

# **Indications for thrombectomy in acute ischemic stroke**

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- Endovascular treatment, made possible with the development of microcatheters capable of intracranial access, represents another approach that enables effective local intra-arterial fibrinolysis for middle cerebral artery (MCA) occlusion within 6 hours of onset.(in 1999 and 2007 )
- The Merci Retriever (the then Concentric Medical In(In 2005 and 2008) and the Penumbra System (Penumbra, Inc.(In 2008 and 2009) were subsequently developed for mechanical thrombectomy (MT).
- The recently developed stent retrievers Solitaire FR (Covidien) (in 2012) and Trevo (Stryker Corporation)(in 2012) have safety and efficacy profiles superior to the Merci Retriever.

- the Merci Retriever in April 2010 and the Penumbra System in June 2011 were approved for use in MT. All-patient postmarketing surveillance was conducted over the 3 years following approval, with medical societies and others reporting some of the surveillance results. The Solitaire FR in December 2013 and the Trevo ProVue in March 2014 were approved as stent retrievers.

## Mechanical Thrombectomy Eligibility–Vessel Imaging:

- For patients who otherwise meet criteria for mechanical thrombectomy, noninvasive vessel imaging of the intracranial arteries is recommended during the initial imaging evaluation. (eg, during alteplase infusion if feasible).
- A recent systematic review evaluated the accuracy of prediction instruments for diagnosing LVO. the author suggested that the NIHSS score is the best of the LVO prediction instruments.
- According to their meta-analysis, a threshold of  $\geq 10$  would provide the optimal balance between sensitivity (73%) and specificity (74%).
- To maximize sensitivity (at the cost of lower specificity), a threshold of  $\geq 6$  would have 87% sensitivity and 52% specificity.

- However, even this low threshold misses some cases with LVO, whereas the low specificity indicates that falsepositives will be common.
- The sensitivity of CTA and MRA compared with the gold standard of catheter angiography ranges from 87% to 100%, with CTA having greater accuracy than MRA.
- In patients with suspected intracranial LVO and no history of renal impairment, who otherwise meet criteria for mechanical thrombectomy, it is reasonable to proceed with CTA if indicated before obtaining a serum creatinine concentration.
- It may be reasonable to incorporate collateral flow status into clinical decision-making in some candidates to determine eligibility for mechanical thrombectomy. (IIb)
- The ESCAPE trial (Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion With Emphasis on Minimizing CT to Recanalization Times), using multiphase CTA to select patients with moderate to good collateral circulation for mechanical thrombectomy up to 12 hours from onset, was stopped early for efficacy. Acquisition of advanced imaging should not delay door-to-groin puncture times.

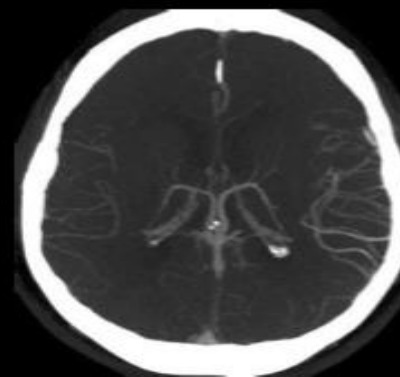
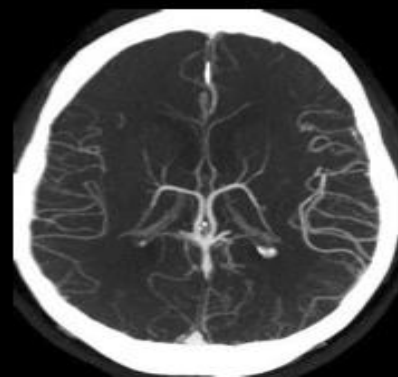
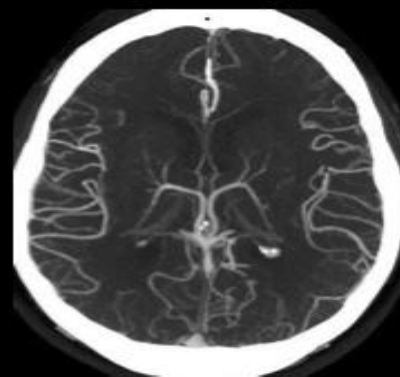
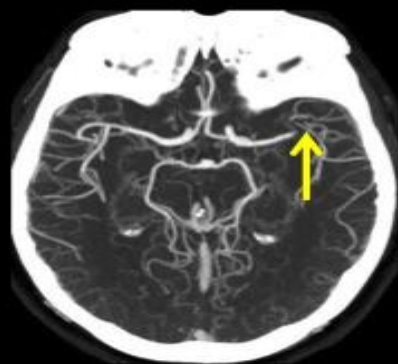
Site of Occlusion

Phase 1

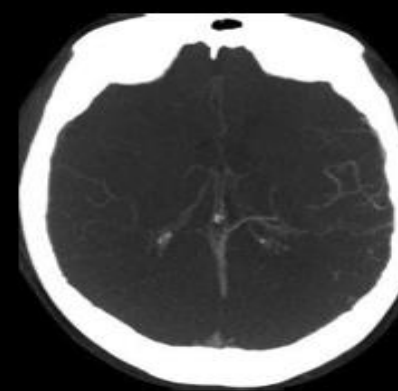
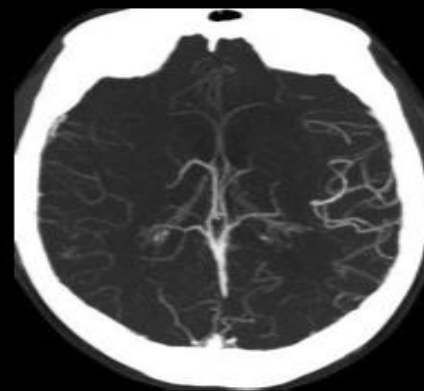
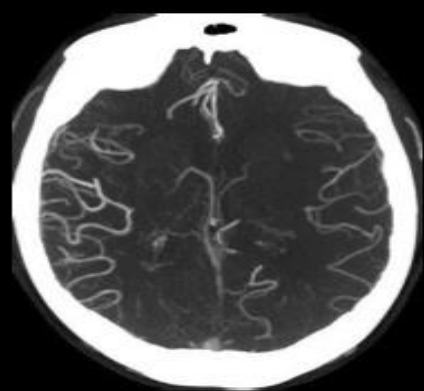
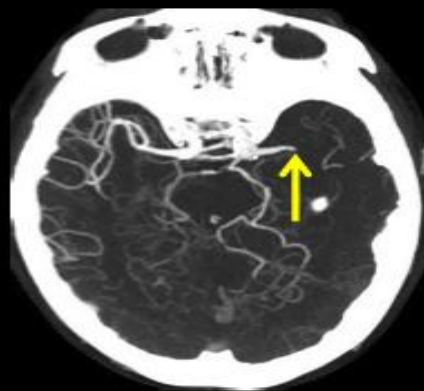
Phase 2

