Scuola Superiore di Neurologia Sin

**IV CORSO**

***Nuovi sviluppi nel trattamento acuto dell'ictus ischemico***

# Valutazione neuroradiologica pre-intervento: cosa è necessario e cosa è superfluo


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OSPEDALE SAN RAFFAELE

UNIVERSITÀ VITA-SALUTE SAN RAFFAELE

DIVISION OF NEUROSCIENCE

# cosa è necessario e cosa è superfluo

# Valutazione neuroradiologica pre-intervento

RM+DWI

TC + Angio-TC


RM+DWI
TC + Angio-TC
Collat./SWI
Perf. TC/MR

# European Consensus Statement on Thrombectomy

*(Accepted for publication in International Journal of Stroke)*

## Mechanical thrombectomy in acute ischemic stroke: Consensus statement by ESO-Karolinska Stroke Update 2014/2015, supported by ESO, ESMINT, ESNR and EAN

Nils Wahlgren[1,2], Tiago Moreira[1,2], Patrik Michel[1,2], Thorsten Steiner[1,2], Olav Jansen[1,3,4], Christophe Cognard[1,2,3], Heinrich P Mattle[1,2], Wim van Zwam[1], Staffan Holmin[1], Turgut Tatlisumak[1,2], Jesper Petersson[1],Valeria Caso[1,2], Werner Hacke[1,2], Mikael Mazighi[2], Marcel Arnold[2], Urs Fischer[2], Istvan Szikora[3], Laurent Pierot[3], Jens Fiehler[2,3,4], Jan Gralla[2,3,4], Franz Fazekas[5], Kennedy R Lees[2] for ESO-KSU, ESO, ESMINT, ESNR and EAN

Organisations represented by the authors

[1)] European Stroke Organisation-Karolinska Stroke Update (ESO-KSU) consensus conference

[2)] European Stroke Organisation (ESO)

[3)] European Society of Minimally Invasive Neurological Therapy (ESMINT)

[4)] European Society of Neuroradiology (ESNR)

[5)] European Academy of Neurology (EAN)

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# Mechanical thrombectomy in acute ischemic stroke: Consensus statement by ESO-Karolinska Stroke Update 2014/2015, supported by ESO, ESMINT, ESNR and EAN

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# Treatment recommendations

Mechanical thrombectomy, in addition to intravenous thrombolysis within 4.5 hours when eligible, is recommended to treat acute stroke patients with large artery occlusions in the anterior circulation up to 6 hours after symptom onset (Grade A, Level 1a, KSU Grade A). - *new*

Thrombectomy is recommended for LVO Stroke of the anterior circulation in addition to IV up to

6h after onset

# Treatment recommendations

If intravenous thrombolysis is contraindicated (e.g. Warfarin-treated with therapeutic INR) mechanical thrombectomy is recommended as first-line treatment in large vessel occlusions (Grade A, Level 1a, KSU Grade A) – *changed and updated level of evidence*.

Thrombectomy is recommended as first line treatment in case IV is contraindicated

# Treatment recommendations

Patients with acute basilar artery occlusion should be evaluated in centres with multimodal imaging and treated with mechanical thrombectomy in addition to intravenous thrombolysis when indicated (Grade B, Level 2a, KSU Grade C); alternatively they may be treated within a randomized controlled trial for thrombectomy approved by the local ethical committee - *new*

Thrombectomy can be performed in the posterior circulation

But NO Evidence

# Treatment recommendations

For mechanical thrombectomy, stent retrievers approved by local health authorities should be considered (Grade A, Level 1a, KSU Grade A). - *new*

Other thrombectomy or aspiration devices approved by local health authorities may be used upon the neurointerventionists discretion if rapid, complete and safe revascularisation of the target vessel can be achieved (Grade C, Level 2a, KSU Grade C) - *new*

Evidence only concerns stent-retrievers

Door is open to other device/technique

But need evaluation

# Treatment recommendations

The decision to undertake mechanical thrombectomy should be made jointly by a multidisciplinary team comprising at least a stroke physician and a neurointerventionist and performed in experienced centres providing comprehensive stroke care and expertise in neuroanaesthesiology (Grade C, Level 5, GCP, KSU Grade C).

Thrombectomy must be done by comprehensive neurovascular team

# Treatment recommendations

Mechanical thrombectomy should be performed by a trained and experienced neurointerventionist who meets national and/or international requirements (Grade B, Level 2b, KSU Grade B) – *changed in level of evidence*.

And by highly specialized Neuro-interventionists

What are the National / International requirements ?

# Patient Selection

Patients with radiological signs of large infarcts (for ex. using the ASPECTS score) may be unsuitable for thrombectomy (Grade B, Level 2a, KSU Grade B) - *new*

The major question!

Which patient should not receive thrombectomy due to a too large stroke?

On Which imaging criteria we should refuse to perform a thrombolysis ?

And why?

Is thrombectomy dangerous?

Or just futile

# Thrombectomy
# What we don't know

1) What means "up to 6h after onset" ?
2) Even in minor stroke? NIHSS < 5 ?
3) Even in major stroke? NIHSS > 25 ?
4) Even with large infarct? ASPECT < 4 ?
5) Which type of anesthesia ?
6) Which imaging do we need?

# RUOLO DELL'IMAGING

1. Presenza di emorragia

2. Presenza di trombo/embolo in un vaso di largo calibro trattabile per via i.v.

3. Estensione del core ischemico

4. Presenza di zona di penombra ischemica (?)

# IMAGING: ASPETTI TECNICI

Sia la TC che la RM possono essere utilizzate per:

- escludere emorragie o mimics di stroke

- riconoscere e quantificare il danno tissutale

# IMAGING: TC

**TC** **Livello 1/ CLASSE I** : esclusione emorragia
primo esame per la valutazione dello stroke

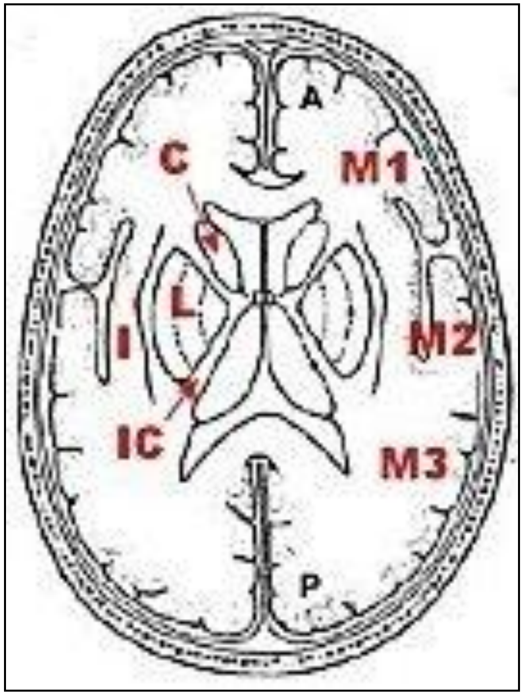
| | |
|---|---|
| **Livello 1: quasi sempre utile e disponibile per tutti i pazienti**<br>Livello 2: potenzialmente utile e disponibile per la maggior parte dei pazienti<br>Livello 3: disponibile per la ricerca ed eventualemente per studi clinici. | **CLASSE I: evidenza o generale consenso di beneficio, utilità e efficacia nel trattamento dello stroke**<br>CLASSE II: evidenza e opinioni contrastanti riguardo l'utilità/efficacia nel trattamento dello stroke<br>CLASSE IIa: evidenza/opinioni a favore della utilità /efficacia<br>CLASSE IIb: utilità/efficacia meno definite da evidenza o opinioni esperti<br>CLASSE III: nessuna evidenza su utilità/efficacia e in alcuni casi pericoloso in uso clinico |

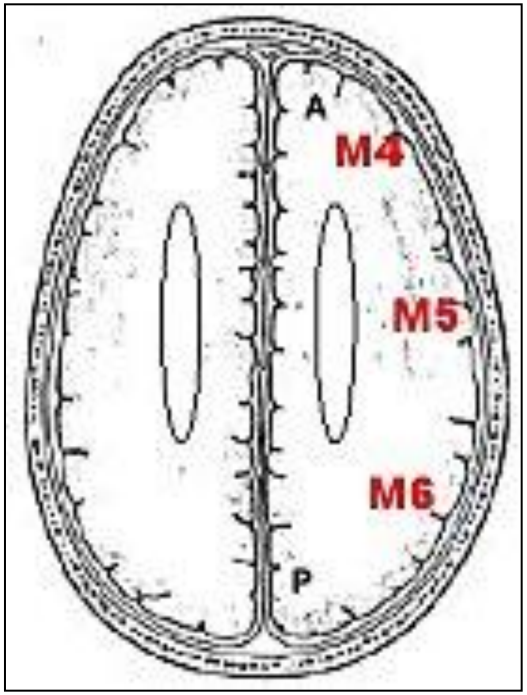
Gonzales GR et al MGH acute stroke algorithm,
*J Neurointervent Surg 2013*

# IMAGING: TC

## Estensione della lesione infartuale

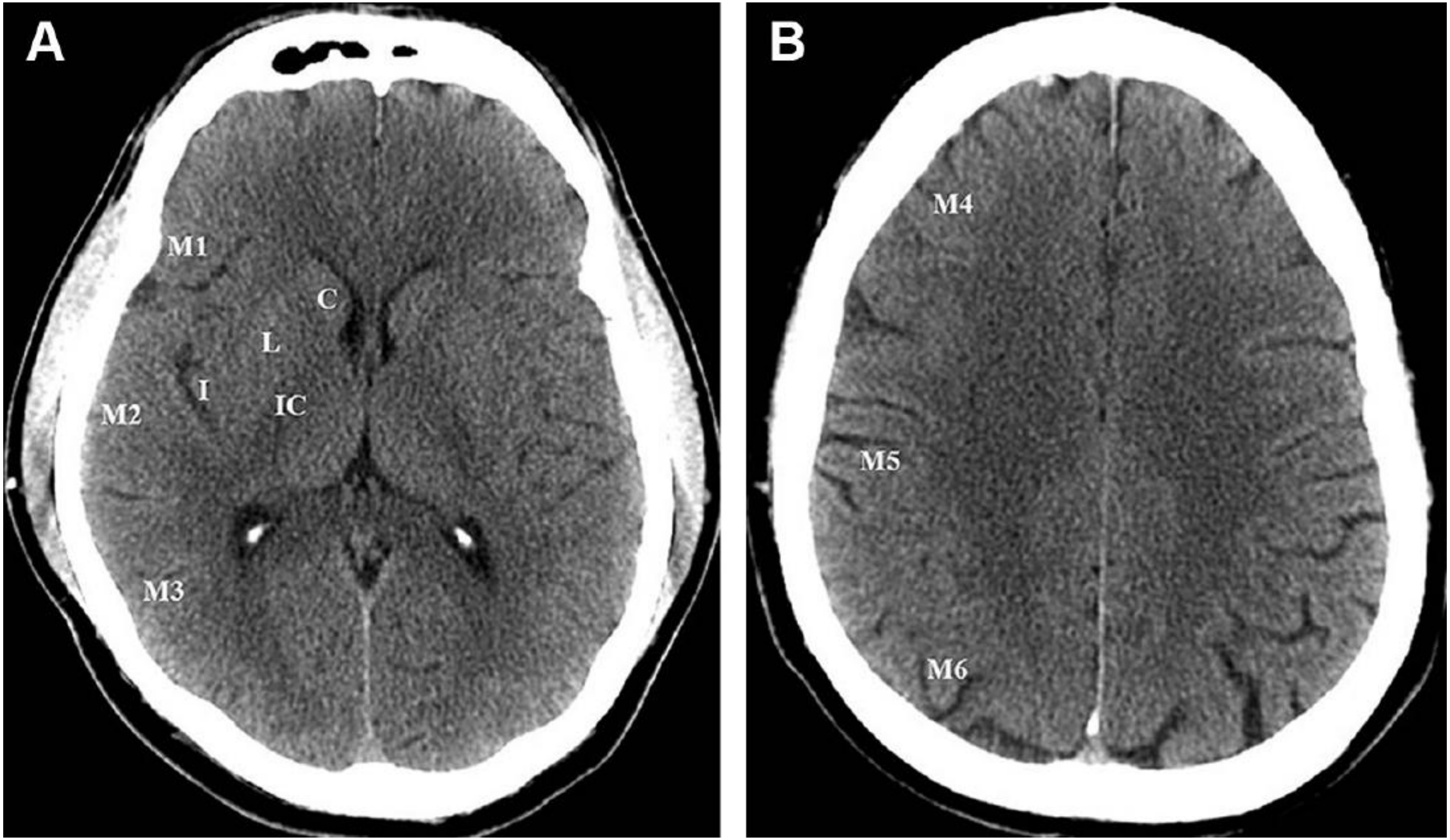
**Ma…** **Livello 2/ CLASSE IIa** definizione dell'estensione dell'infarto (core) (in fase acuta)




ICC 0,834 for NCCT among 4 readers. Stroke, 2013

# ASPECTS (Alberta Stroke Program Early CT Score)



# ASPECTS

Patients with an ASPECTS score of 7 or less have a substantially increased risk of thrombolysis-related parenchymal hemorrhage, have a trend toward poorer outcomes, and are less likely to benefit from IV tPA. Although the decision to treat patients with intraarterial therapy varies between institutions, in general, patients with ASPECTS scores of 8 to 10 are considered good candidates and those with a score of less than 5 are typically not treated.

# Patient Selection

Imaging techniques for determining infarct and penumbra sizes can be used for patient selection and correlate with functional outcome after mechanical thrombectomy (Grade B, Level 1b, KSU Grade B) - *new*.

- 1/3 MCA: No

- ASPECT: No

- Volume of diffusion by automated software: Yes but which volume?

- Mutliphase CTA (Calgari) ?

- “Rapid” mismatch ?

# Patient Selection

Intracranial vessel occlusion must be diagnosed with non-invasive imaging whenever possible before considering treatment with mechanical thrombectomy (Grade A, Level 1a, KSU Grade A) - *new*.

