The Role of Computed Tomography in Diagnosis of a Stroke

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Introduction

- Computed Tomography (CT) is the most common imaging study done to diagnose a stroke.

- There are two types of stroke which include ischemic and hemorrhagic.

- Different CT examinations are done depending on the type of stroke.

- The three most common exams done include a noncontrast CT of the head, a CT angiogram of the head, and a CT perfusion study.

What Is A Stroke?

- "The World Health Organization defines stroke as rapidly developing clinical signs of focal or global disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause than that of vascular origin" (Cantangui, 2013, p. 240).

- "A stroke occurs when the blood flow to the brain is suddenly interrupted, depriving brain cells of oxygen and glucose and leading to further cell death" (Kakkar et al., 2021, p. 1).

Why Computed Tomography?

- CT is the preferred modality of choice when diagnosing a stroke because of the fast-paced abilities of a CT scan.

- Other advantages include its affordability, as well as wide availability.

- Compared to other modalities such as Magnetic Resonance Imaging (MRI), CT is still the preferred modality of choice for the reasons listed above.

- The results of a statistical analysis concluded that "A diagnostic imaging strategy of initial CT alone was noninferior to an initial CT with additional MRI with regard to clinical outcomes of death or dependence at hospital discharge or prevention of stroke or death at 1 year after discharge" (Frade et al., 2022, pp. 6-7).

Stroke Facts and Statistics

- "Stroke is the second leading case of death, and the third leading cause of disability in adults worldwide" (Campbell & Khatri, 2020, p. 129).

- "In the US, approximately 795,000 patients suffer a stroke each year" (Doig & Brown, 2022, p. 598).

- The fast-paced ability of a CT scan allows for quick diagnosis of a stroke, and rapid treatment.

Stroke Facts and Statistics (Cont.)

- o Delays in treatment can result in neurological damage, permanent disability, or death.
- o For every minute an ischemic stroke is untreated, patients lose an average of 1.9 million neurons in the affected brain area.

(Ferrara, 2020)

Hemorrhagic Stroke

- A hemorrhagic stroke is caused by a rupture in a blood vessel in or around the brain.

- When a blood vessel in the brain ruptures a bleed in the brain is now present.

- A way in which hemorrhagic strokes are classified, are based on the location of the hemorrhage.

- Four different categories include:
  - o Intracerebral
  - o Subarachnoid
  - o Subdural
  - o Epidural   (Kakkar et al., 2021)

- About 13% of strokes are hemorrhagic (Bendok & Naidech, 2012).

  - o Although a hemorrhagic stroke is less likely, they are considered more fatal when compared to an ischemic stroke (Ferrara, 2020).

Noncontrast Head CT (NCCT)

- A noncontrast image of the head is often the primary imaging study for the initial evaluation of patients with suspected hemorrhagic stroke.

- "A NCCT has nearly 100% specificity and sensitivity in detecting cerebral hemorrhage" (Ferrara, 2020, p. 452).

- A noncontrast image is best to detect a pool of blood because the color that indicates blood on a CT scan is bright white.

Figure 1: A right fronto-parietal hemorrhage seen on a noncontrast CT (Ferrara, 2020, p. 425).

Ischemic Stroke

- An ischemic stroke is due to a blockage in the blood vessels in the brain, thus interrupting blood flow.

- Most ischemic strokes are due to an embolism (Campbell & Khatri, 2020).

- As defined by Kakkar et al., an Ischemic stroke begins when a blood clot causes a sudden cessation of blood supply to a part of the brain (2020).

- Ischemic strokes are more common compared to hemorrhagic and make up 85% of strokes (Bendok & Naidech, 2012).

- The two categories of ischemic stroke include:
  - o Atherothrombotic: originates directly from the sight of the occlusion.
  - o Embolic: originates in a distant part of the body, travels through the vessels, and causes an occlusion in the brain.

(Bendok & Naidech, 2012)

Computed Tomography Angiography (CTA)

- CT angiogram of the head is the preferred study after a hemorrhagic stroke is ruled out, and ischemic stroke is suspected.

- CT contrast allows for vessels in the brain to be easily visualized, thus being able to identify an intracranial occlusion.

- "Its sensitivity and specificity are approximately 98%, and some studies found it more accurate than magnetic resonance angiography" (Ferrara, 2020, p. 453).

