Emergency Bulletin
Hong Kong College of Emergency Medicine

Ischaemic stroke with mechanical thrombectomy done for large vessel occlusion

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A 76-year-old lady, with past medical history of chronic rheumatic heart disease not on anticoagulation and history of left thalamic stroke with good neurological recovery, woke up at 05:30 noting left sided weakness but still able to go to toilet and brush her teeth. Her son found her leaning on the left side with facial asymmetry and slurring of speech at 08:00am.

She was last seen well at 01:30 on the same day. Premorbidly, she could walk unaided and perform activities of daily living independently.

On arrival to the emergency department at 09:15, her vital signs were as follow:

- GCS: E3V5M6
- BP: 196/113mmHg, Pulse: 82bpm
- Afebrile. SpO2 was 100% on room air
- PEARL 3mm

Neurological examination revealed gaze deviation to the right side and left upper motor neuron type facial nerve palsy. The power of the left upper and lower limb was 3/5 while that of right upper limb and lower limb was 5/5.

Urgent plain CT Brain (Figure 1) showed loss of grey-white differentiation and sulcal effacement over the right parietal region of cerebrum. The Alberta Stroke Program Early CT Score (ASPECTS) was 7.

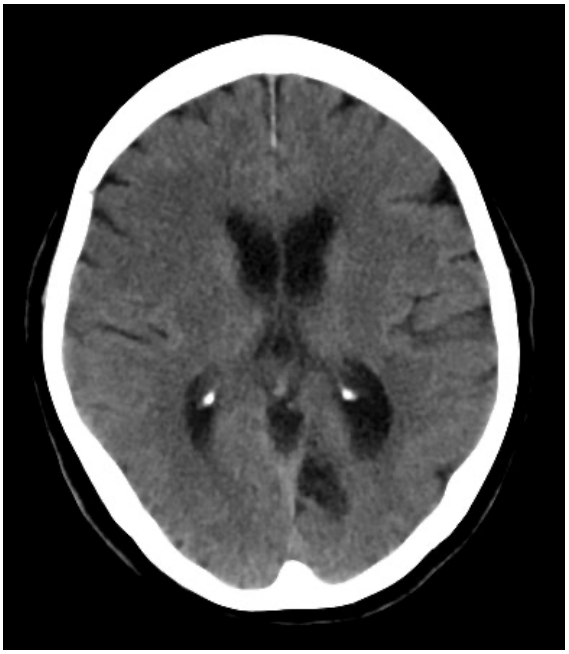

Figure 1: Urgent plain CT brain of the patient

What are the early signs of ischaemic stroke in plain CT brain?

Early signs of ischaemic stroke in plain CT brain include:[1-5]

1. Loss of grey-white matter differentiation in the basal ganglia, such as obscuration of the lentiform nucleus which may be seen as early as 1 hour after occlusion. (Visible in 75% of patients at 3 hours[6])
2. Loss of insular ribbon or obscuration of Sylvian fissure,
3. Cortical hypo-attenuation and sulcal effacement.

What is ASPECTS?

ASPECTS is a 10-point quantitative topographic CT scan score used for patients with middle cerebral artery (MCA) stroke.[6] A segmental estimation of the middle cerebral artery (MCA) territory and two standard axial non-contrast CT images were evaluated; one at the level of the thalamus and basal ganglia, and one just rostral to the basal ganglia. (Figure 2)

One point is deducted from the initial score of 10 for any evidence of early ischemic change for each of the defined regions.

