CT appearances of the intra cranial haemorrhage

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ABSTRACT

Intracranial haemorrhage (ICH), also known as intracranial bleed, is bleeding within the skull. Computed tomography (CT) scan is the modality of choice in the vast majority of patient with suspected ICH. The diagnostic accuracy is facilitated by the fact that acute bleed is bright (hyperdense) compared to the brain parenchyma especially if the CT is performed early and the amount of blood is large enough to be detected. Types and causes of ICH, location and complications will be discussed in this article. CT angiogram(CTA) is used to assess the vascular cause of subarachnoid haemorrhage and CT venogram (CTV) is used to assess the patency of dural venous sinuses.

Epidemiology and Risk Factors

Intracerebral haemorrhage (ICH) is the presence of blood outside the vessels within the cranium. It is the second most common cause of stroke after acute ischemia accounting for 15 % of stroke cases. It is a significant cause of disability and mortality in adults.[1]

Hypertension, current smoking, excessive alcohol drinking, hypocholesterolemia, and use of anticoagulation are risk factors for ICH. ICH is reported to be more common in the elderly, males, Asians, and patients from low and middle-income countries.

Differentiating ICH from acute ischemia as a cause of stroke is very crucial. Clinical bedside examination is unreliable for this differentiation, and imaging studies, like CT brain scans, can identify ICH easily and rapidly, allowing rapid intervention in acute stroke units to improve the outcomes and prevent complications. [2,3]

Classification of ICH

According to the Location into: [4]

1. Intra-axial haemorrhage/intracerebral haemorrhage which could be lobar, pontine, cerebellar or in the basal ganglia. See **figure1**
2. Extra-axial haemorrhage include extradural (EDH), intralaminar dural, subdural (SDH), subarachnoid (SAH), intraventricular (IVH) and subpial haemorrhage. See **figure 2 and 3**

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According to the cause:

1. Traumatic
2. Non traumatic: includes hypertension, cerebral amyloid angiopathy, tumour-related haemorrhage and vascular-related haemorrhages like haemorrhagic conversion of ischemic infarction (**figure 4**), cerebral aneurysms (**figure 5**), cerebral arteriovenous malformations, dural arteriovenous fistula, vasculitis, and venous sinus thrombosis, among other causes.[4]

About 85% of non-traumatic haemorrhages are seen in patients with hypertension or cerebral amyloid angiopathy (CAA). In hypertension, the haemorrhages are typically in a central position in the basal ganglia, pons, thalamus and cerebellum, while in CAA they are typically more in a peripheral location - deep in the frontal, parietal or temporal lobes - also called lobar haemorrhages.[5]

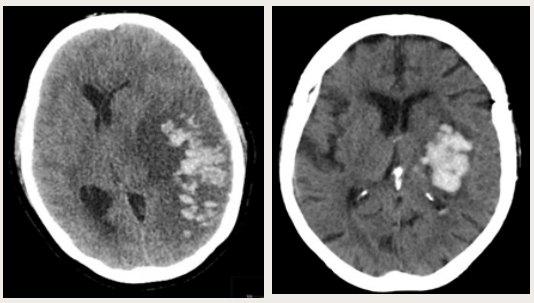


Figure 1 | Intra axial/parenchymal bleed **a**: Acute left lobar bleed (the bright area) with oedema (the adjacent hypodense area) and midline shift. **b**: Acute left Basal ganglia haematoma.

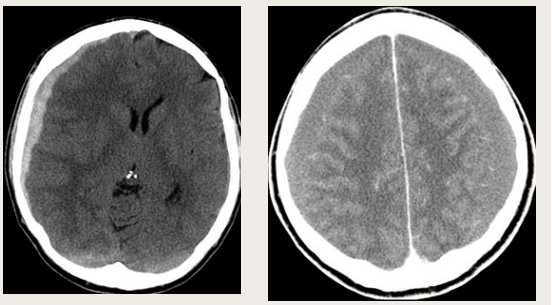


Figure 2 | **a**: Acute right frontal Subdural haematoma (bright and concavoconvex shape) with midline shift to the left. **b**: Bilateral isodense subacute subdural haematoma, no midline shift.

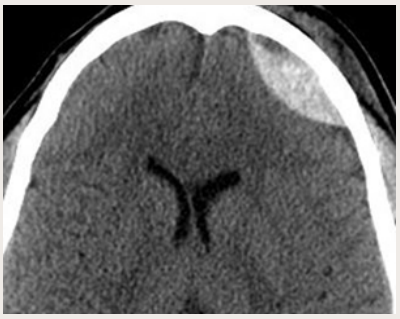


Figure 3 | Acute left frontal epidural haematoma (Biconvex shape) with minimal pressure effect on adjacent sulci.

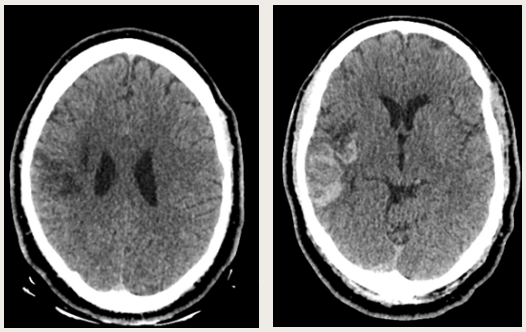


Figure 4 | **a**: Acute right frontoparietal infarct (hypodense area) **b**: Haemorrhagic transformation at day 5 of the infarct (the bright area).