Phase 3

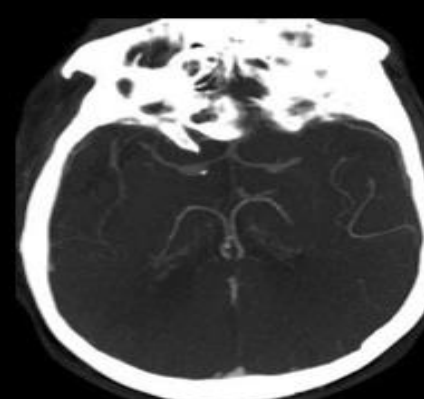
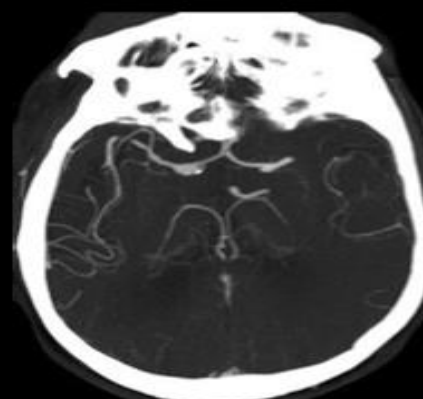
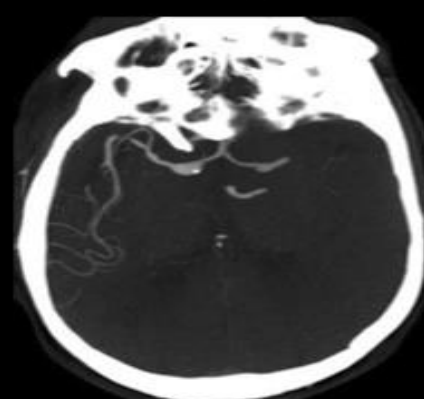
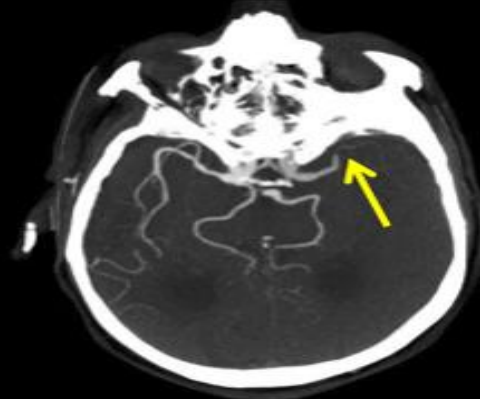
Good  
collaterals