No thrombectomy if no LVO

# IMAGING: TC

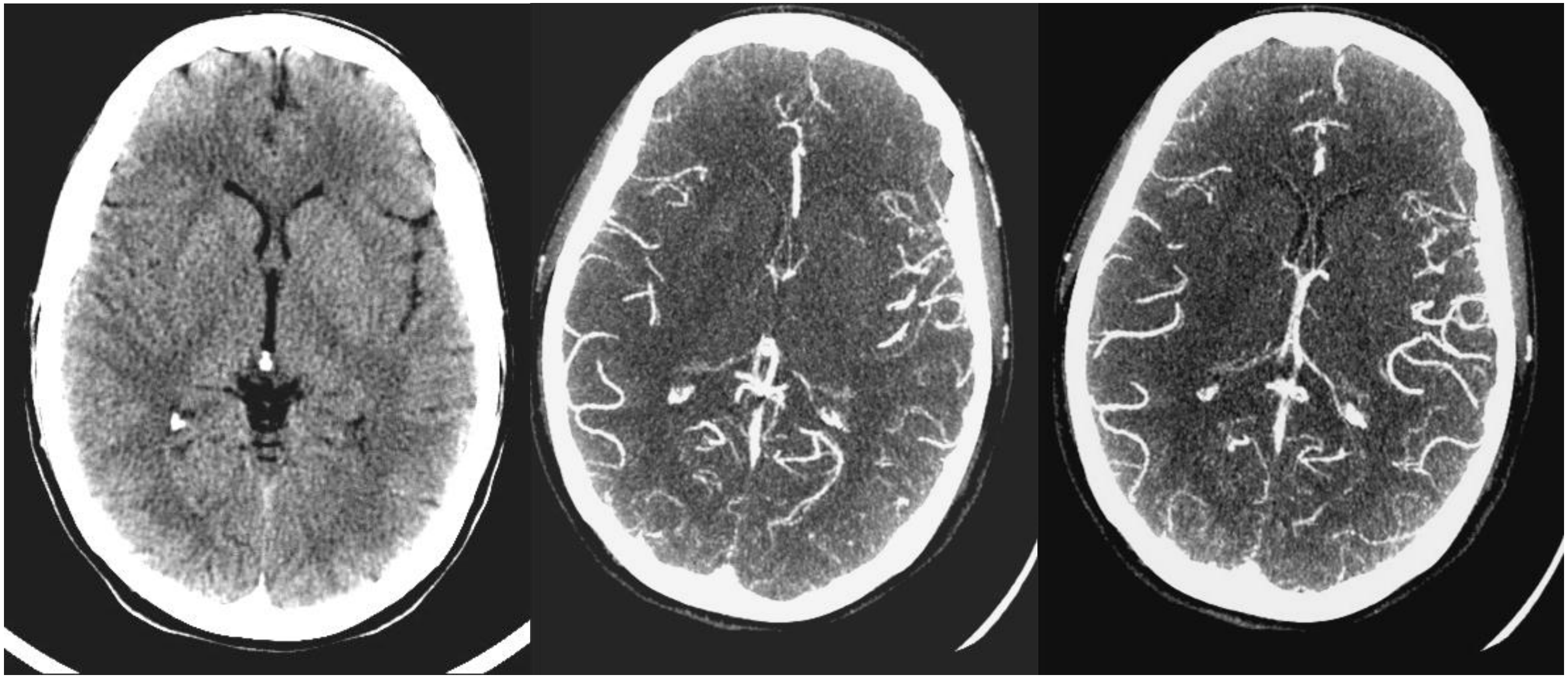
## STENO-OCCLUSIONE VASCOLARE

**Angio TC** **Livello 1/ CLASSE I** per valutazione occlusione vasi medio/grosso calibro (ICA, ACM, AB)

# IMAGING: TC

## STENO-OCCLUSIONE VASCOLARE

**CTA-Source Images** **Livello 2/ CLASSE III**



*Camargo et al ,Radiology 2007*
*Pulli et al ,Radiology 2012*

# Patient Selection

Imaging techniques for determining infarct and penumbra sizes can be used for patient selection and correlate with functional outcome after mechanical thrombectomy (Grade B, Level 1b, KSU Grade B) - *new*.

- 1/3 MCA: No
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- Mutliphase CTA?
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# IMAGING: TC

## STENO-OCCLUSIONE VASCOLARE

**Angio TC** **Livello 1/ CLASSE I** per valutazione occlusione vasi medio/grosso calibro (ICA, ACM, AB)

Circoli collaterali

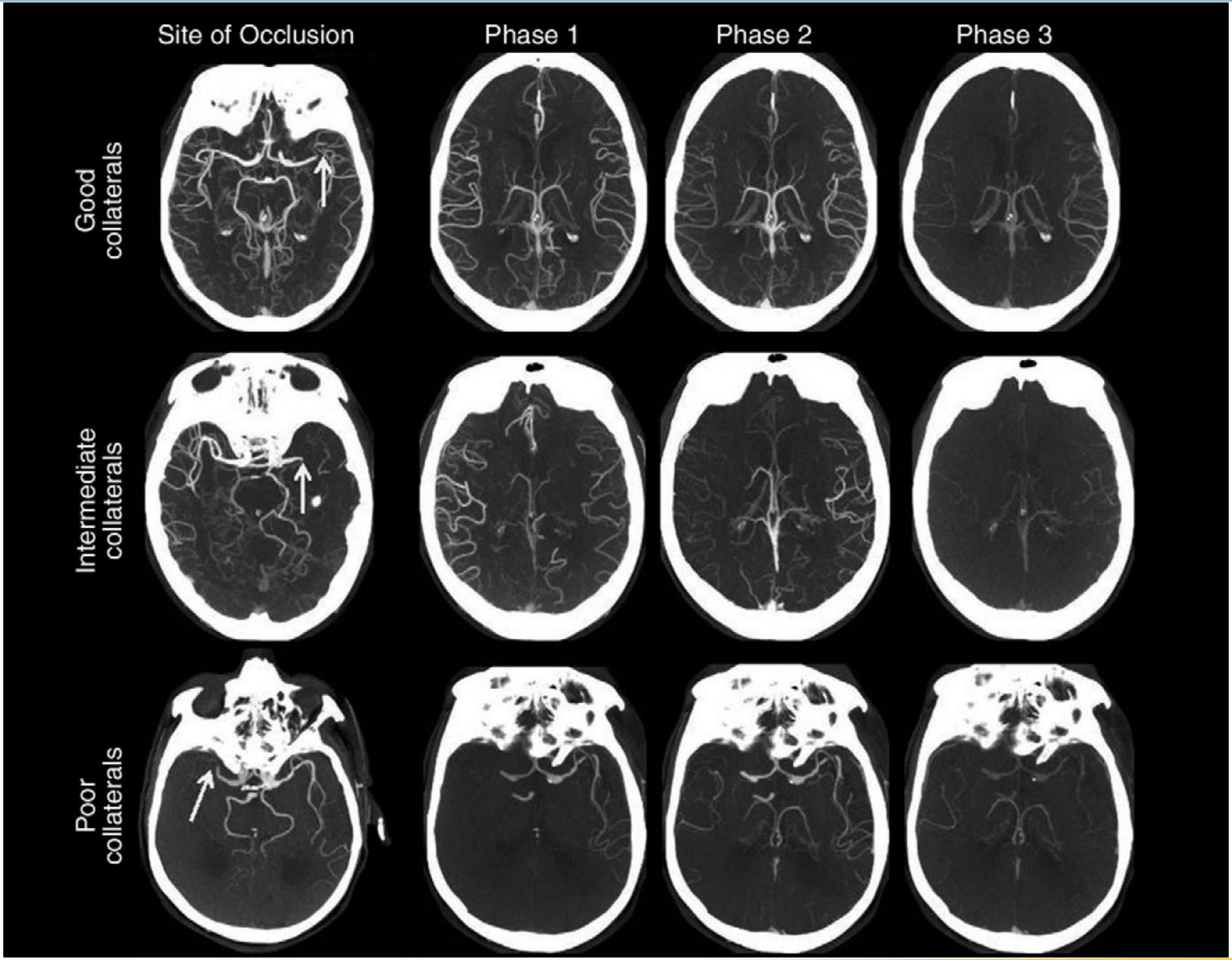
Ripetibile, affidabile

**Collateral blood vessels in acute ischaemic stroke: a potential therapeutic target**

*Ashfaq Shuaib, Ken Butcher, Askar A Mohammad, Maher Saqqur, David S Liebeskind*

**Lancet Neurology 2011; 10:909-921**

# IMAGING: TC



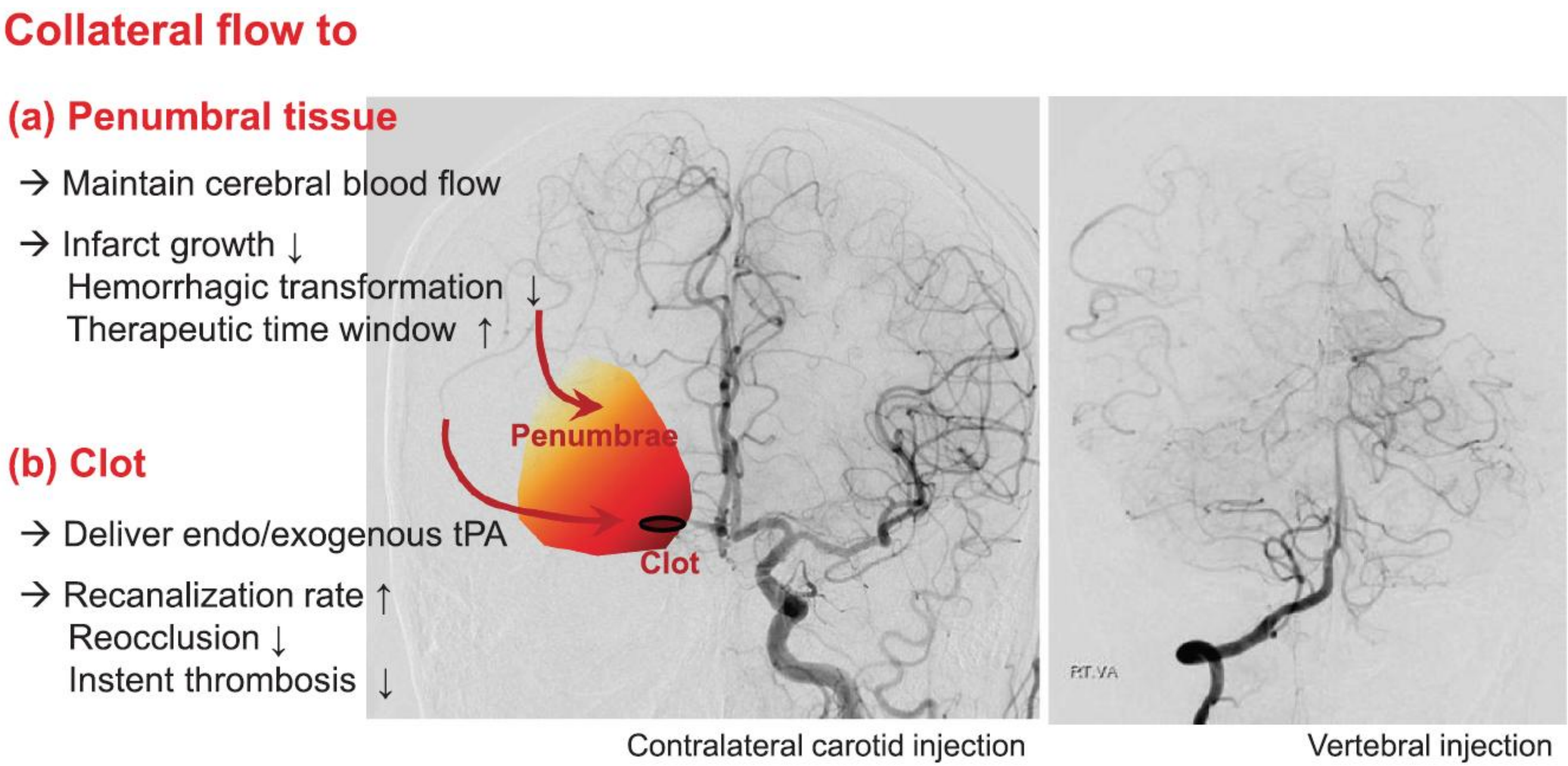
Site of Occlusion
Phase 1
Phase 2
Phase 3
Good collaterals
Intermediate collaterals
Poor collaterals

# Collateral Circulation in Ischemic Stroke

## Assessment Tools and Therapeutic Strategies

Oh Young Bang, MD, PhD; Mayank Goyal, MD; David S. Liebeskind, MD

*Stroke*. 2015;46:3302-3309. DOI: 10.1161/STROKEAHA.115.010508.)