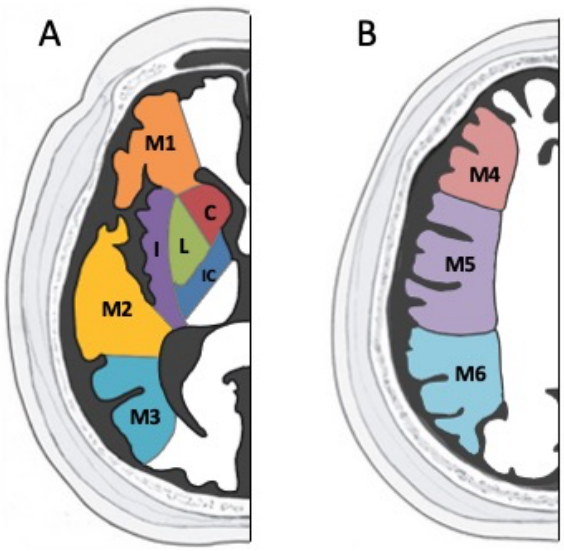

Figure 2: Ten defined regions in ASPECT score: A: At the level of basal ganglia; B: At the level rostral to the basal ganglia

The ten defined regions include:

Three subcortical regions at the level of the basal ganglia
- Caudate (C)
- Lentiform nucleus (L)
- Internal capsule (IC)

Four cortical regions at the level of the basal ganglia
- Anterior MCA cortex (M1)
- Lateral MCA cortex (M2)
- Posterior MCA cortex (M3)
- Insular cortex (I)

Three cortical regions just rostal to the basal ganglia
- Anterior MCA cortex (M4)
- Lateral MCA cortex (M5)
- Posterior MCA cortex (M6)

The score was designed to help identify patients who were likely to demonstrate the most clinical benefit from intravenous thrombolysis.[6]

Subsequently, this score was applied in imaging selection for endovascular therapies to isolate patients with greatest extent of ischemic damage, in whom recanalization would be harmful or even futile.[7-8]

More recently, ASPECTS has been recognized as a key selection criterion in the updated American Heart Association guidelines on the management of acute stroke, where endovascular therapy in patients with baseline ASPECTS≥6 is recommended.[9]

Progress of the patient

The premorbid modified Rankin Scale of the patient was 0 while the Rapid Arterial Occlusion Evaluation Scale (RACE) was 6. Despite uncertain onset time of stroke, stroke team was consulted for reperfusion therapy.

After assessment by neurologist, intravenous thrombolysis was not suggested since the risk was determined to outweigh the benefit in view of early infarct change on CT scan.

Instead, CT cerebral angiography was arranged which showed large vessel occlusion at right middle cerebral artery M2. CT brain perfusion scan showed mismatch volume of 57ml and mismatch ratio of 2.5.

What is a CT brain perfusion scan?

CT perfusion imaging includes a series of CT scans obtained following the injection of an intravenous bolus of iodinated-contrast. It uses

contrast to measure the amount and timing of blood flow to certain areas of the brain.[10]

Maps showing the perfusion of the brain will be generated with the perfusion analysis software. It enables the estimation of the cerebral blood flow (CBF), cerebral blood volume (CBV), mean transit time of contrast through brain (MTT), time to peak (TTP), and time to peak of the residue function.[11,12]

These maps enable the differentiation of salvageable ischemic brain tissue (the penumbra) from the irreversibly infarcted brain (the infarct core). Areas that have a very low blood flow are likely irreversibly injured, whereas areas that have enough blood flow but high time to peak (TTP) for the blood to reach that area are at risk but not yet irreversibly injured. (Figure 3)

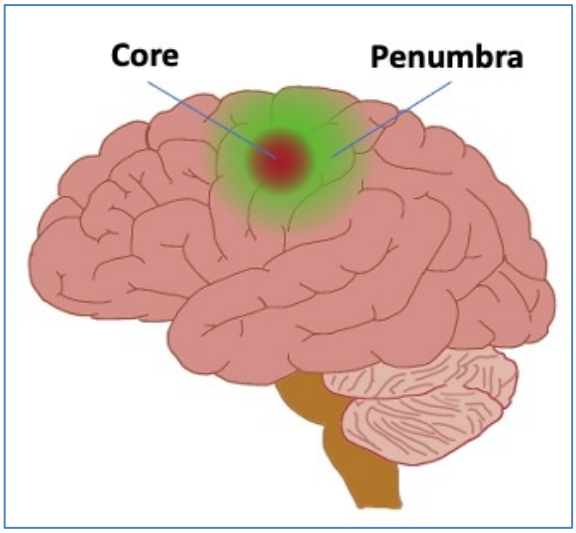

Figure 3: Infarct core and penumbra

Mechanical thrombectomy in the late time window (6 to 24 hours after stroke onset) rely on CT perfusion scan to identify patients with small ischemic cores and relatively large penumbra.