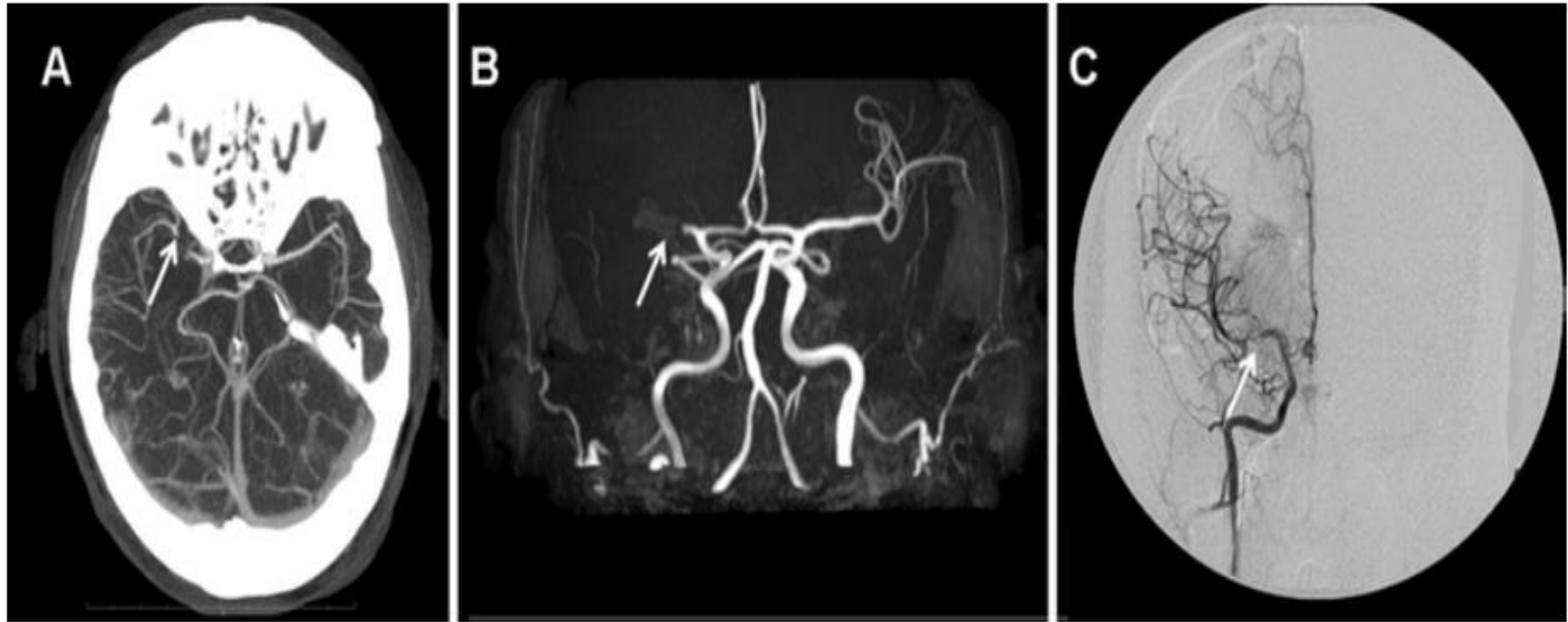


Intermediate  
collaterals



Poor  
collaterals





Vascular occlusion detected by CTA, MR 3D-TOF, and DSA. **A:** CTA maximum intensity projection demonstrating stenosis in the M<sub>1</sub> segment of the right MCA (*arrow*). There is retrograde filling of the distal portions of the right MCA. **B:** MR 3D-TOF image demonstrating overestimation of the stenosis and showing absence of antegrade flow in the distal to the stenosis. **C:** DS angiogram demonstrating a short segment of tight stenosis in the proximal right MCA with collaterals.

## • **Mechanical Thrombectomy Eligibility–Multimodal Imaging**

- When selecting patients with AIS within 6 to 24 hours of last known normal who have LVO in the anterior circulation, obtaining CTP or DW-MRI, with or without MRI perfusion, is recommended to aid in patient selection for mechanical thrombectomy, but only when patients meet other eligibility criteria from one of the RCTs that showed benefit from mechanical thrombectomy in this extended time window.
- The DAWN trial (Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention With Trevo) used clinical-core mismatch (a combination of age-adjusted NIHSS score and age-adjusted core infarct size on CTP or DW-MRI) as an eligibility criterion to select patients with large anterior circulation vessel occlusion for mechanical thrombectomy between 6 and 24 hours from last known normal.
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- This trial demonstrated an overall benefit in functional outcome at 90 days in the treatment group (mRS score 0–2, 49% versus 13%; adjusted difference, 33% [95% CI, 21–44]; posterior probability of superiority >0.999).<sup>51</sup>