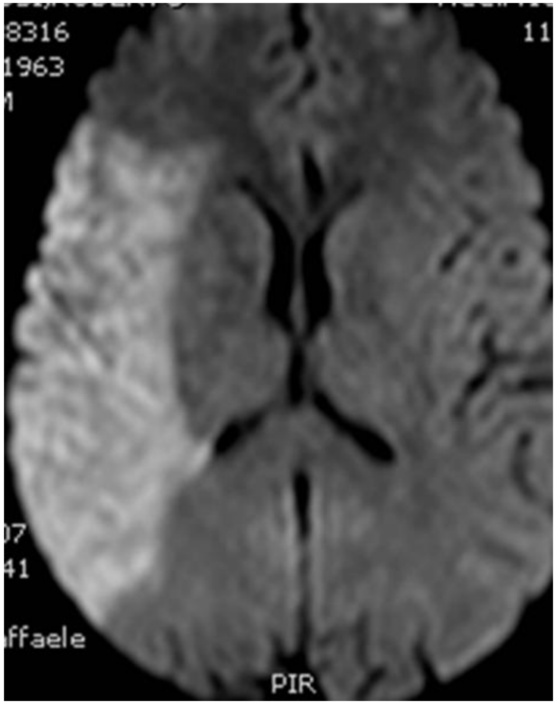


# IMAGING: RM - DWI

## Estensione della lesione infartuale

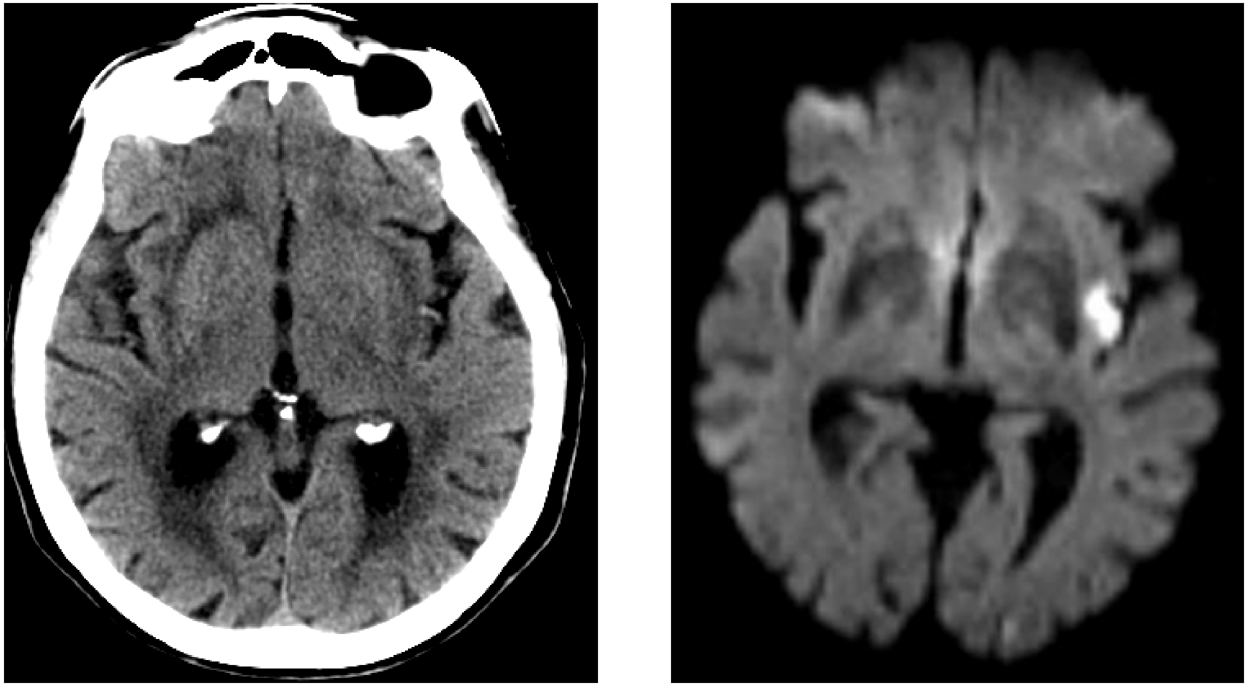
**DWI** **Livello 1/CLASSE I** nella valutazione del "core"

Sensibile e specifica

# Estensione della lesione infartuale

**DWI** **Livello 1/CLASSE I** nella valutazione del “core”
Sensibile e specifica



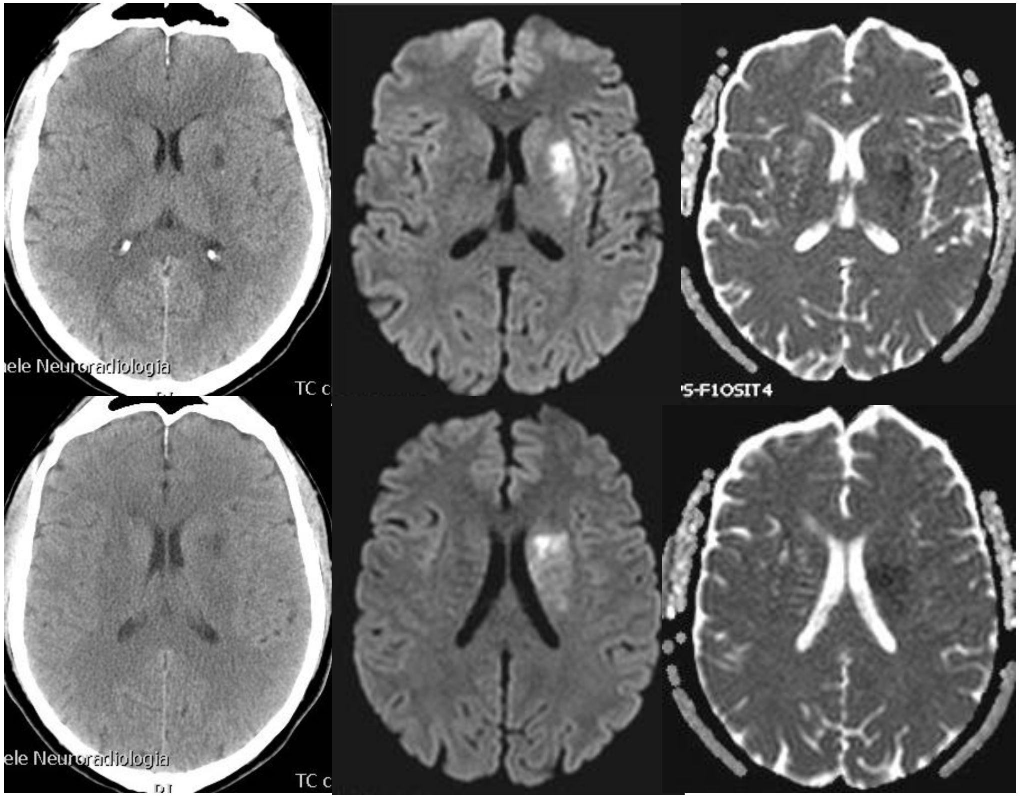
*MA,72aa, emisindrome ds 3,5 ore prima*

# Estensione della lesione infartuale

**DWI** **Livello 1/CLASSE I** nella valutazione del "core"

Sensibile e specifica

Sottostima la dimensione dell'infarto, reversibile




*UA,65aa, emisindrome sn 4ore prima*

# Estensione della lesione infartuale

**DWI** Multiple studies have demonstrated that initial DWI infarct volumes of greater than 70 mL are highly predictive of poor clinical outcomes irrespective of time of presentation and treatment in most patients

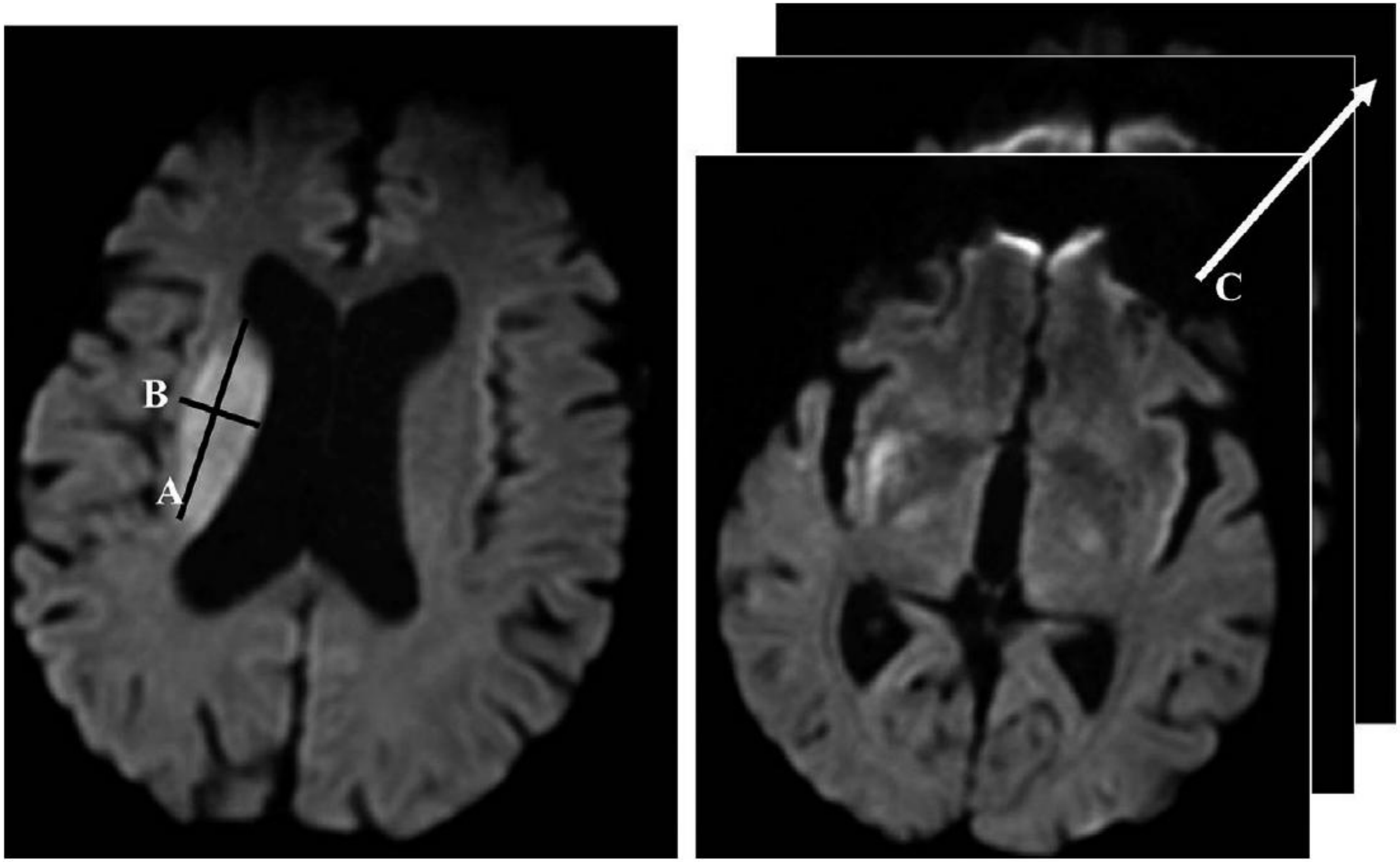
Yoo AJ, Chaudhry ZA, Nogueira RG, et al. Stroke 2012;43(5):1323–30.
Yoo AJ, Verduzco LA, Schaefer PW, et al. Stroke 2009;40(6):2046–54.
Sanak D, Nosal V, Horak D, et al Neuroradiology 2006;48(9):632–9.
Lansberg MG, Straka M, Kemp S, et al. Lancet Neurol 2012;11(10):860–7.

# Patient Selection

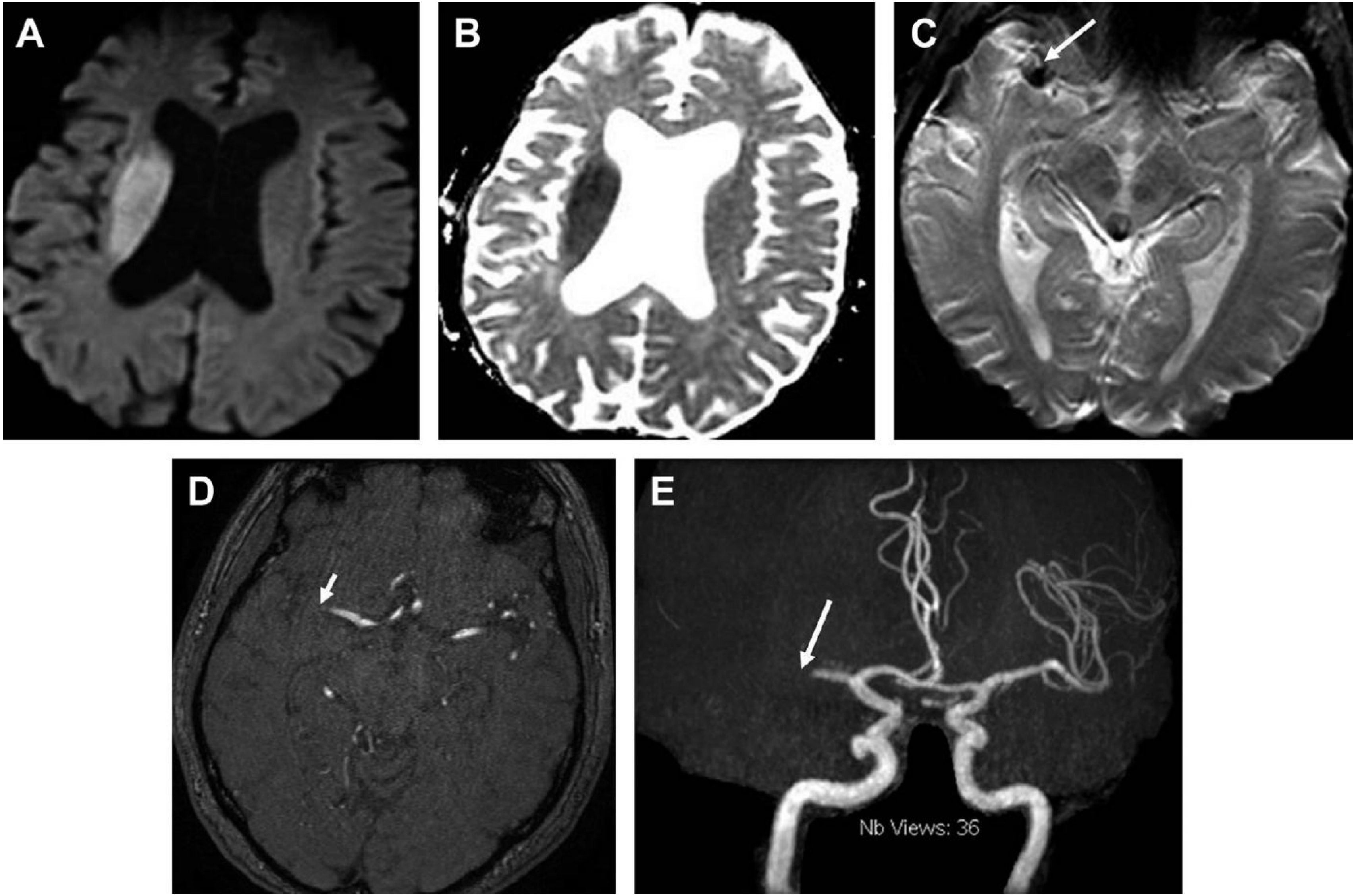
Imaging techniques for determining infarct and penumbra sizes can be used for patient selection and correlate with functional outcome after mechanical thrombectomy (Grade B, Level 1b, KSU Grade B) - *new*.

- 1/3 MCA: No
- ASPECT: No
- Volume of diffusion by automated software: Yes but which volume?
- Mutliphase CTA (Calgari) ?
- “Rapid” mismatch ?

