Neuroimaging of Stroke

(Early signs on CT and MRI)

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Introduction

- Stroke is a leading cause of death and disability worldwide. The majority are ischaemic in origin.

- Intravenous or intraarterial lysis are new therapeutic options for ischaemic strokes.

- The aim of this new therapy option is the rapid restoration of blood to hypoperfused brain tissue that has not been irreversibly damaged.
Introduction

- Strict selection of patients benefits from lysis therapy is necessary, otherwise complications may occur.
- Time window for intravenous lysis therapy is 3 hours after onset of symptoms (practically difficult)
- Effort of neuroumaging is to identify potentially salvageable brain tissue for the aim of extension of time window for safe and effective treatment.
Noncontrast CT is the most important initial diagnostic study in patients with acute stroke.

The basic role is to exclude primary intracerebral haemorrhage.

Exclusion of some clinically vague presented cases that could resemble stroke as subdural hematoma, hemiplegic or hemisensory migraine, cerebritis and tumors,

The sensitivity for signs of ischemia on non contrast CT scans is within the range between 45% and 88% (mean 55.3%).
Early signs of brain infarction on CT

- Normal CT findings.
- Hyperattenuating arteries.
- Hypoattenuation of grey matter structures:
  - Insular ribbon sign
  - Disappearing basal ganglia sign.
- Mass effect.
Hperattenuating vessel sign

- Indirect sign of acute infarction.
- Represents Stasis of flow due to intraluminal thrombus or embolus, mostly seen in MCA.
- The most early sign!
- First 90 min - 75%
- 12 - 24 hours – 15%

D/D: Calcified atherosclerosis (higher density, disappear in follow up CT).
Hyperattenuating vessel sign

- Proximal occlusion:
  M1 segment of MCA

- Distal occlusion:
  M2, M3 segments of MCA
Prognostic value of Hyperattenuating vessel sign

- It has been reported that proximal hyperdense vessel sign is associated with poor short- and long-term prognosis in patients with ischemic stroke (The patient either dead or dependent after 3 months*). Intravenous thrombolysis ineffective.

- Patients with a distal hyperattenuating MCA sign does not implicate poor outcome (independent in 64% of cases*). Applicable to thrombolytic therapy.

*Barber et al, Stroke 2001
Proximal MCA hyperdense sign

6 hrs

30 hrs
Proximal MCA hyperdense sign

4hrs

72hrs
Distal MCA hyperdense sign (dot sign)

6hrs

32hrs
Hyperdense PCA sign

- Hyperdensity within ambient cistern.
- CT marker of acute ischaemia in territory of PCA.
- Could be associated with thalamic infarction.
A

4hrs

B

C

24hrs
Insular ribbon sign

- Normal stripe = Thin white line (gray matter) adjacent to darker gray line (subcortical white matter)
- With ischemia
  Insular stripe is lost due to cytotoxic oedema in grey matter → loss of differentiation
Insular ribbon sign
Insular ribbon sign
Insular stroke

- **Minor insular stroke**
  
  <2/3 of insula involved.

- **Major insular stroke**
  
  >2/3 of insula involved, usually with other MCA territories.
Cytotoxic oedema & hypodensity on CT

- Increase in tissue water content by 1%
  → 2.5 HU decrease in parenchymal attenuation

- Mean attenuation decrease in MCA stroke
  50.0 → 48.4 HU  1 hour
  50.0 → 42.5 HU  4 hours
Loss of basal ganglia differentiation

- Due to occlusion of M1 segment of MCA proximal to lenticulostriate arteries.
- Good adjustment of CT window setting is necessary (w:80, C:35)
Mass effect

Early mass effect includes effacement of sulci and narrowing of Sylvian fissure.
MRI

Protocol:

- Conventional sequences as T1WI&T2WI have no advantages over CT in the diagnosis of hyperacute stroke.
- FLAIR is more sensitive.
- DWI.
- PWI.
- MRA.
DWI

- DWI can detect stroke in early acute stages of stroke (0 - 6 hours after onset of symptoms).

- Cellular energy failure leads to loss of ion homeostasis and cytoxic edema, i.e., more intracellular water, less extracellular water; water (protons) have more restricted diffusion intracellularly than extracellularly → hyperintense signal
High signal on DWI does not necessarily mean acute lesion since DWI is affected by T2 effects of vasogenic edema in chronic infarcts ("T2 shine-through").

- Rapid sequence, less artifact.
- Should be correlated with ADC
DWI SEEN ALSO IN

- Status epilepticus induced by barbiturate,
- Severe hypoglycemia
- Venous thromobososis, eclampsia (incr. ADC with vasogenic edema).
- DWI and PWI together are quite specific for ischemia
Important to detect the **penumbra**

Usually correlated with DWI(PWI/DWI)

If PWI/DWI mismatch > 25% → patient applicable to thrombolytic therapy

*Steven R et al, Stroke 2007*
DWI
PWI
MRA
MRA
DWI
Lacunar infarctions

- About 25% of all strokes.
- Frequently found in basal ganglia, internal capsule, thalamus and pons.
- Usually not recognized in acute stage on CT due to their small size.
- D/D:dilated perivascular Virchow-Robin spaces.
Lacunar infarctions
Venous infarction

- High pospartum incidence, trauma, dehydration, pyogenic infection,..
- Clinically: headache, nausea, neurological deterioration, seizures.
- May affect large sinus or small deep veins.
- Infarctions usually bilateral, parasagittal and often haemorrhagic.
Venous infarction

- **NECT:**
  - Cord sign of superficial cerebral vein.
Venous infarction cont.

NECT

- Cortical or subcortical hypodensity (usually bilateral).
Venous infarction cont.

- **NECT**
  - Cortical or subcortical hyperdensity, if haemorrhagic, (usually bilateral).
Venous infarction cont.

**CECT:**

Empty delta sign.
Venous infarction

- **MRI**
  - Loss of the normal signal void within the thrombosed sinus in T2WI, replaced by hyperintensity that represents the thrombus.
  - Hypointensity in T1WI and hyperintensity in T2WI in cortical or subcortical areas in cases of pure infarction.
  - In cases of haemorrhage the signals depend on the age of haematoma.
Venous infarction  MRI
MRV
CONCLUSION

- CT scan is the standard of care in acute stroke imaging. It is widely available, fast and practical.
- Early CT signs of stroke are of therapeutic and prognostic value and can indicate specific arterial occlusion.
- DWI in MRI is more sensitive in the hyperacute stage of stroke but should be used with ADC.
- MRI is also better in clarifying cerebellar and brain stem infarctions.
- PWI/DWI mismatch on MRI can select patient for thrombolysis therapy beyond currently known time window.
Brain imaging can reduce health cost if it prevents the disability and death of stroke victims.
Thank you