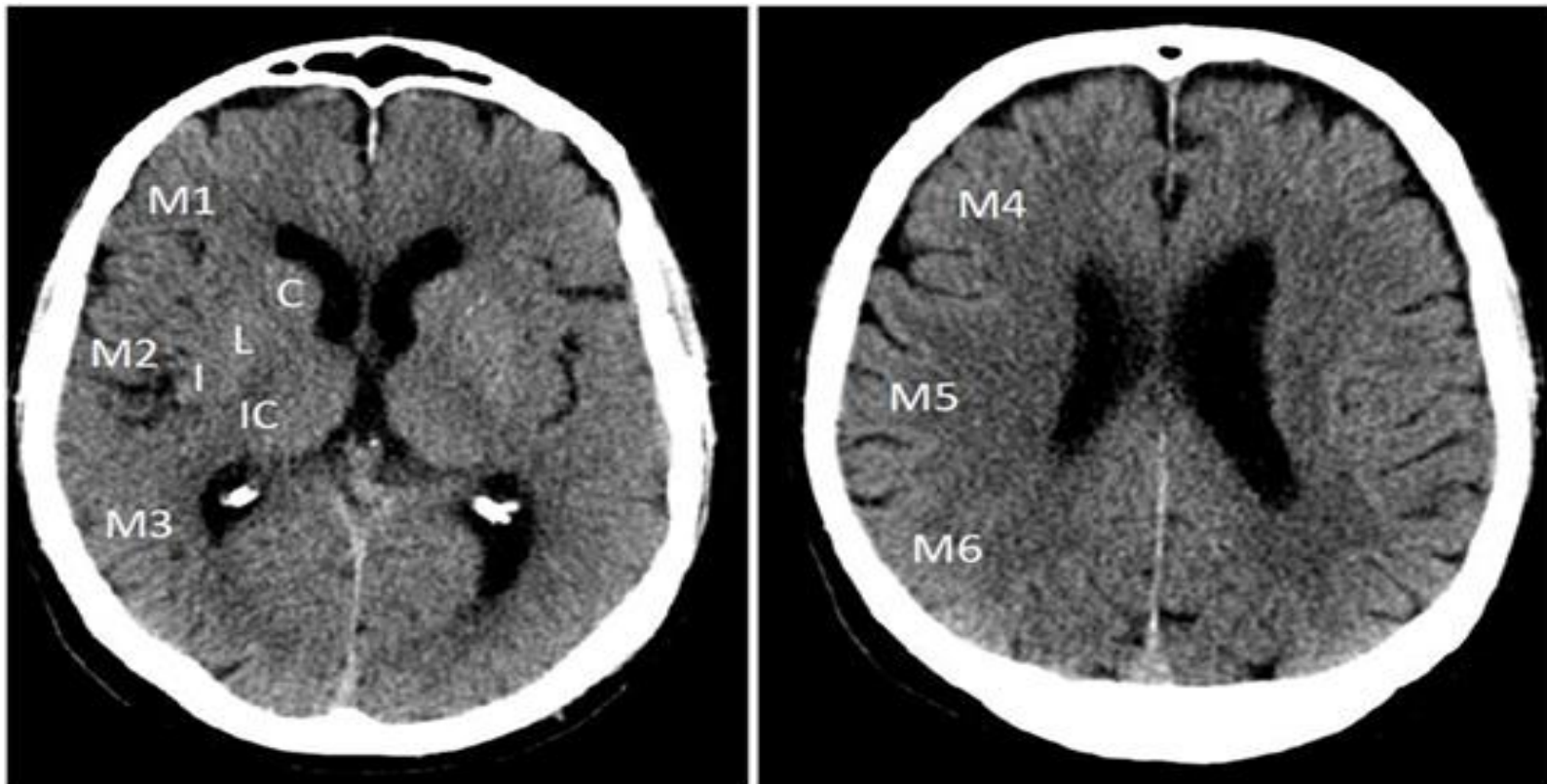


- The DEFUSE 3 trial (Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution) used perfusion-core mismatch and maximum core size as imaging criteria to select patients with large anterior circulation occlusion 6 to 16 hours from last seen well for mechanical thrombectomy. This trial showed a benefit in functional outcome at 90 days in the treated group.
- When evaluating patients with AIS within 6 hours of last known normal with LVO and an Alberta Stroke Program Early Computed Tomography Score (ASPECTS) of  $\geq 6$ , selection for mechanical thrombectomy based on CT and CTA or MRI and MRA is recommended in preference to performance of additional imaging such as perfusion studies.
- In patients for whom mechanical thrombectomy is planned and who have not received IV fibrinolytic therapy, it is reasonable to maintain BP  $\leq 185/110$  mm Hg before the procedure. (IIa)

# **Mechanical Thrombectomy Concomitant With IV Alteplase**

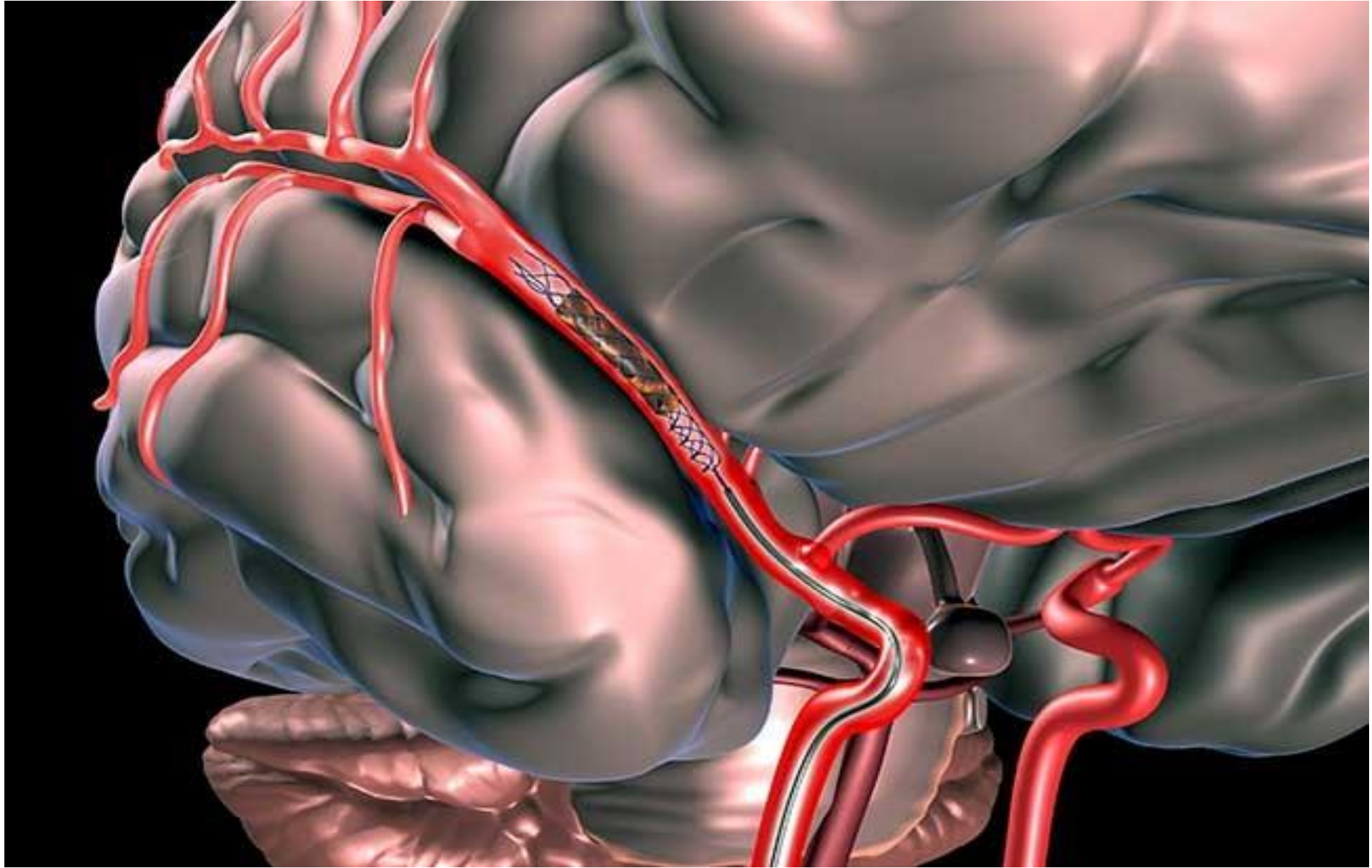
- Patients eligible for IV alteplase should receive IV alteplase even if mechanical thrombectomy is being considered.(I,A)
- In patients under consideration for mechanical thrombectomy, observation after IV alteplase to assess for clinical response should not be performed.

- . When evaluating patients with AIS within 6 hours of last known normal with LVO and an Alberta Stroke Program Early Computed Tomography Score (ASPECTS) of  $\geq 6$ , selection for mechanical thrombectomy based on CT and CTA or MRI and MRA is recommended in preference to performance of additional imaging such as perfusion studies.