# VOLUME CORE ISCHEMICO DWI: ABC/2



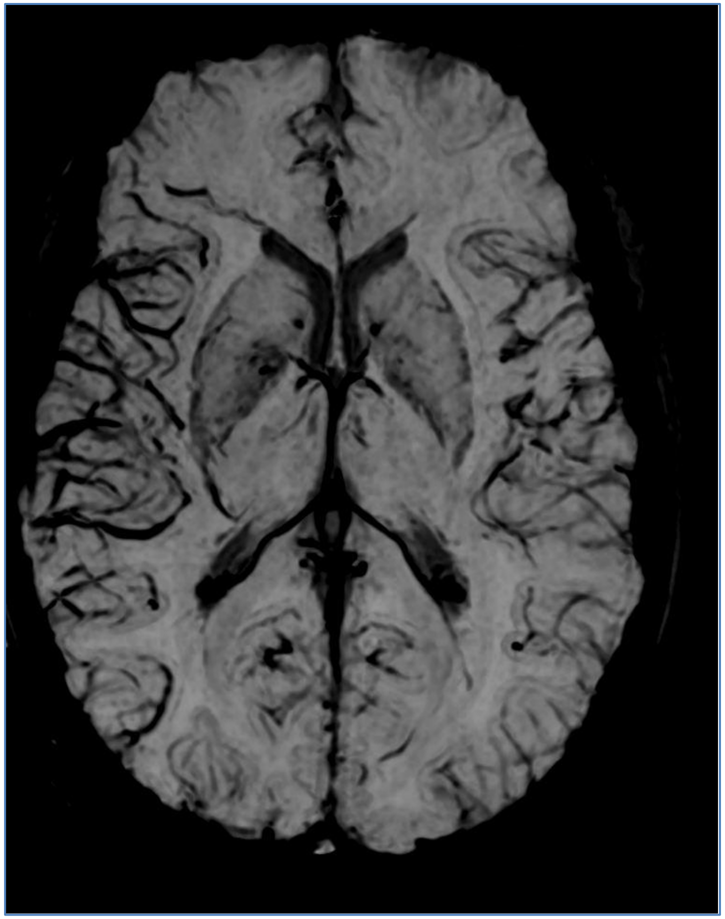
# IMAGING: RM – SWI (Susceptibility weighted imaging)



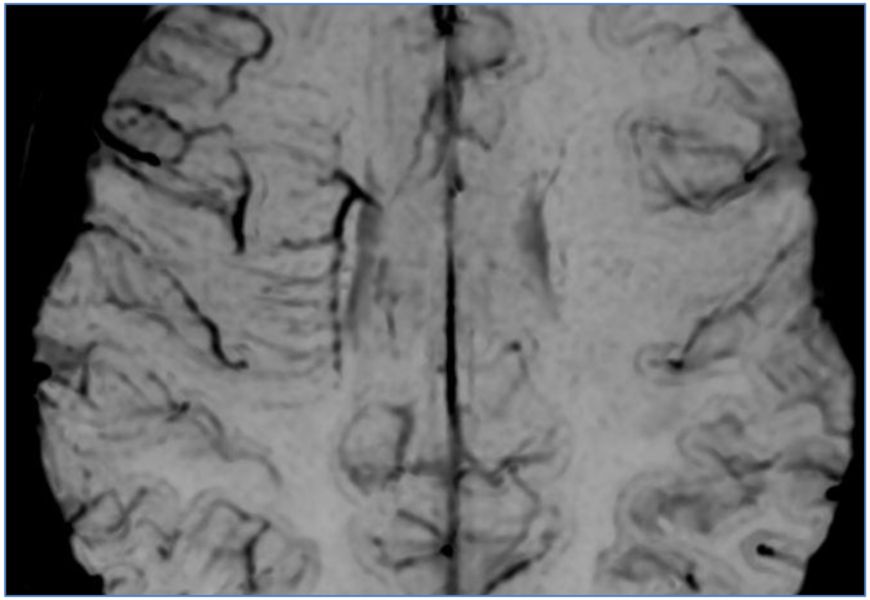

Beharoze A.V., Schaefer P.V. Radiol Clin N Am 2015

# IMAGING: RM - SWI

## Prominent Vessels Sign

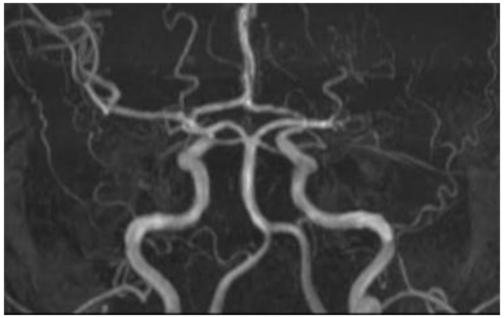


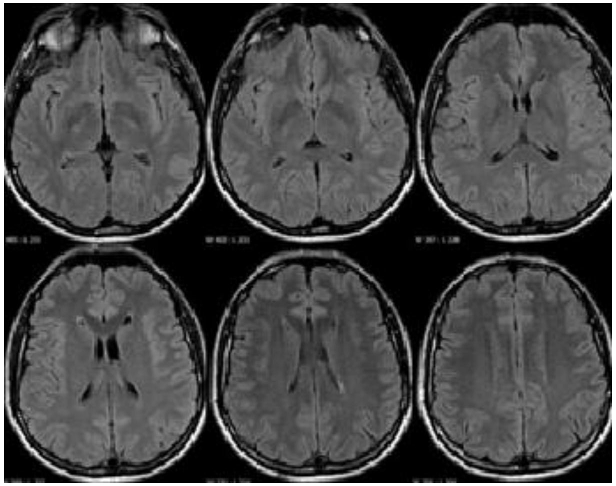
«Prominent cortical veins»

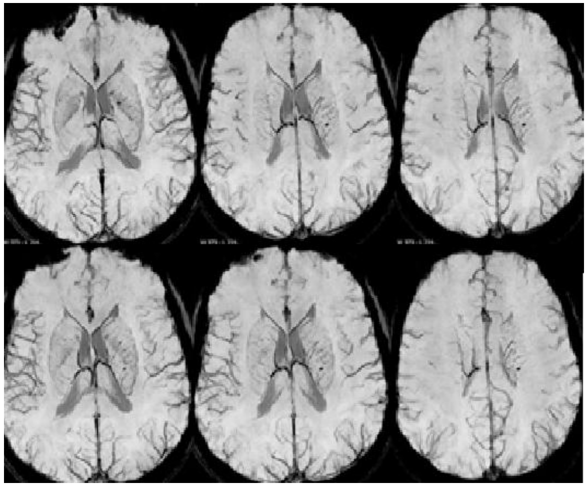


«Brush sign»

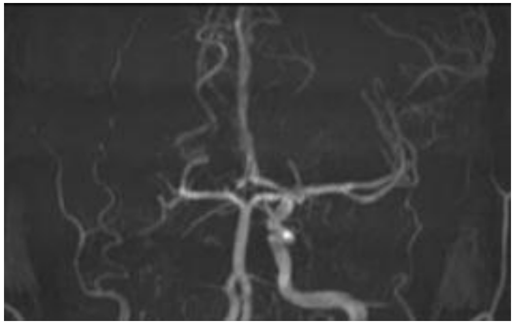
# IMAGING: RM - SWI

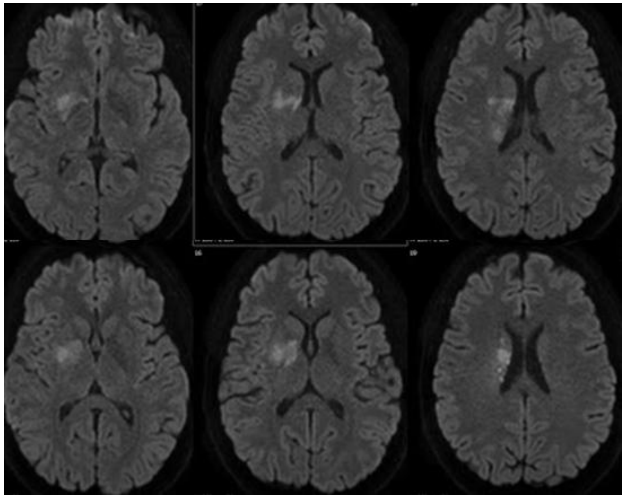


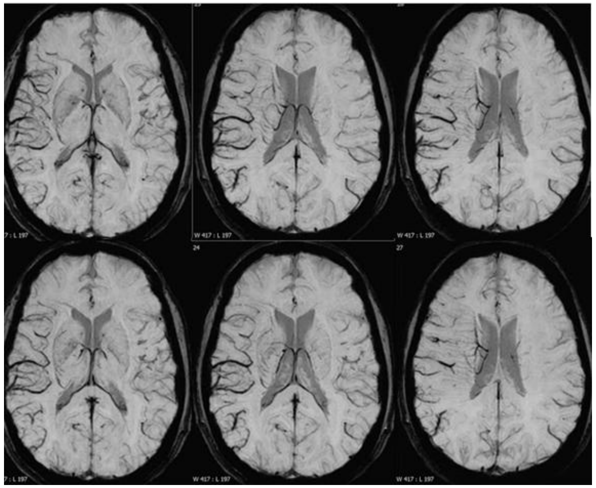




Paziente 1







Paziente 2

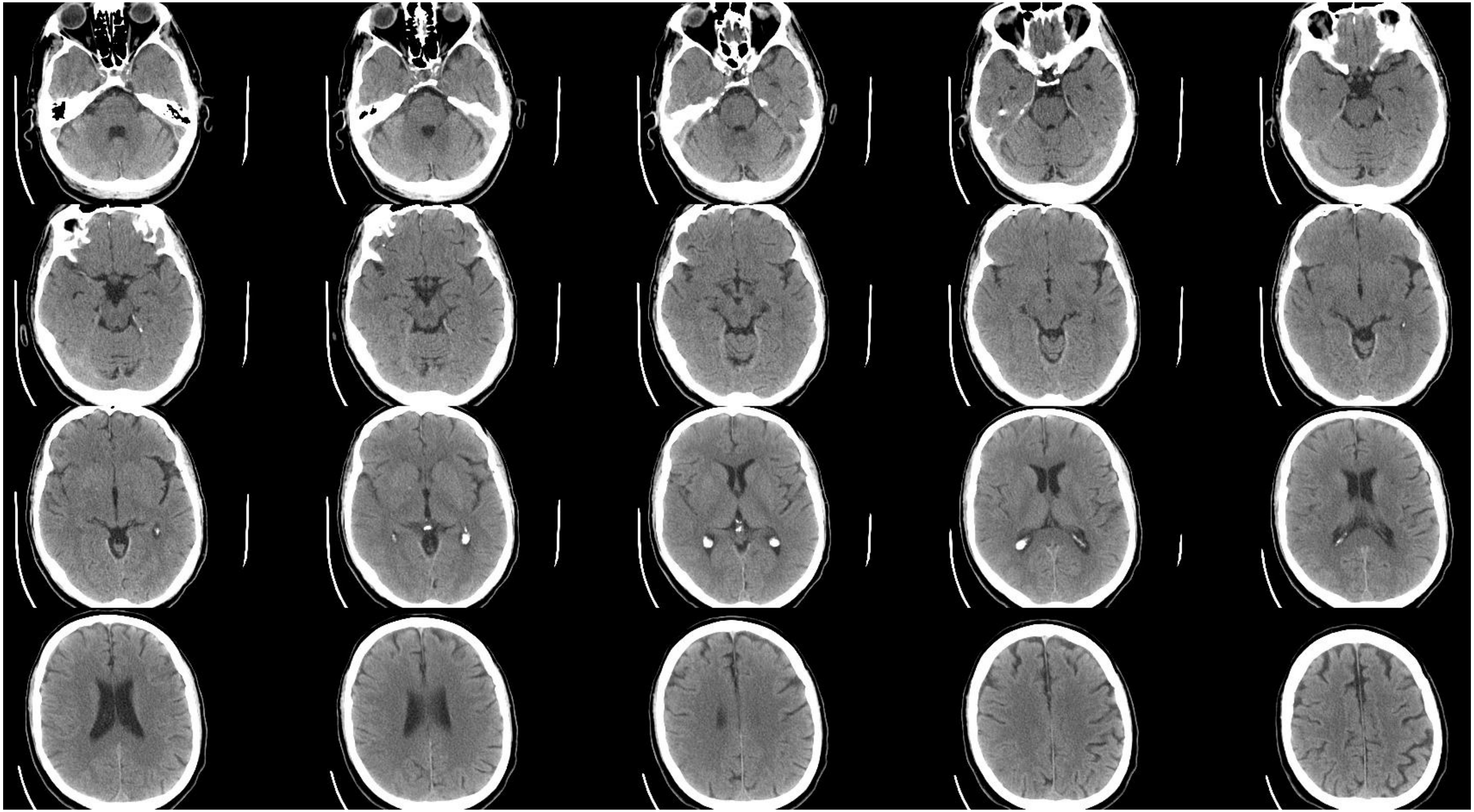
Mismatch SWI-DWI: penombra ischemica?