Areas of hypoattenuation on CT perfusion source images correlate with infarcted brain regions. Study has found that the ASPECTS method applied to CT perfusion source images was more accurate for identifying irreversible infarction and clinical outcome than ASPECTS applied to non-contrast CT brain or CTA source images.[13]

Progress of the patient

After discussion between radiologist and neurologist, intra-arterial mechanical thrombectomy was performed. Patient was admitted to Intensive Care Unit after mechanical thrombectomy.

What is the acute therapy for the patient?

The patient suffered from acute ischaemic stroke. The primary goal is re-vascularization. The treatment is guided by the time from the onset of stroke, the severity of neurological deficit and findings on neuroimaging.

For eligible patients, the treatment includes intravenous thrombolysis with alteplase and mechanical thrombectomy.[14]

<u>Intravenous thrombolysis with alteplase</u>

Intravenous alteplase is the mainstay of treatment for patients with acute ischaemic stroke. Alteplase, a recombinant tissue plasminogen activator (tPA), initiates local fibrinolysis by binding to fibrin in a thrombus (clot) and converting entrapped plasminogen to plasmin. The plasmin then breaks up the fibrin in the thrombus. (Figure 4)

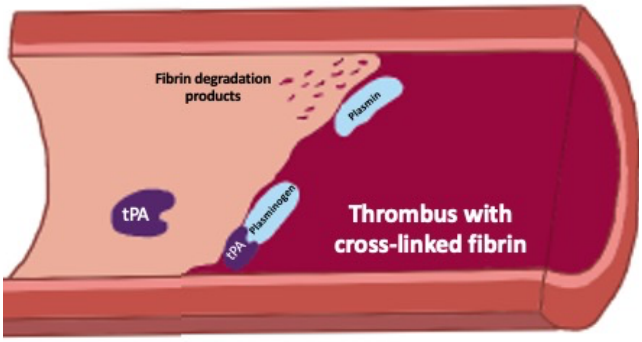

Figure 4: Mechanism tPA to breaks up the fibin in the thrombus to fibrin degradiation product

The treatment should be started as quickly as possible within the 4.5 hours of symptoms onset. The treatment benefit is time-dependent; the

sooner the treatment is initiated, the more likely it is beneficial.[14]

Mechanical thrombectomy

Mechanical thrombectomy is a type of minimally invasive procedure in which an interventional radiologist uses specialized equipment to remove a clot from a patient's artery. Under fluoroscopy, the doctor guides instruments through the patient's arteries to extract the clot.

Selection criteria for mechanical thrombectomy is guided in part by criteria used in recent trials and recommendation provided by stroke association guidelines.

The 2018 American Heart Association/American Stroke Association (AHA/ASA) and European Stroke Organization guidelines have extended the therapeutic time window and support thrombectomy for selected strokes due to large artery occlusion up to 16 (Class I recommendation) to 24 (Class IIa recommendation) hours from time last known well regardless of whether they receive IV thrombolysis for the same ischemic stroke event.[14]

Early time window (present within <6hrs) – AHA/ASA guidelines[14]

Patients are eligible for mechanical thrombectomy within 6 hours of symptom onset if they fulfil the following criteria.