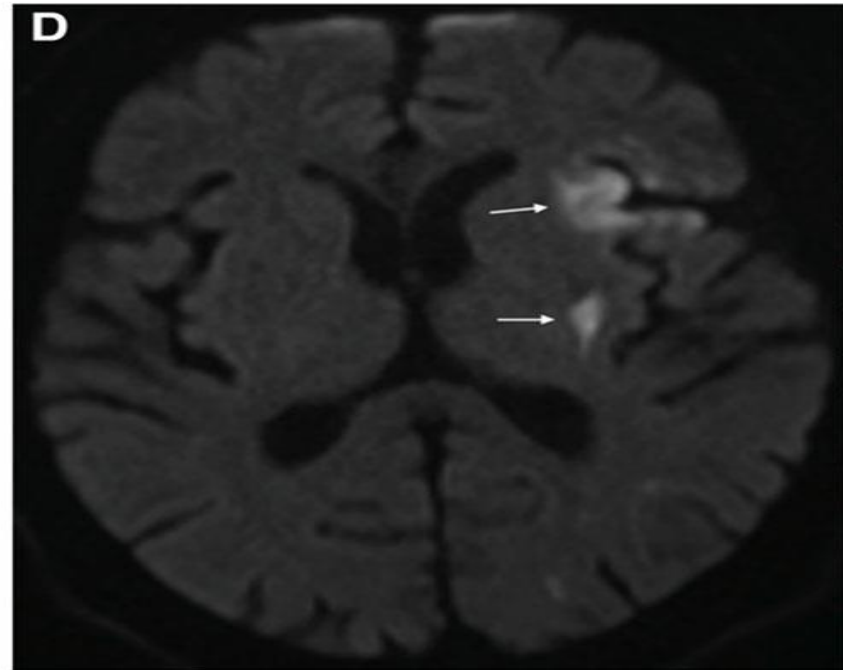
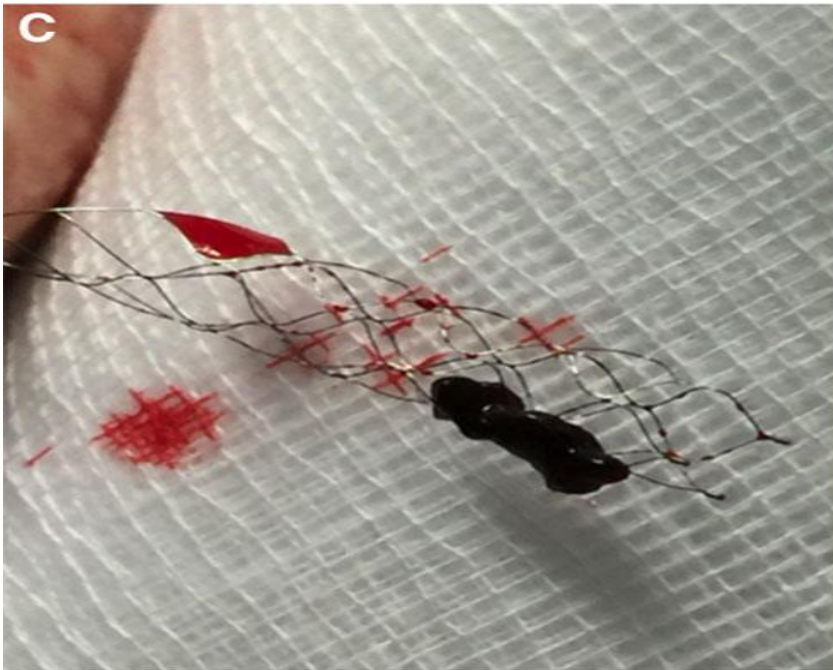
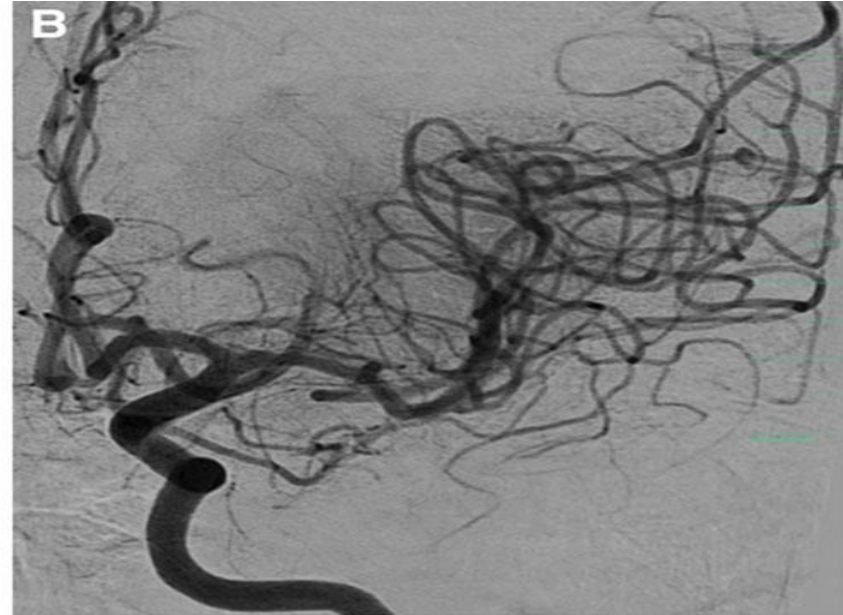
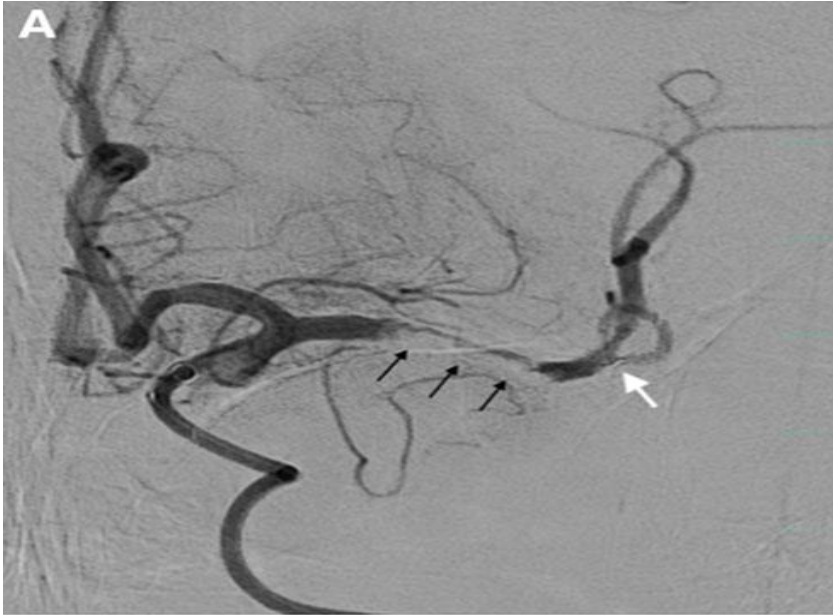