# CORE E TROMBECTOMIA

- MR CLEAN: ASPECT con CT + CTA. Tempo medio insorgenza stroke/puntura femorale 260 min
- ESCAPE: CT multifase. Tempo medio insorgenza stroke/ricanalizzazione 241 min
- EXTEND-IA: CTP. Tempo medio insorgenza stroke/puntura femorale 220 min
- SWIFT PRIME: CT, CTA, CTP o RM. Tempo medio insorgenza stroke/puntura femorale 224 min

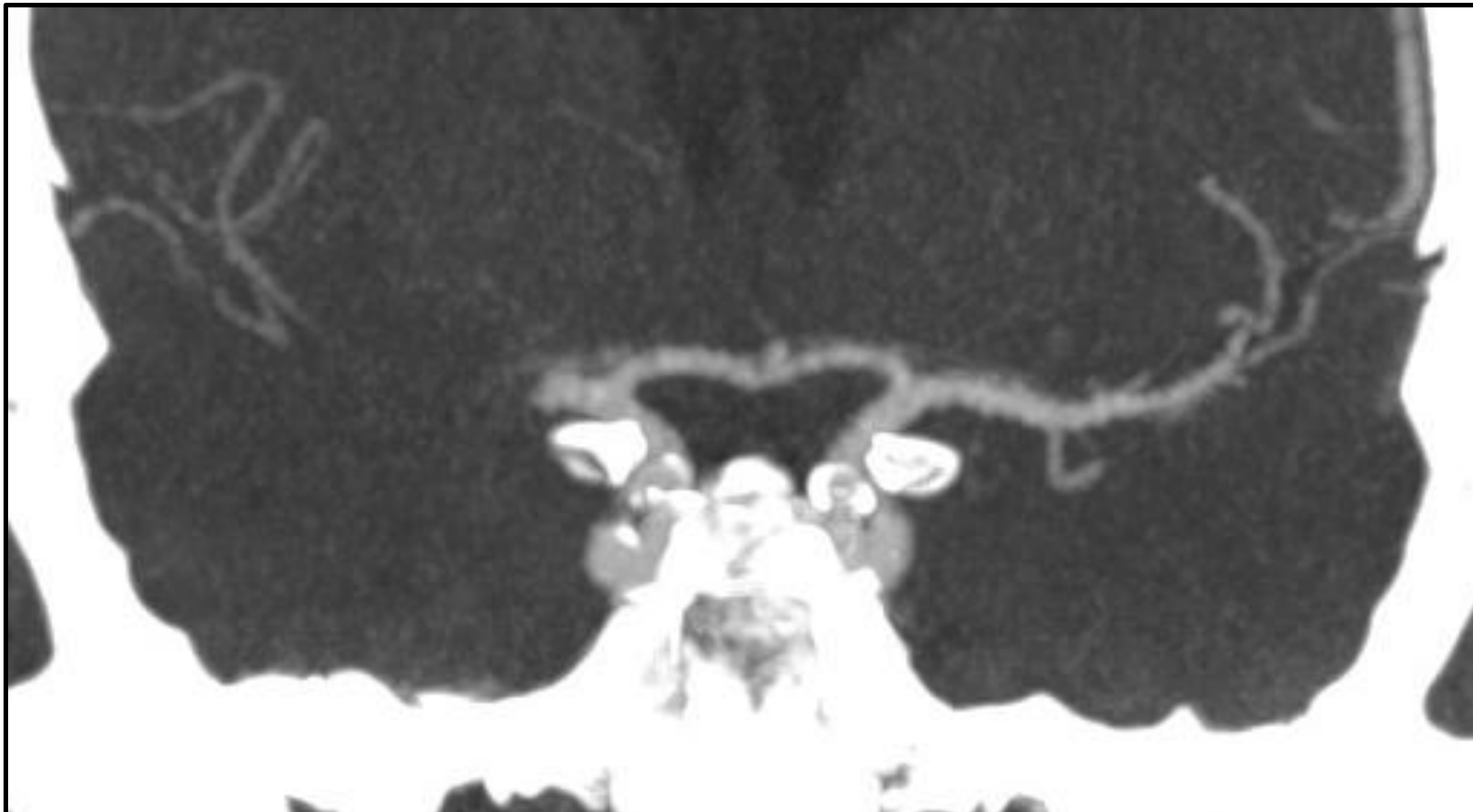
M, 57 aa
Pregresso IMA
Paziente in TAO, portatore di LVAD (Left Ventricular Assist Device)
Emiplegia sin ad esordio acuto
NIHSS 17

# TC h13.07



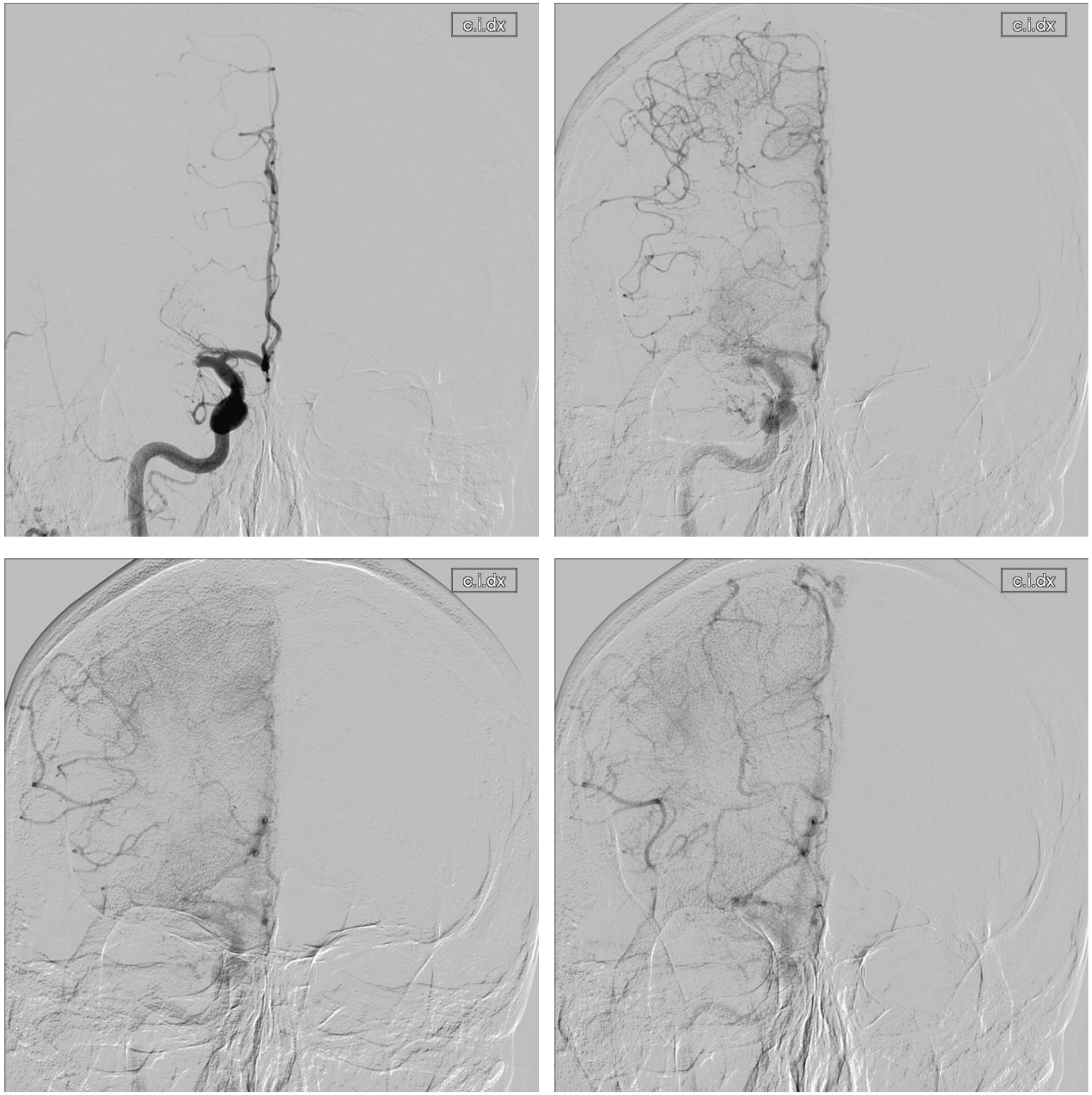
Dubbia iperdensità ACM dx, ASPECT 8 (insula post, temporale)

AngioTC h. 13.09



Occlusione ACM dx

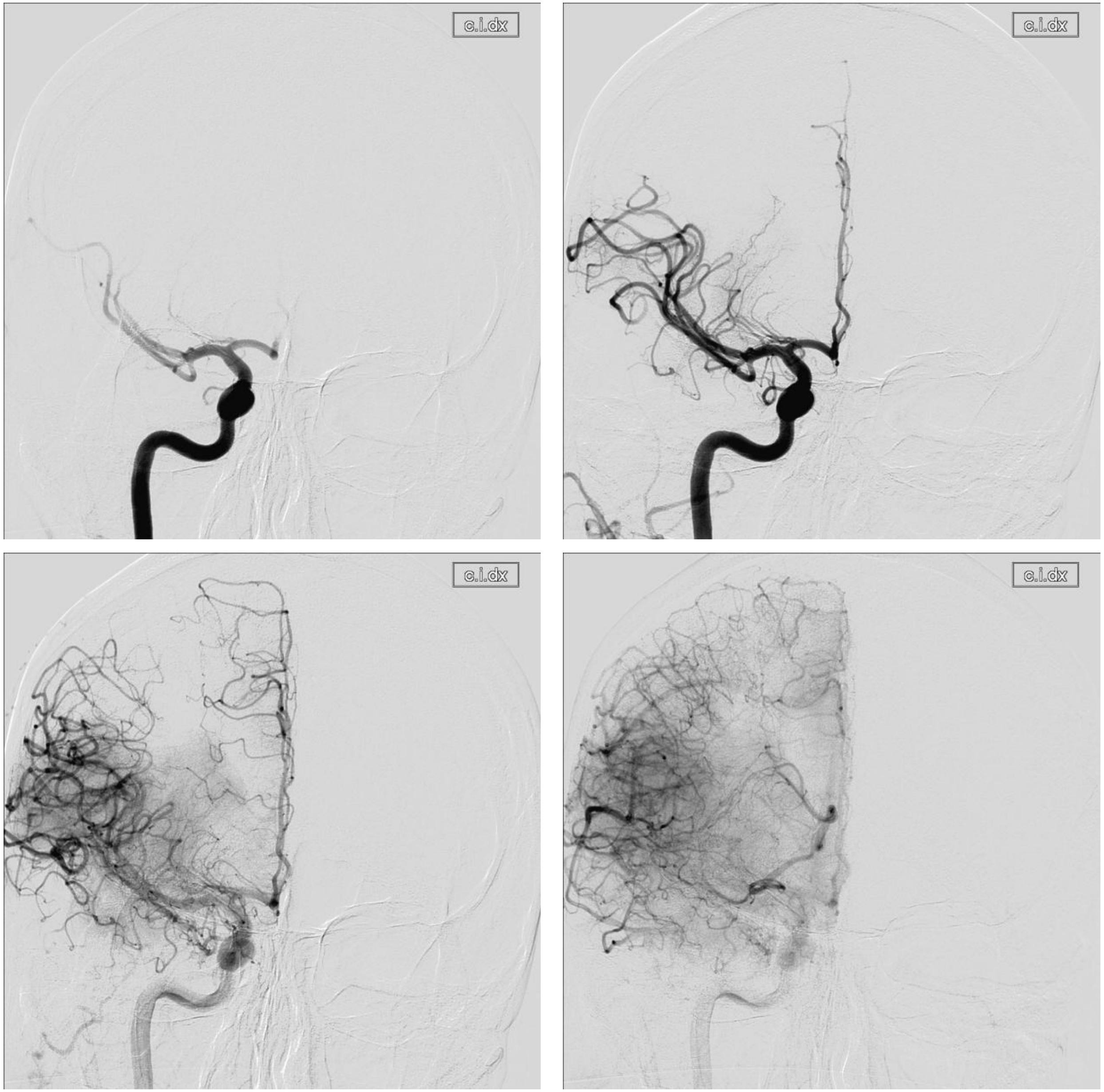
# Carotidografia interna dx, h13.54




Occlusione ACM dx, compensi transcorticali da ACA dx

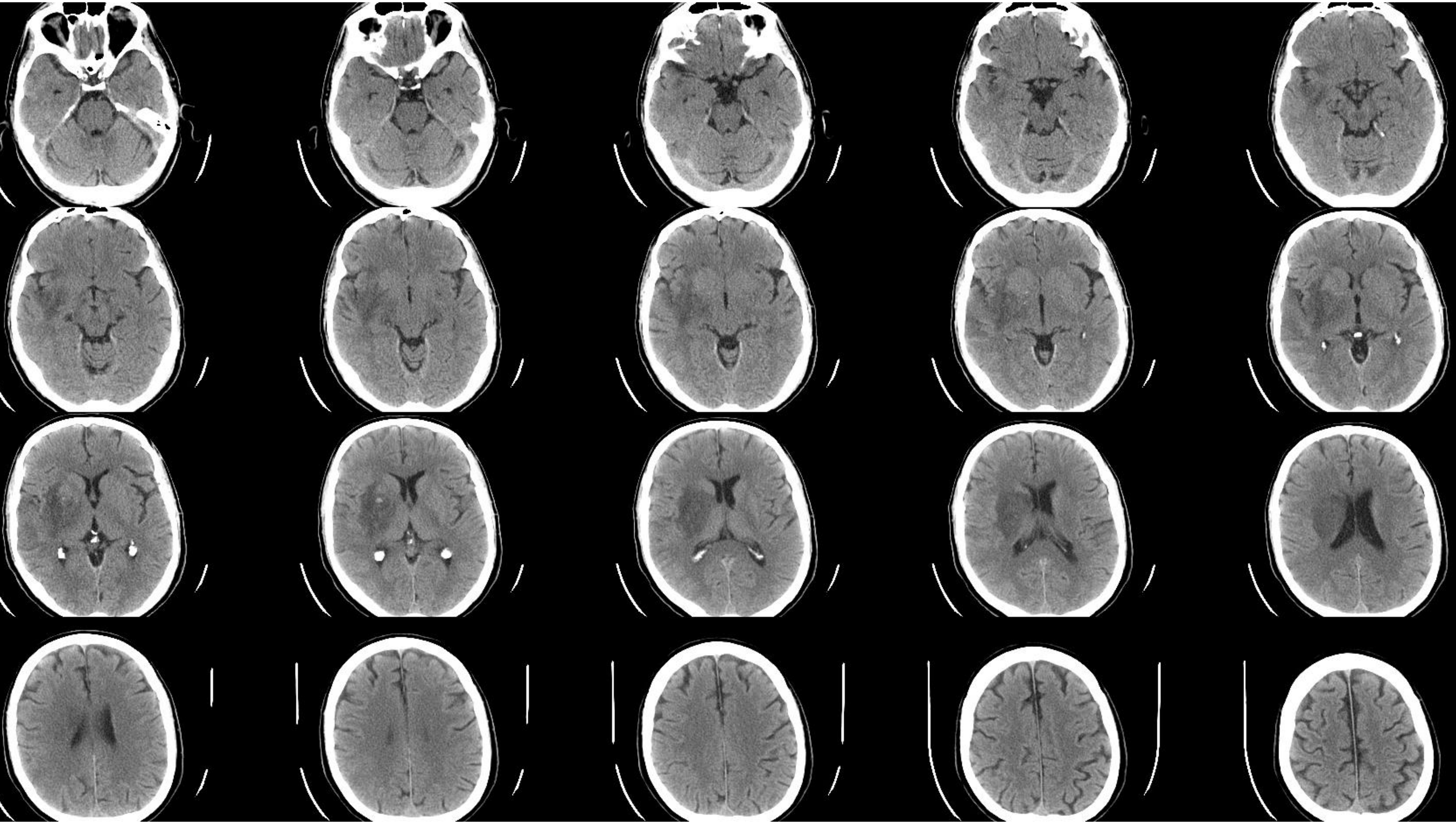
Tromboaspirazione con sistema Penumbra
1 passaggio
Rimozione di frustolo trombotico