- A CTA is beneficial in the findings of an ischemic stroke, but a contraindication would include an allergy to the iodinated contrast used in CT.
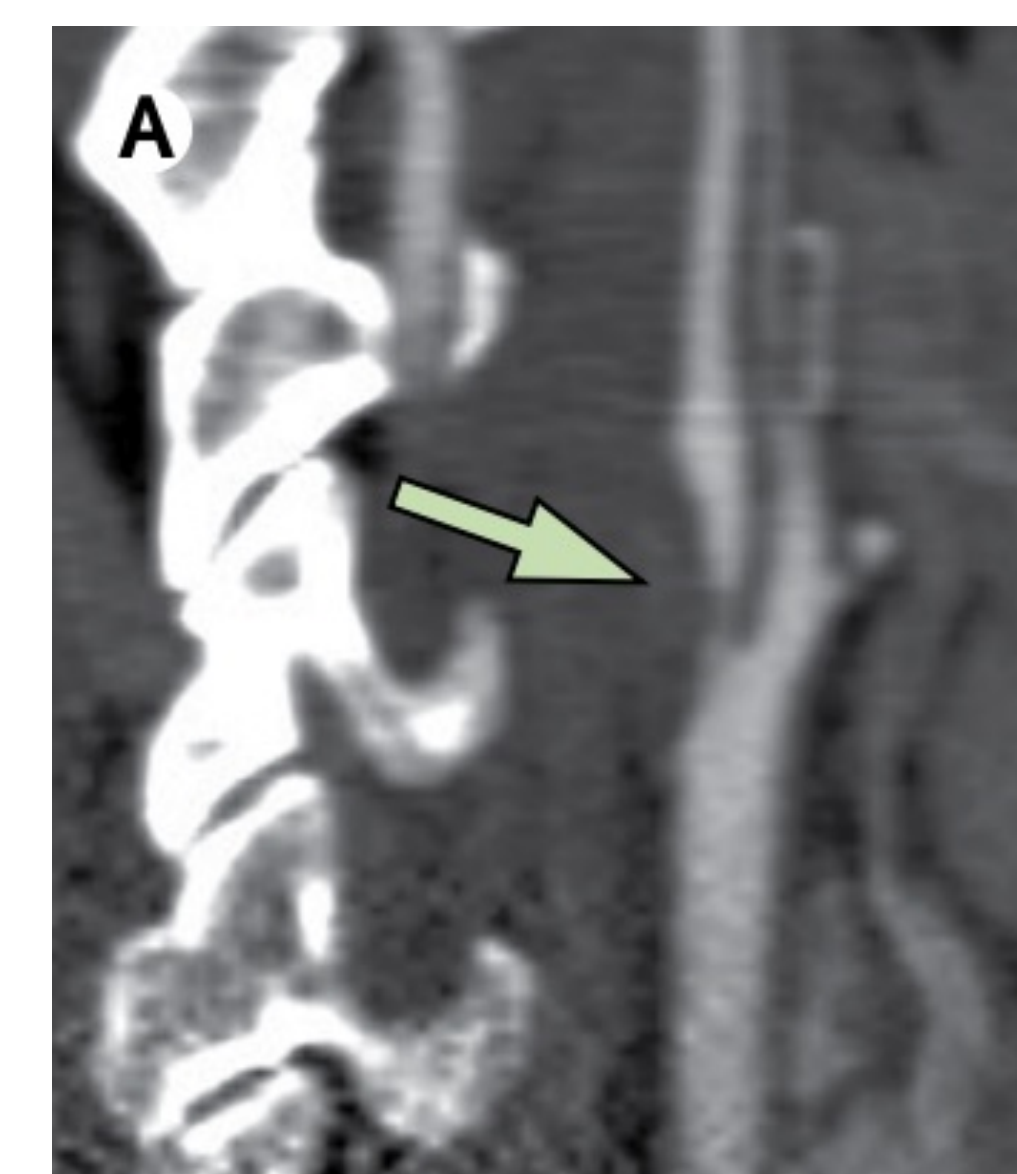

Figure 2: A blockage of the internal carotid artery seen on a CT angiography (Campbell & Khatri, 2020, p. 131).

Computed Tomography Perfusion

- A CT perfusion study in the diagnosis of stroke can specifically be helpful for treatment.

- Information gained by using a perfusion study includes:
  - o Volume of blood flowing through a specified brain volume.
  - o Rate if cerebral blood flow during a specified time unit.
  - o Average time the contrast agent takes to pass through a region of the brain.
  - o Time it takes for peak enhancement to appear, as well as the time to drain from peak enhancement.   (Ferrara, 2020)

- Specification of the function of the vessels can be obtained.