- **Patients should receive mechanical thrombectomy with a stent retriever if they meet all the following criteria:**
  - (1) prestroke mRS score of 0 to 1
  - (2) causative occlusion of the internal carotid artery or MCA segment 1 (M1)
  - (3) age  $\geq 18$  years
  - (4) NIHSS score of  $\geq 6$
  - (5) ASPECTS of  $\geq 6$
  - (6) treatment can be initiated (groin puncture) within 6 hours of symptom onset.
- **Direct aspiration thrombectomy as first-pass mechanical thrombectomy is recommended as noninferior to stent retriever for patients who meet all the following criteria:**
  - (1) prestroke mRS score of 0 to 1; (2) causative occlusion of the internal carotid artery or M1; (3) age  $\geq 18$  years; (4) NIHSS score of  $\geq 6$ ; (5) ASPECTS  $\geq 6$ ; and (6) treatment initiation (groin puncture) within 6 hours of symptom onset.

- Thrombectomy may be considered in patients with anterior circulation AIS and NIHSS score  $<6$  when associated with disabling symptoms [class IIa, level B-NR]. However, care should be taken when treating these patients to keep complication and hemorrhagic rates below those reported in RCTs.(Society of NeuroInterventional Surgery (SNIS))







- **Although the benefits are uncertain,** the use of mechanical thrombectomy with stent retrievers may be reasonable for carefully selected patients with AIS in whom treatment can be initiated (groin puncture) within 6 hours of symptom onset and who have causative occlusion of the MCA segment 2 (M2) or MCA segment 3 (M3) portion of the MCAs.(Iib)
- **Although its benefits are uncertain,:** the use of mechanical thrombectomy with stent retrievers may be reasonable for patients with AIS in whom treatment can be initiated (groin puncture) within 6 hours of symptom onset and who have prestroke mRS score >1, ASPECTS <6, or NIHSS score <6, and causative occlusion of the internal carotid artery (ICA) or proximal MCA (M1). .(Iib)
- **Although the benefits are uncertain,** the use of mechanical thrombectomy with stent retrievers may be reasonable for carefully selected patients with AIS in whom treatment can be initiated (groin puncture) within 6 hours of symptom onset and who have causative occlusion of the anterior cerebral arteries, vertebral arteries, basilar artery, or posterior cerebral arteries. .(Iib)



## 6 to 24 Hours From Onset

- In selected patients with AIS within 6 to 16 hours of last known normal who have LVO in the anterior circulation and meet other DAWN or DEFUSE 3 eligibility criteria, mechanical thrombectomy is recommended.(I)
- In selected patients with AIS within 16 to 24 hours of last known normal who have LVO in the anterior circulation and meet other DAWN eligibility criteria, mechanical thrombectomy is reasonable.(IIa)

- The DAWN trial (Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention With Trevo) used clinical-core mismatch (a combination of age-adjusted NIHSS score and age-adjusted core infarct size on CTP or DW-MRI) as an eligibility criterion to select patients with large anterior circulation vessel occlusion for mechanical thrombectomy between 6 and 24 hours from last known normal.
- The DEFUSE 3 trial (Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution) used perfusion-core mismatch and maximum core size as imaging criteria to select patients with large anterior circulation occlusion 6 to 16 hours from last seen well for mechanical thrombectomy.

<b>Inclusion criteria</b>	<b>DEFUSE-3<sup>10</sup></b>	<b>DAWN<sup>9</sup></b>
Time window	6–16 hours since time last known well	6–24 hours since time last known well
Age	18–90 years	≥18 years
mRS score before qualifying stroke	≤2; life expectancy ≥6 months	≤1; life expectancy ≥6 months
NIHSS score	≥6	≥10 (see below)
Arterial occlusion	ICA and/or M1 *	ICA and/or M1
Mismatch definition	Target mismatch profile on CT or MR perfusion imaging, as determined by an automated image postprocessing system: Infarct core volume <70 mL† AND mismatch volume >15 mL (Tmax>6 s‡) AND mismatch ratio (penumbra/core) >1.8	Clinical-imaging mismatch Age <80 years and NIHSS score ≥10 and infarct core 0–30 mL OR age <80 years and NIHSS score ≥20 and infarct core 31–51 mL OR age ≥80 years and NIHSS score ≥10 and infarct core 0–20 mL

\*Carotid occlusions could be cervical or intracranial, with or without tandem MCA lesions in DEFUSE-3.

†Based on CT perfusion or MRI diffusion.

‡The size of the penumbra was estimated from the volume of tissue for which there was delayed arrival of an injected tracer agent (time to maximum of the residue function (Tmax) exceeding 6 s.<sup>148</sup>

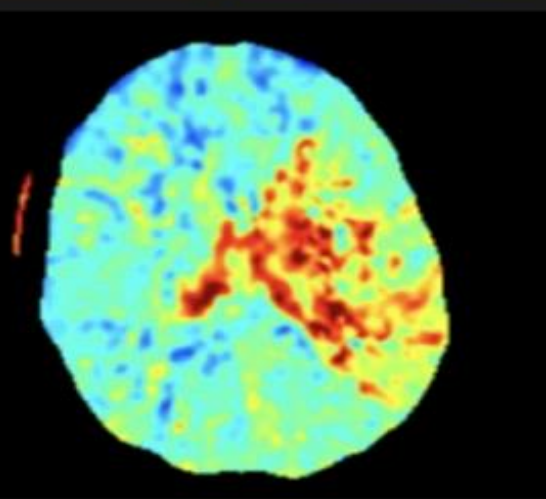
ICA, internal cerebral artery; MCA, middle cerebral artery; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale.