# Carotidografia interna dx, h14.12

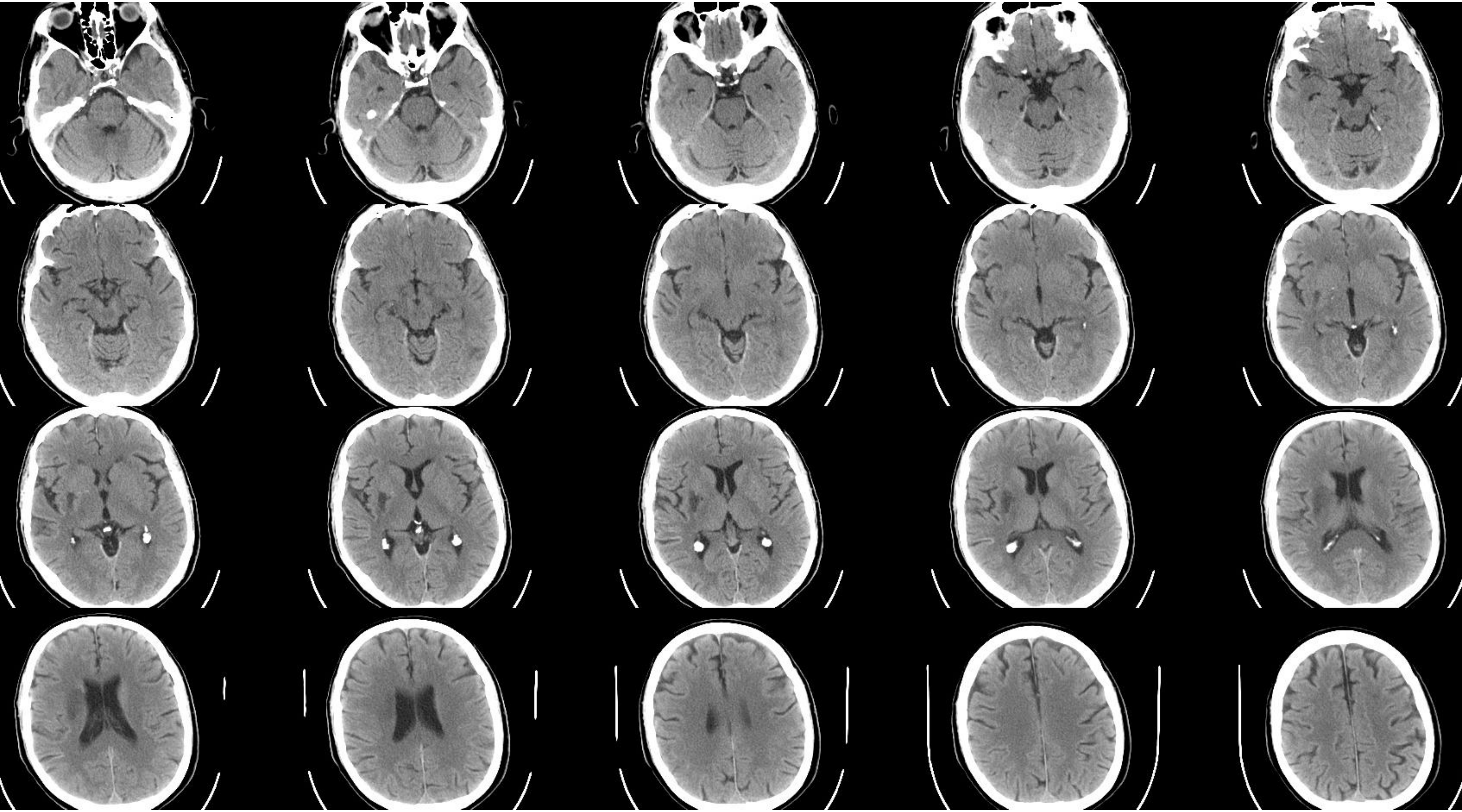



Ricanalizzazione completa (TICI 3)

# TC dopo 6gg

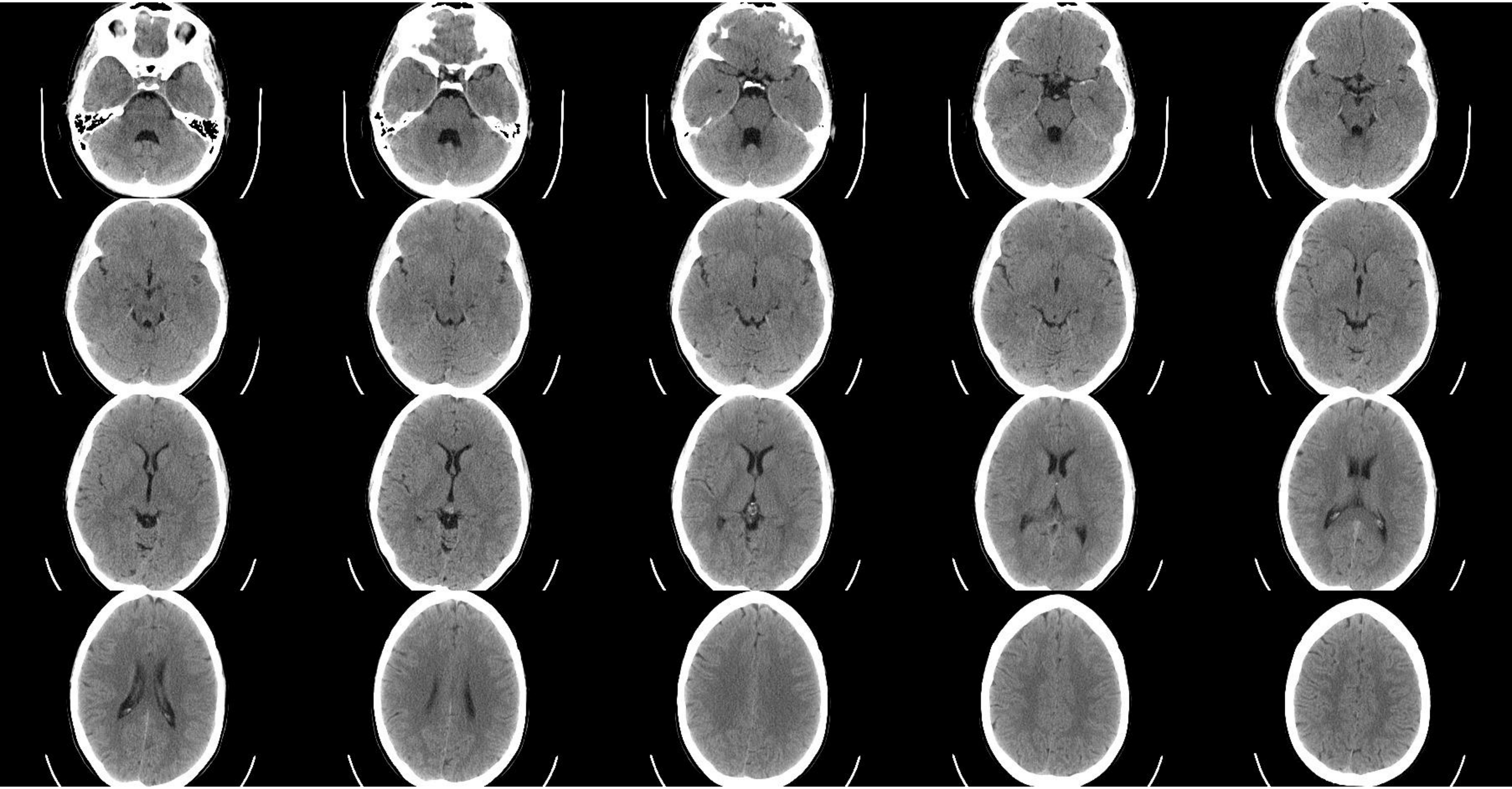


# TC dopo 20gg



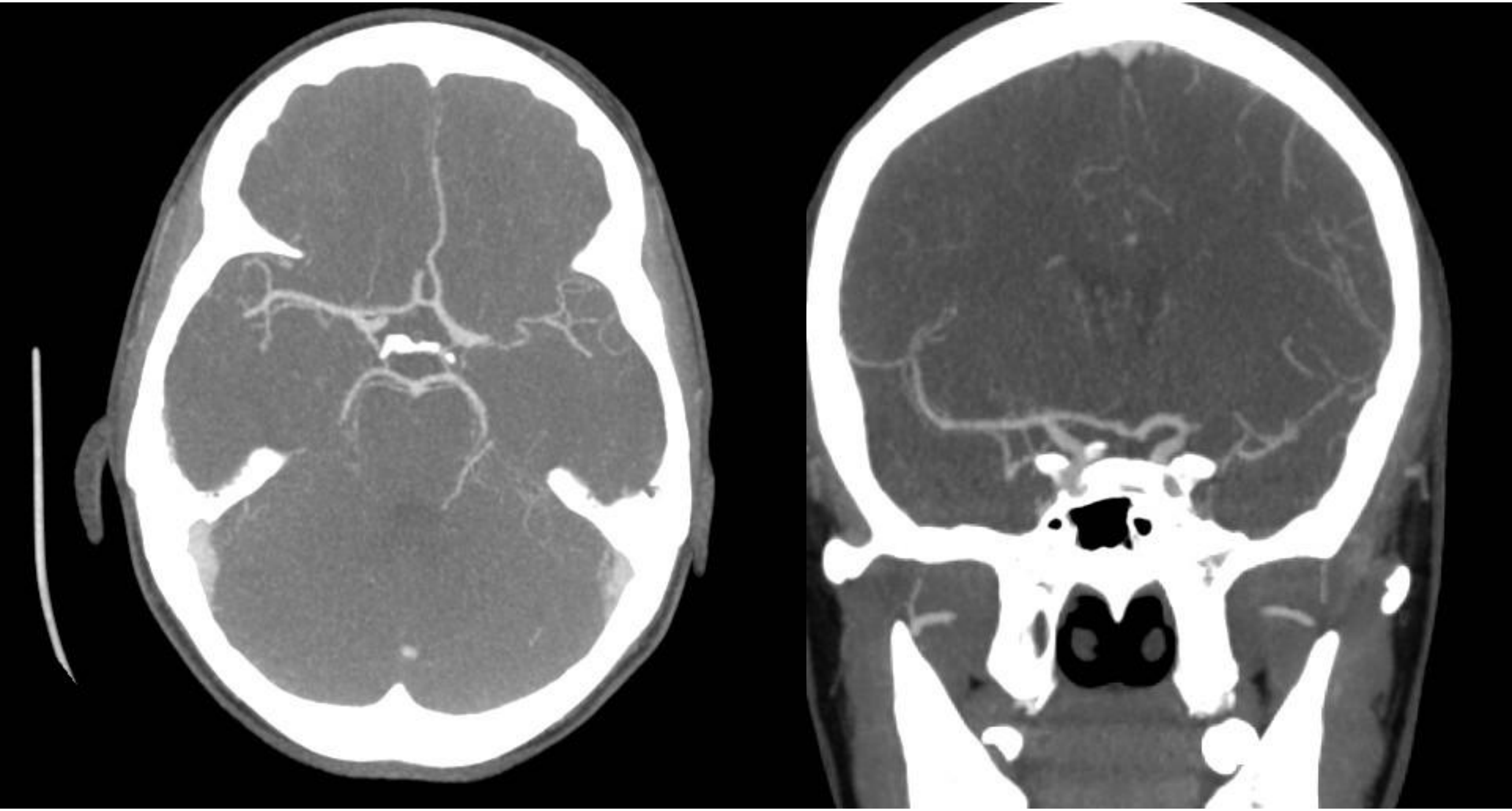
F, aa25
APR muta
Esordio postcoitale di
emisindrome destra e afasia

# TC h21.32



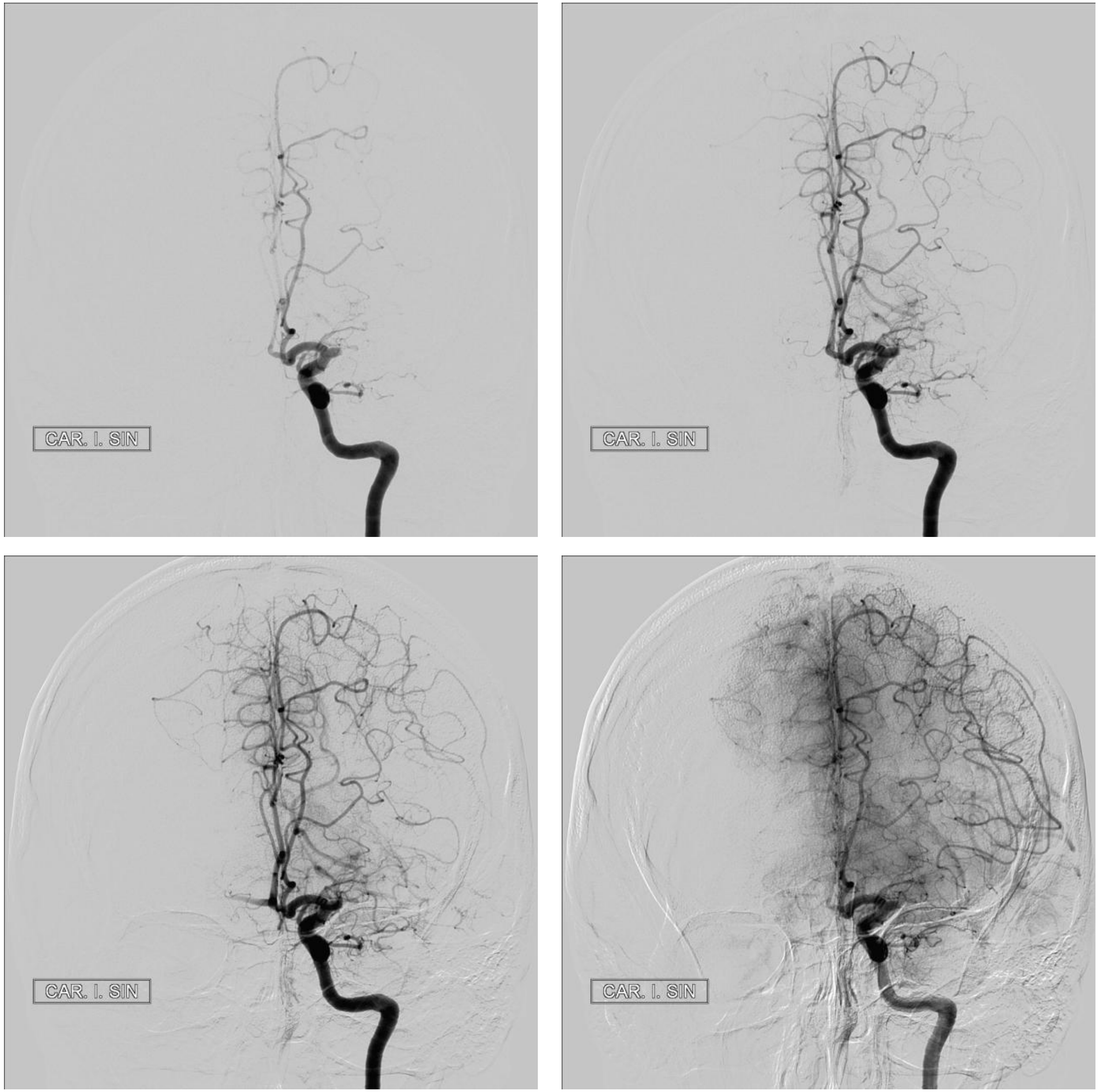
Iperdensità ACM sin, ASPECT 9 (insula)

