1996;27(8):1304-5.

Hemphill JC, III, Bonovich DC, Besmertis L, Manley GT, Johnston SC, Tuhrim S. The ICH Score : A Simple, Reliable Grading Scale for Intracerebral Hemorrhage Stroke 2001;32(4):891-7.

Jagoda AS, Cantrill SV, Wears RL, et al. Clinical policy: Neuroimaging and decisionmaking in adult mild traumatic brain injury in the acute setting. Ann Emerg Med 2002;40(2):231-49.

Patient Case Outcome

The patient's head CT in the ED documented a small parenchymal hemorrhage that was unusual in appearance for a primary ICH. The patient was admitted and underwent an MRI which documented hemorrhage into a small neoplasm, with other lesions that were cumulatively suspicious for metastases. Further work-up revealed an invasive carcinoma of the lung. The patient is currently undergoing chemotherapy and radiation with a guarded prognosis.