- **CT perfusion in ischemic stroke:**
- The CBV, and to a lesser extent CBF, differentiates penumbra and core infarct:
- **core**
  - increased MTT/Tmax
  - markedly decreased CBF
  - markedly decreased CBV
- **penumbra**
  - increased MTT/Tmax
  - moderately reduced CBF
  - near-normal or increased CBV

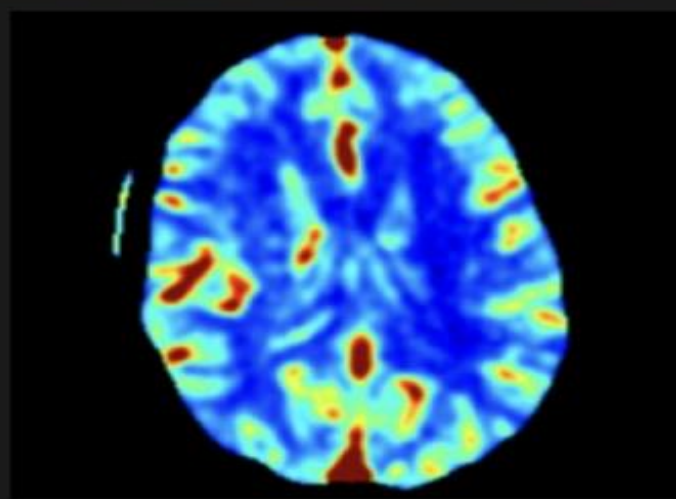
Key concept

Ischaemic penumbra

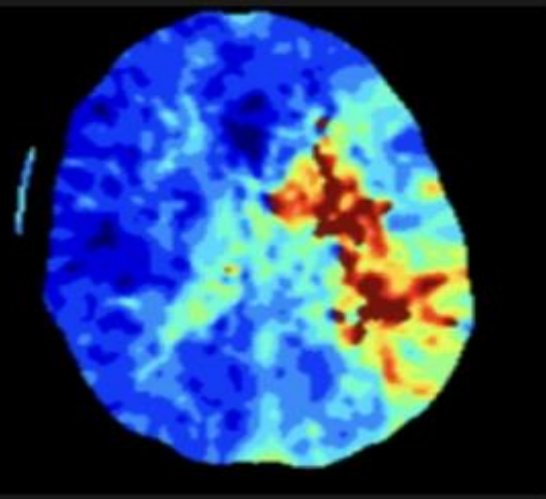
MTT



CBF



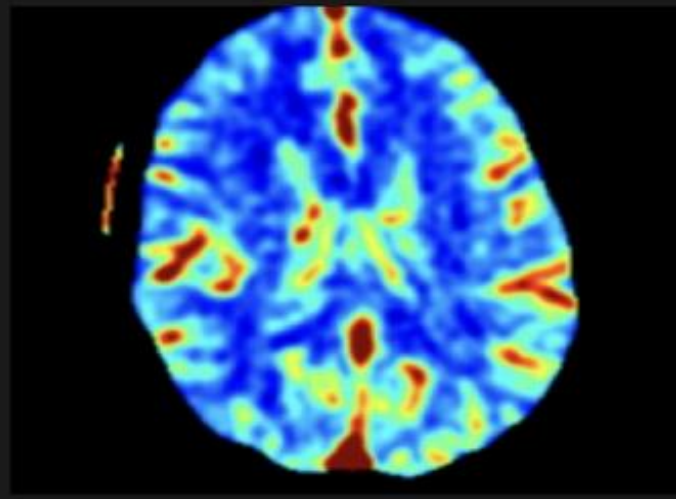
TTP  
(Tmax)



CBV

normal

or

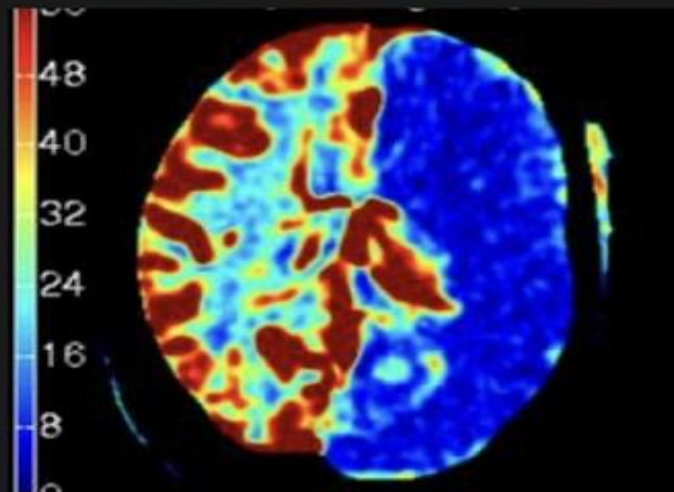
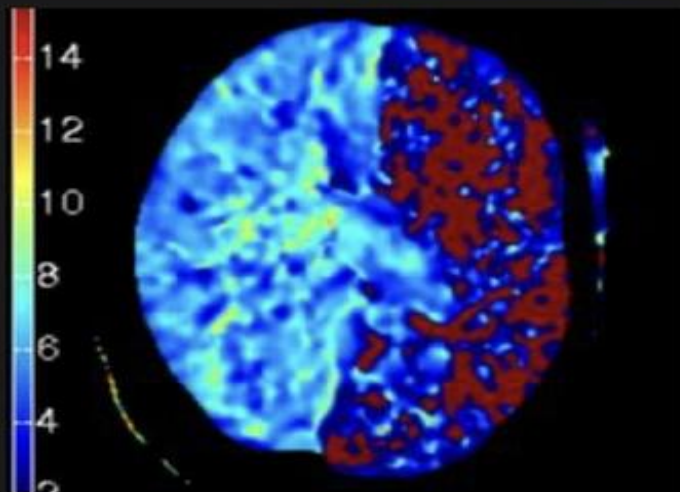