1. Pre-stroke modified Rankin Scale (mRS) score of 0 to 1
2. Causative occlusion of the internal carotid artery or MCA segment 1 (M1)
3. Age ≥18 years
4. NIHSS score of ≥6 points
5. ASPECTS score ≥6
6. Treatment can be initiated (groin puncture within 6 hours of symptom onset.

The use of mechanical thrombectomy may be used for carefully selected patients with acute ischaemic stroke who have causative occlusion of the MCA segment 2 (M2) or MCA segment 3 (M3) portions. (Grade IIb recommendation)

Late time window (present from 6hrs to 16hrs) – AHA/ASA guidelines[14]

Mechanical thrombectomy is recommended in selected patients who have large vessel occlusion in the anterior circulation and meet other DAWN or DEFUSE 3 eligibility criteria. (Class I recommendation)

Late time window (present from 16hrs to 24hrs) – AHA/ASA guidelines[14]

Mechanical thrombectomy is reasonable in selected patients who have large vessel occlusion in the anterior circulation and meet other DAWN eligibility criteria. (Class IIa recommendation)

The eligibility criteria for DAWN and DEFUSE 3 study are shown in table 1.[15,16]

Can patient received both modality of therapy?

Many patients who are eligible for mechanical thrombectomy will be treated with intravenous alteplase prior to mechanical thrombectomy.

Patients who are not candidates for intravenous alteplase can still be treated with mechanical thrombectomy if otherwise eligible according to the criteria outlined above.

Potential advantages of intravenous thrombolysis before mechanical thrombectomy include complete or partial lysis of the thrombus causing the large vessel occlusion, lysis of thrombotic emboli in distal vessels beyond the reach of mechanical thrombectomy, and faster resolution of brain ischemia.[17]

Potential disadvantages of giving intravenous thrombolysis first include a delay in the time to the start of the mechanical thrombectomy procedure, an increased risk of symptomatic brain haemorrhage, and partial lysis of the large vessel thrombus that allows it to travel to more distal vessels beyond the reach of mechanical thrombectomy.

How to manage a patient with unwitnessed stroke onset or "wake-up" stroke?

If the exact time of stroke onset is unknown, it is defined as the time the patient was last known to be normal.

For patients whose stroke symptoms are first noted upon awakening from sleep ("wake-up" stroke), the time last known to be normal may be the time they went to bed or the time last seen normal by another.

These patients are not ordinarily eligible for IV thrombolysis unless the time last known to be normal is less than 4.5 hours. However, with imaging-based criteria, IV thrombolysis and mechanical thrombectomy is an option for selected patients.

Progress of patient

Patient was discharged back to Acute Stroke Unit after staying in ICU for 5 days. The power of her left upper and lower limbs improved. She was able to walk with stick after course of rehabilitation. She was discharged home after carer training given to her son and daughter.

Eligibility criteria	DEFUSE-3[16]	DAWN[15]
Time window	6-16 hours	6-24 hours
Age	18-90 years old	≥ 18 years old
mRS score before stroke	mRS score of ≤ 2 Life expectancy ≥ 6 months	mRS score ≤ 1 Life expectancy ≥ 6 months
NIHSS score	≥ 6	≥ 10 (see below)
Arterial occlusion	Internal carotid artery and/or M1	Internal carotid artery and/or M1
Mismatch definition	All of the following 1. Infarct core volume < 70 ml 2. Mismatch ratio (Volume of the perfusion lesion divided by the volume of the ischemic core) > 1.8 3. Absolute mismatch volume (volume of perfusion lesion minus the volume of the ischemic core) > 15ml	Less than 1/3 MCA territory involved and, Clinical imaging mis-match defined as one of the following: 1. Core infarct volume <21ml and NIHSS ≥ 10 (and age ≥ 80 years old) 2. Core infarct volume <31ml and NIHSS ≥ 10 (and age < 80 years old) 3. Core infarct volume 31-51ml and NIHSS ≥ 20 (and age < 80 years old)

Table 1: The eligibility criteria for DAWN and DEFUSE 3 study

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