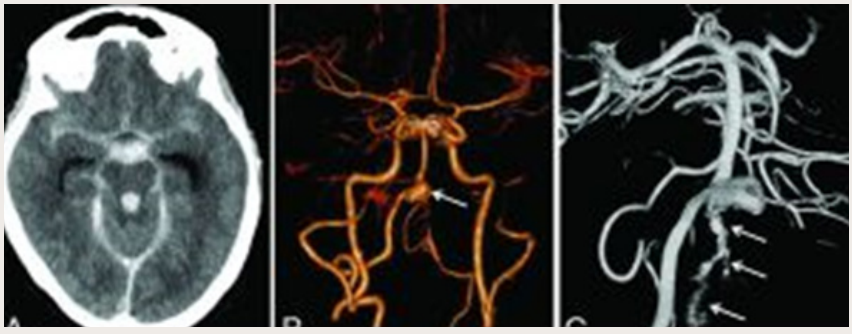


Figure 5 | A 20-year-old patient with sudden headache. **a**: CT demonstrates diffuse SAH with beginning hydrocephalus. **b**: CTA reveals a large vertebral junction aneurysm (arrow). c) 3D angiography with contrast extravasation from the aneurysm (arrows)[13]

Future prospects

The application of artificial intelligence (AI) has the potential to provide good clinical outcomes. Studies demonstrate that AI can help radiologists for better identification of ICH, minimising false negatives.[6,7] Human expertise complemented by AI resulted in a 12.2% increase in ICH detection. The AI algorithm overcalled 1.9% HCT.[8,9] However, these new technology needs to be investigated in depth.[6,7]

Complications

ICH can lead to serious complications, including haematoma expansion, peri haematoma oedema with increased intracranial pressure resulting from swelling of the brain, It can also cause herniation of the brain into the spinal canal leading to death (**Figure 6**). intraventricular extension of haemorrhage (**Figure 7**) with hydrocephalus, seizures, venous thrombotic events, hyperglycaemia, increased blood pressure, fever, and infections are other complications.[10]

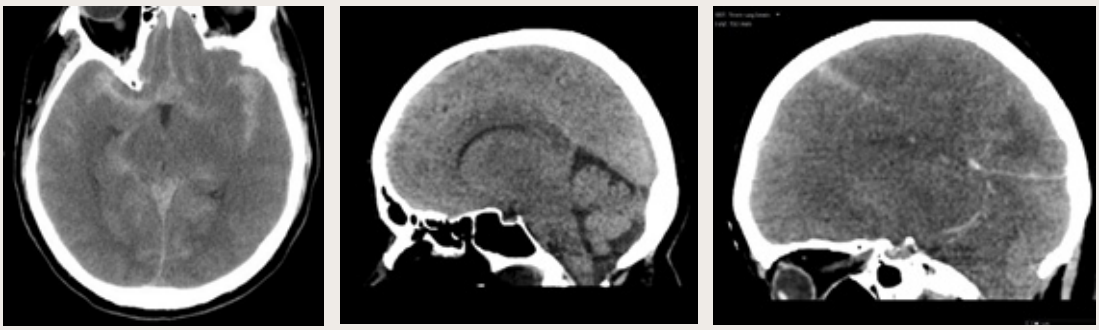
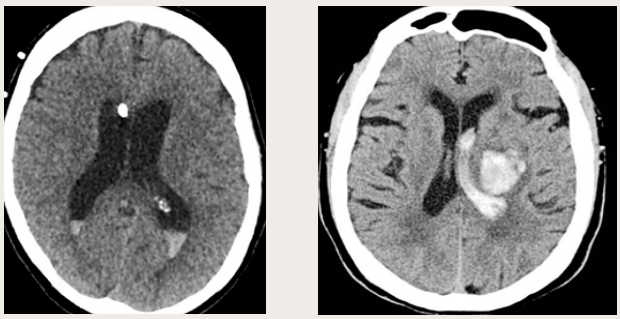


Figure 6 | **a**: Acute subarachnoid haemorrhage, the bright bleed fill the sulci and the CSF spaces. **b**: Severe supratentorial cerebral oedema with preserved posterior fossa within 24 hrs. **c**: Severe diffuse brain oedema including the posterior fossa with conning and cerebellar herniation through foramen magnum after 48hrs (This patient was a candidate for organ donation).

Figure 7 | **a**: Acute (bright) primary Intraventricular bleed in the most dependant part .the occipital horns in a patient with hypertension and using anticoagulant medication. **b**: Secondary Intraventricular bleed/extention from left parenchymal bleed.



The radiological appearance of ICH [11,12]

The acute bleed is bright (hyperdense) compared to the brain parenchyma. The region of interest (ROI) density is measured using the Hounsfield Unit (HU). A few important facts should be appreciated:

1. Hyperacute haematoma: The density of haematoma before clotting is similar to unclotting blooing. It usually varies according to haematocrit but less than 60 HU (35-45 HU).

2. Haematoma increases in density as it clots by contracting solid components and expelling plasma
3. Blood becomes isodense to brain within days to few weeks making it difficult for identification. For example isodense subdural haemorrhage.
4. In the end, the density of the lesion will be similar to CSF.

The time needed for these changes to occur is variable depending on the size of the haematoma, its location, and many other host factors.

CONCLUSION

Any type of bleeding inside the skull or brain is a medical emergency and the neuroimaging is essential for the treating clinician to identify the cause of haemorrhage and to understand the location and severity of haemorrhage, the risk of impending cerebral injury, and to guide often emergent patient treatment.

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Abbreviations: Artificial intelligence (**AI**), Cerebral amyloid angiopathy (**CAA**), Cerebrospinal fluid (**CSF**), Computed tomography (**CT**), CT angiogram (**CTA**), CT venogram (**CTV**), Extradural Haemorrhage (**EDH**), Hounsfield Unit (**HU**), Intracranial haemorrhage (**ICH**), Intraventricular Haemorrhage (**IVH**), Subarachnoid Haemorrhage (**SAH**), Subdural Haemorrhage (**SDH**), Region of interest (**ROI**).

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