# AngioTC h21.50



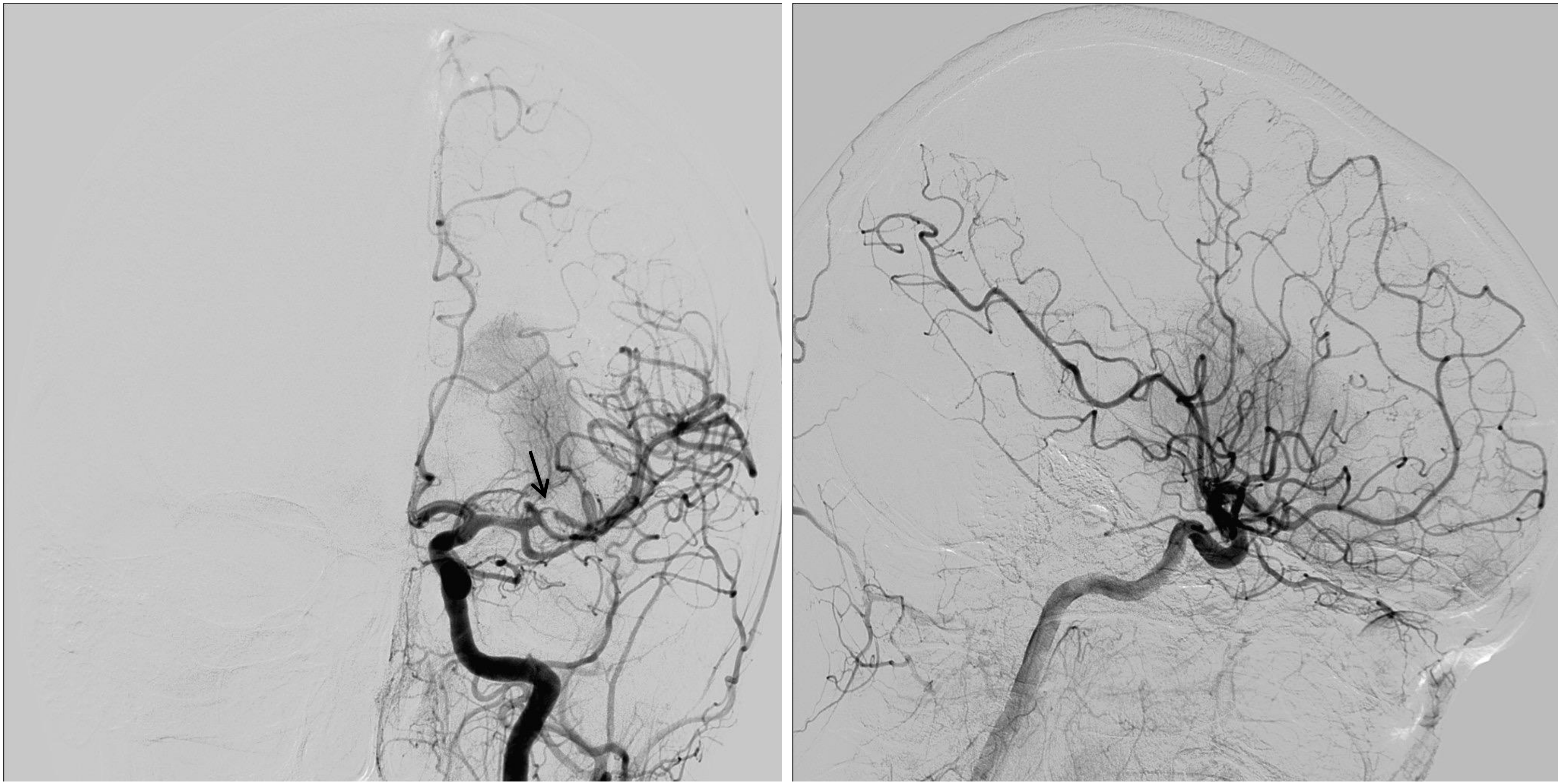
Occlusione ACM sin

# Carotidografia interna sin, h23.10




Occlusione ACM sin, compensi transcorticali da ACA sin

# Carotidografia interna sin, h23.28



Ricanalizzazione di M1 sin mediante aspirazione con residua subocclusione di ramo di triforcazione di M2