Key concept

Core infarct

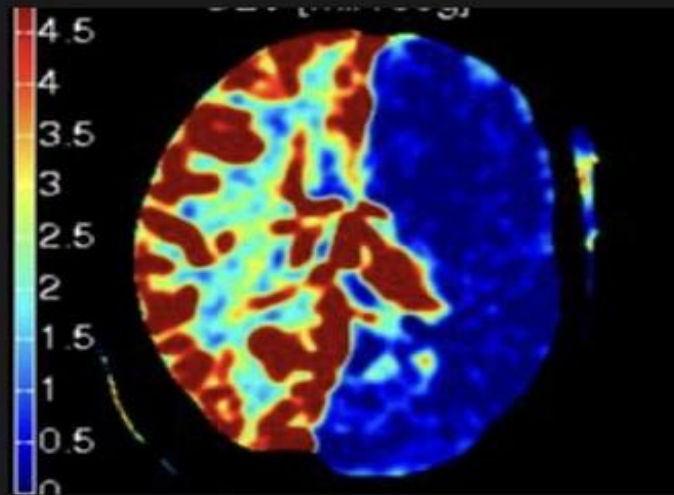
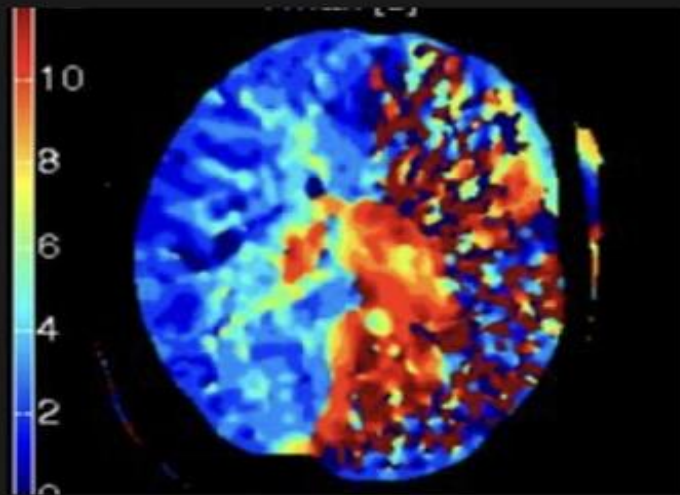
MTT



CBF



TTP  
(Tmax)



CBV



- Use of stent retrievers is indicated in preference to the Mechanical Embolus Removal in Cerebral Ischemia (MERCI) device.
- The technical goal of the thrombectomy procedure should be reperfusion to a modified Thrombolysis in Cerebral Infarction (mTICI) grade 2b/3 angiographic result to maximize the probability of a good functional clinical outcome.

Grade 0	No perfusion
Grade 1	Antegrade reperfusion past the initial occlusion, but limited distal branch filling with little or slow distal reperfusion
Grade 2a	Antegrade reperfusion of less than half of the occluded target artery previously ischemic territory (e.g., in one major division of the MCA and its territory)
Grade 2b	Antegrade reperfusion of more than half of the previously occluded target artery ischemic territory (e.g., in two major divisions of the MCA and their territories)
Grade 3	Complete antegrade reperfusion of the previously occluded target artery ischemic territory, with absence of visualized occlusion in all distal branches

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*MCA indicates middle cerebral artery; and mTICI is modified treatment in cerebral ischemia scale.*



- It is reasonable to select an anesthetic technique during EVT for AIS on the basis of individualized assessment of patient risk factors, technical performance of the procedure, and other clinical characteristics.
- Conscious sedation (CS) was the anesthetic modality widely used during endovascular procedures for acute stroke in the recent endovascular trials (90.9% of ESCAPE, 63% of SWIFT PRIME) with no clear positive or negative impact on outcome.
- Although several retrospective studies suggest that GA for acute stroke endovascular procedures produces worsening of functional outcomes, the limited available prospective randomized data do not support this.
- The use of a proximal balloon guide catheter or a large-bore distal-access catheter, rather than a cervical guide catheter alone, in conjunction with stent retrievers may be beneficial.

- Treatment of tandem occlusions (both extracranial and intracranial occlusions) when performing mechanical thrombectomy may be reasonable.
- The safety and efficacy of IV glycoprotein IIb/IIIa inhibitors administered during endovascular stroke treatment are uncertain.(IIb)
- Use of salvage technical adjuncts, including intra-arterial fibrinolysis, may be reasonable to achieve mTICI grade 2b/3 angiographic results.(IIb)
- Intra-arterial fibrinolytic therapy played a limited role in the recent endovascular trials but was used as rescue therapy, **not initial treatment**. In THRACE, an intra-arterial lytic was used to a maximum dose of 0.3 mg/kg and allowed to establish goal reperfusion, only after mechanical thrombectomy was attempted.

- In patients who undergo mechanical thrombectomy, it is reasonable to maintain the BP at  $\leq 180/105$  mm Hg during and for 24 hours after the procedure.(IIa)

## **Other Endovascular Therapies**

- Mechanical thrombectomy with stent retrievers is recommended over intraarterial fibrinolysis as first-line therapy.(I)
- Intra-arterial fibrinolysis initiated within 6 hours of stroke onset in carefully selected patients who have contraindications to the use of IV alteplase might be considered, but the consequences are unknown.(IIb)

# Pediatric strokes

## **AHA/ASA guidelines:**

- In the absence of pediatric clinical trial data to guide treatment decisions, hyperacute therapies for childhood AIS remain controversial.

## **ESO/ESMINT guidelines:**

- **Nothing**

## **Other evidence + recommendation of the authors**

- **Retrospective Save ChildS Study found good clinical outcomes and low complication rates regardless of device selection.**
- **We recommend to perform EVT in pediatric patients with LVO but caution should be applied if an underlying arteriopathy is suspected.**