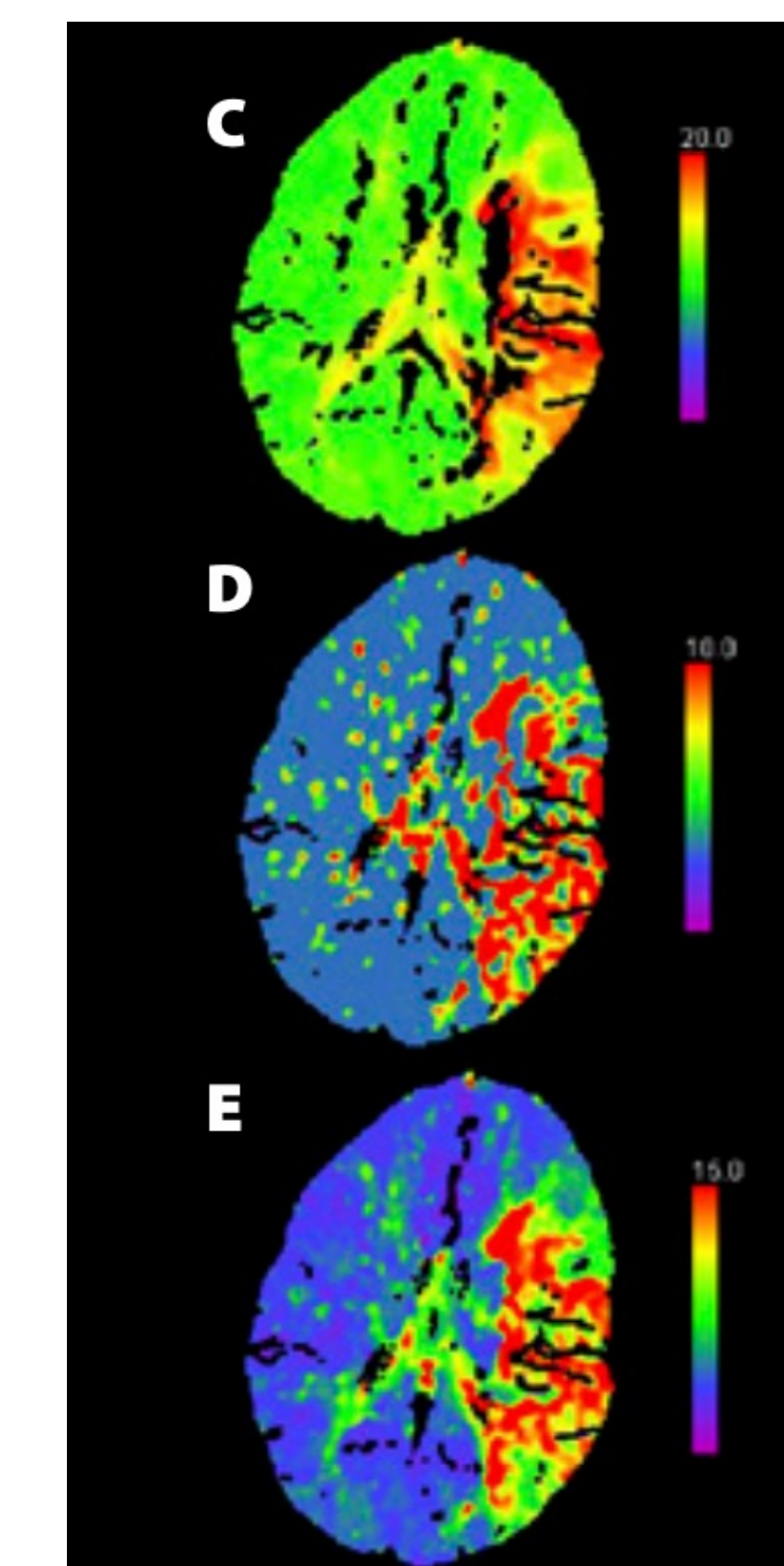- An injection of the contrast agent is administered, and the brain is scanned continuously.

Figure 3: A CT perfusion study showing different functions.
C: Delay in time to peak enhancement of contrast
D: Average time the contrast media takes to pass through a region of the brain
E: Time to drain from peak enhancement

(Ferrara, 2020, p. 455)

Conclusion

- Strokes and their effects are a common occurring issue.

- CT plays a major role in the primary diagnosis of a stroke.

- The many benefits of CT include the fast-paced acquisition time, as well as affordability and availability which allows for rapid assessment and treatment of a diagnosed stroke.

- The new advances in stroke diagnosis and CT will improve the lives of those affected by a stroke, such as mobile stroke units and CT perfusion studies which are becoming a standard tool and aid in treatment for stroke patients (Ferrara, 2020).