# Carotidografia interna sin, h23.40

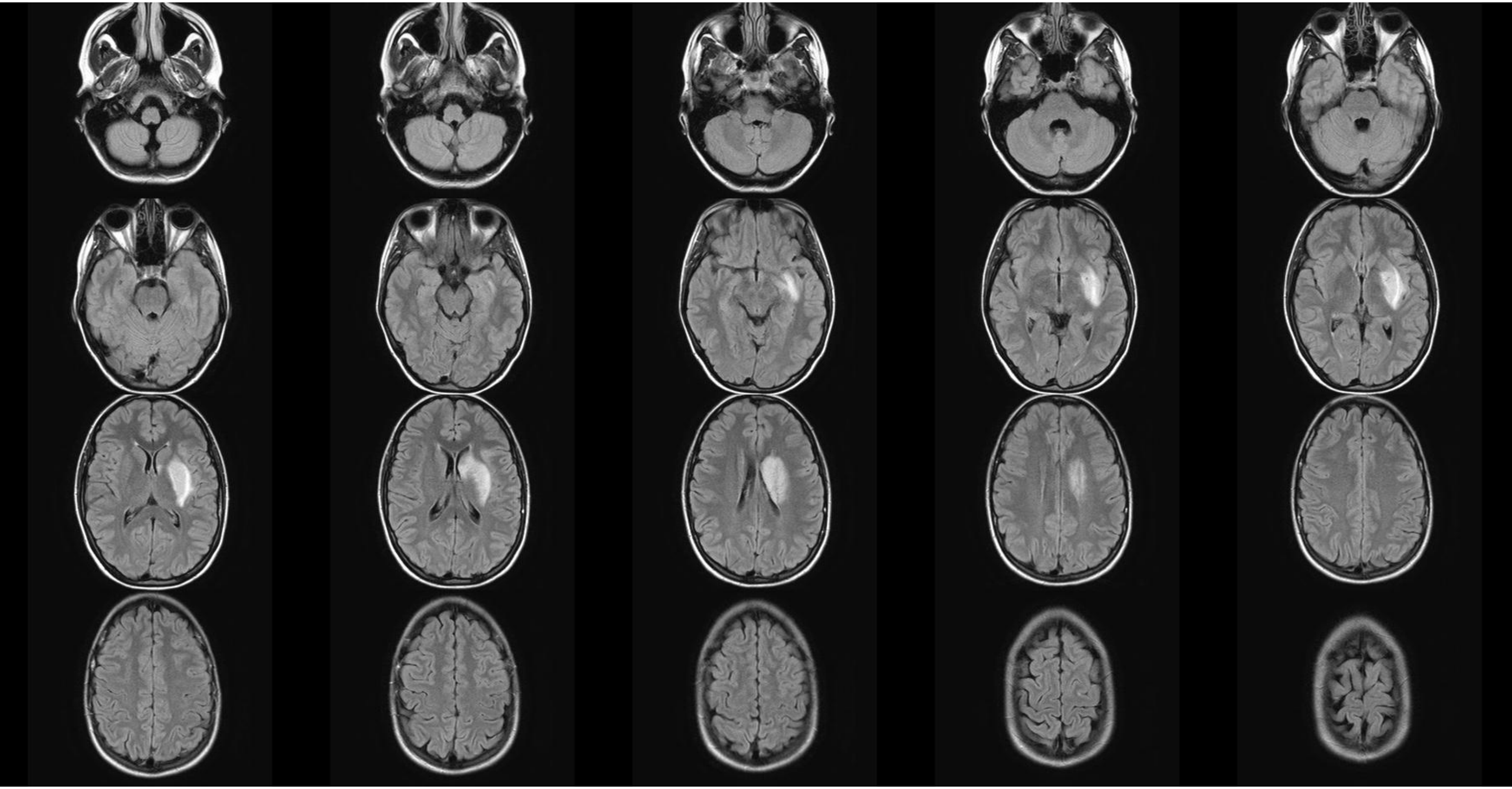

Apertura di stent retriever Solitaire mm4x15

Stent Solitaire e trombo

# Carotidografia interna sin, h23.47

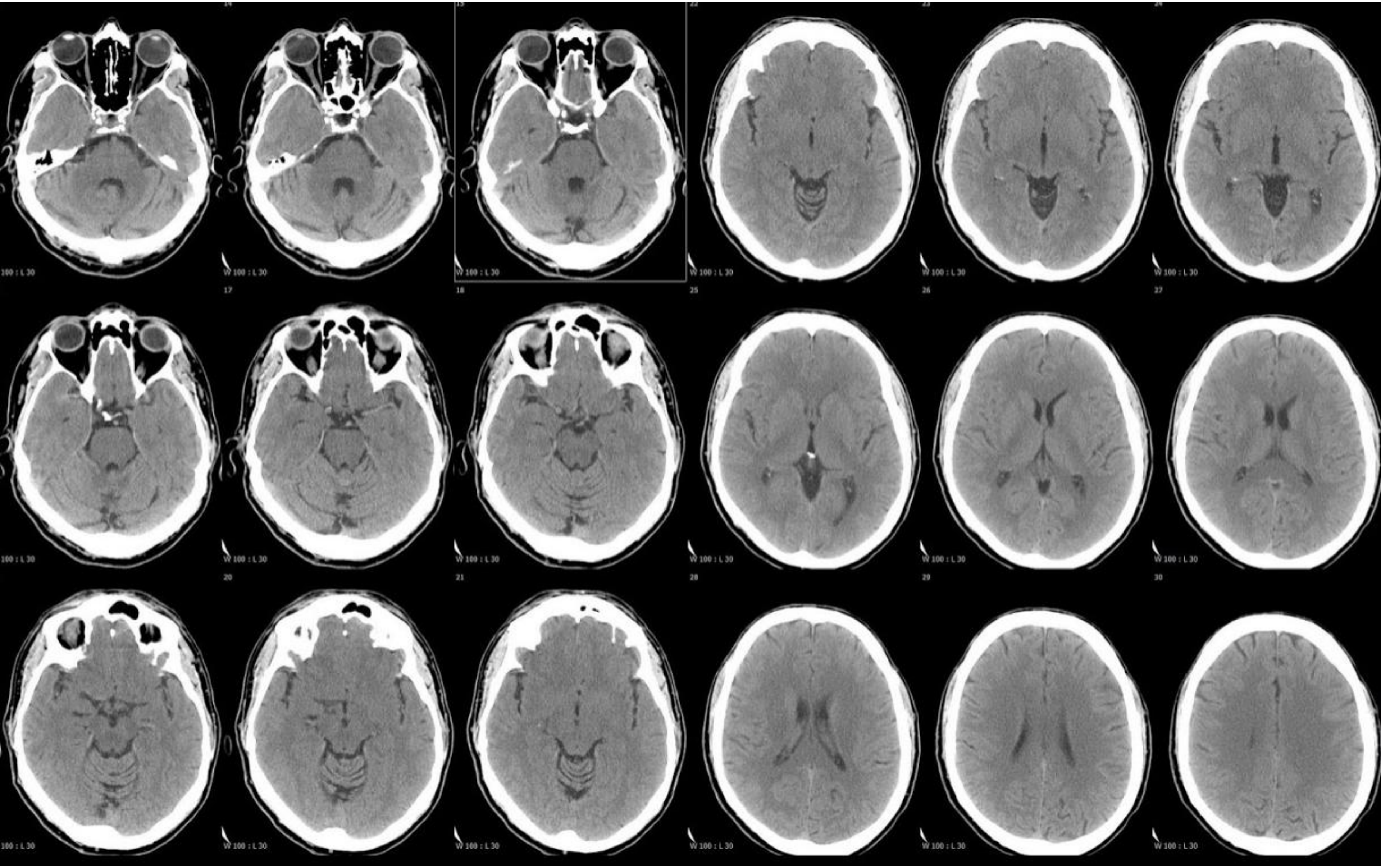

Ricanalizzazione TICI 3; recupero neurologico sul lettino angiografico

# RM dopo 5gg



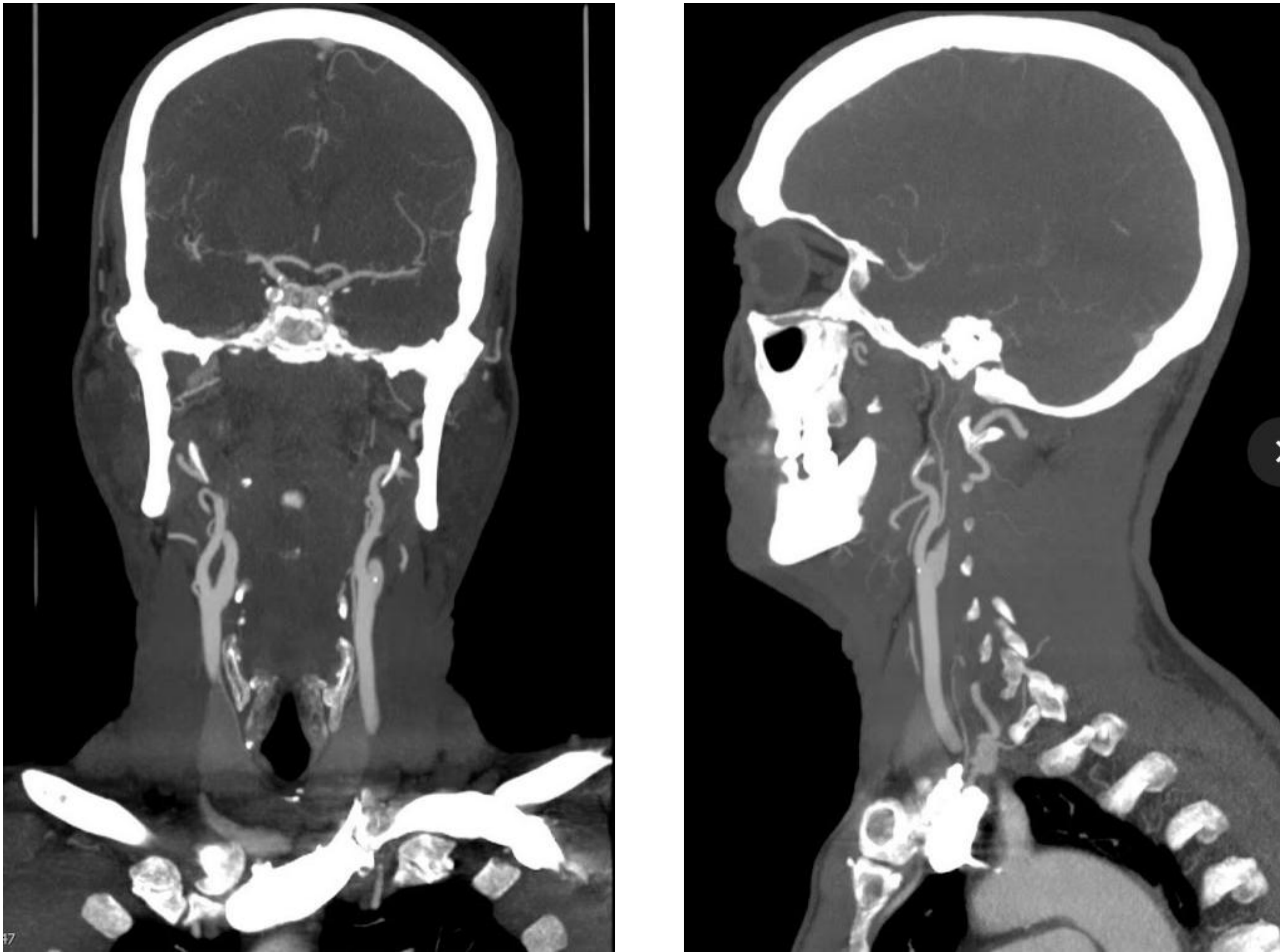
M, aa 54
APR muta
Esordio acuto di afasia motoria

# TC 3.11 h 18.33

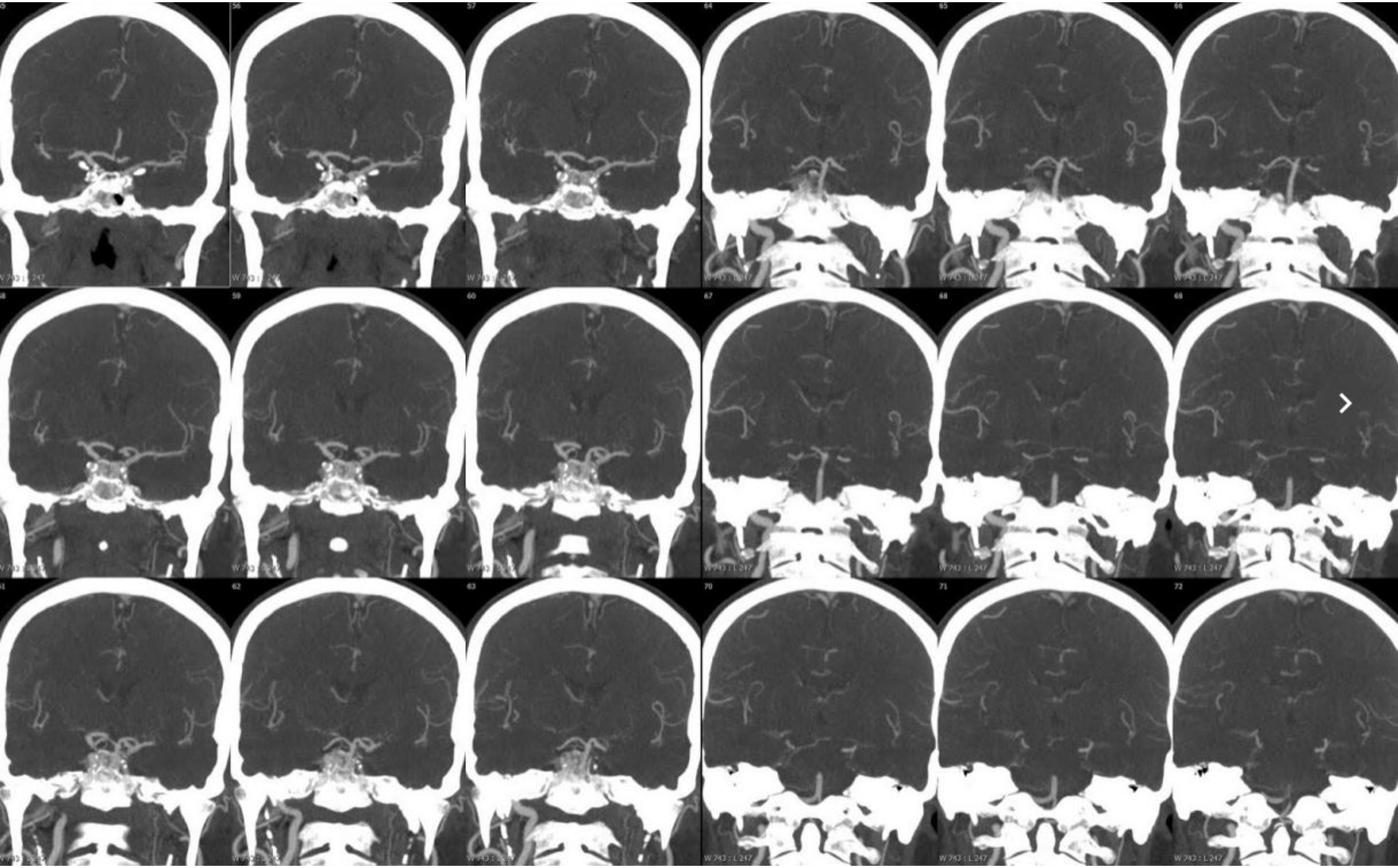


Esame normale, ASPECT 10

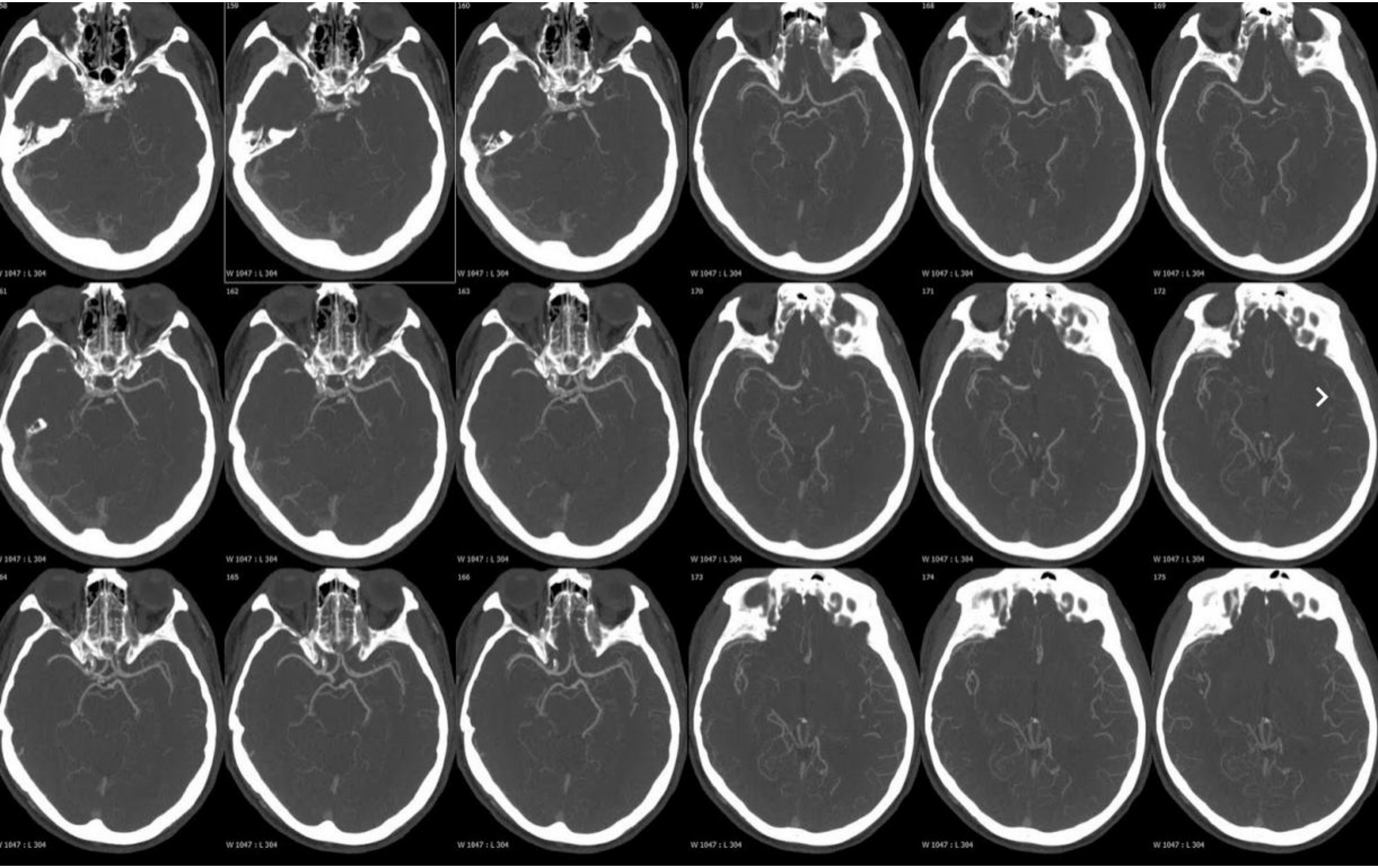
# AngioTC 3.11 h 18.40



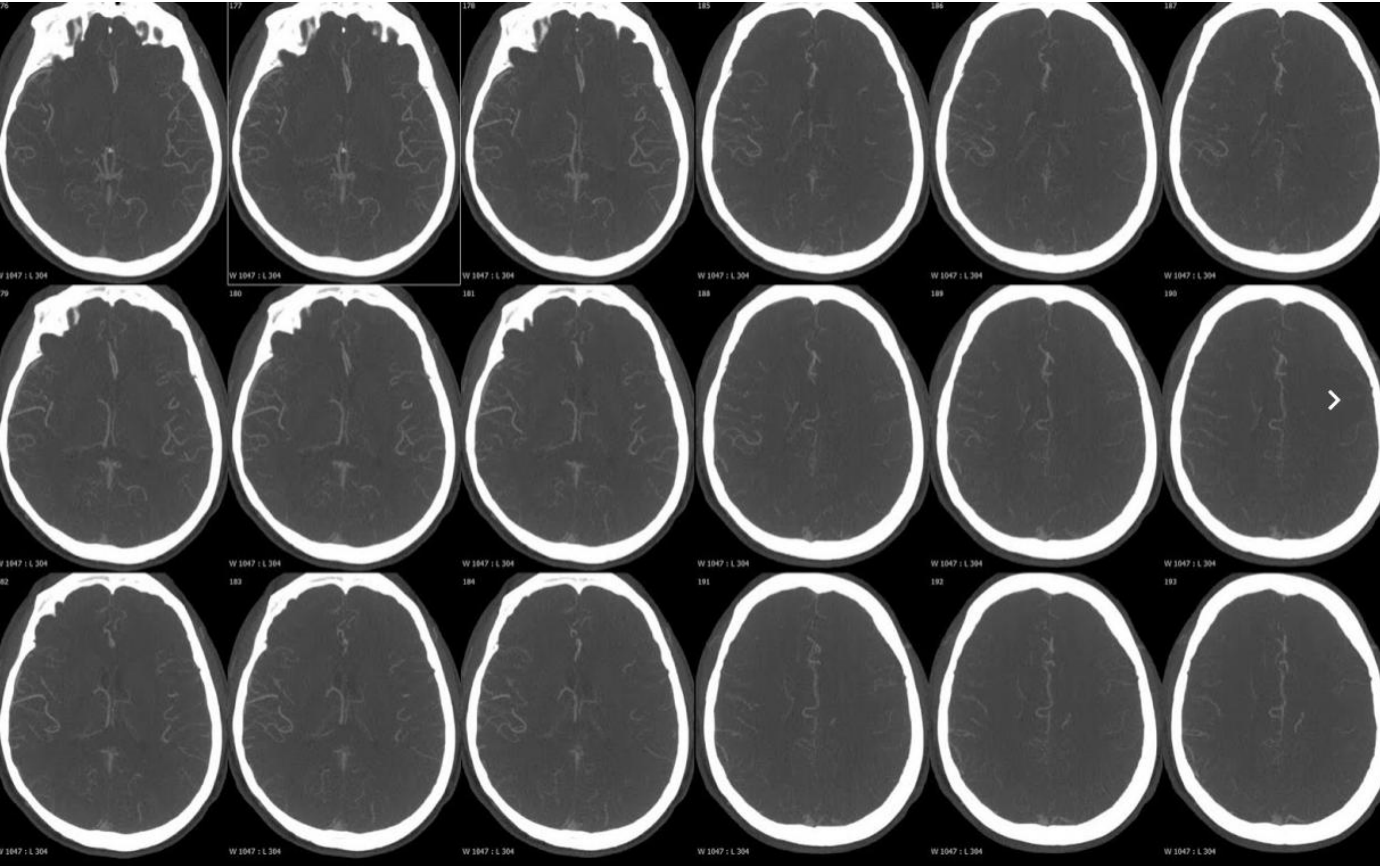
# AngioTC 3.11 h 18.40



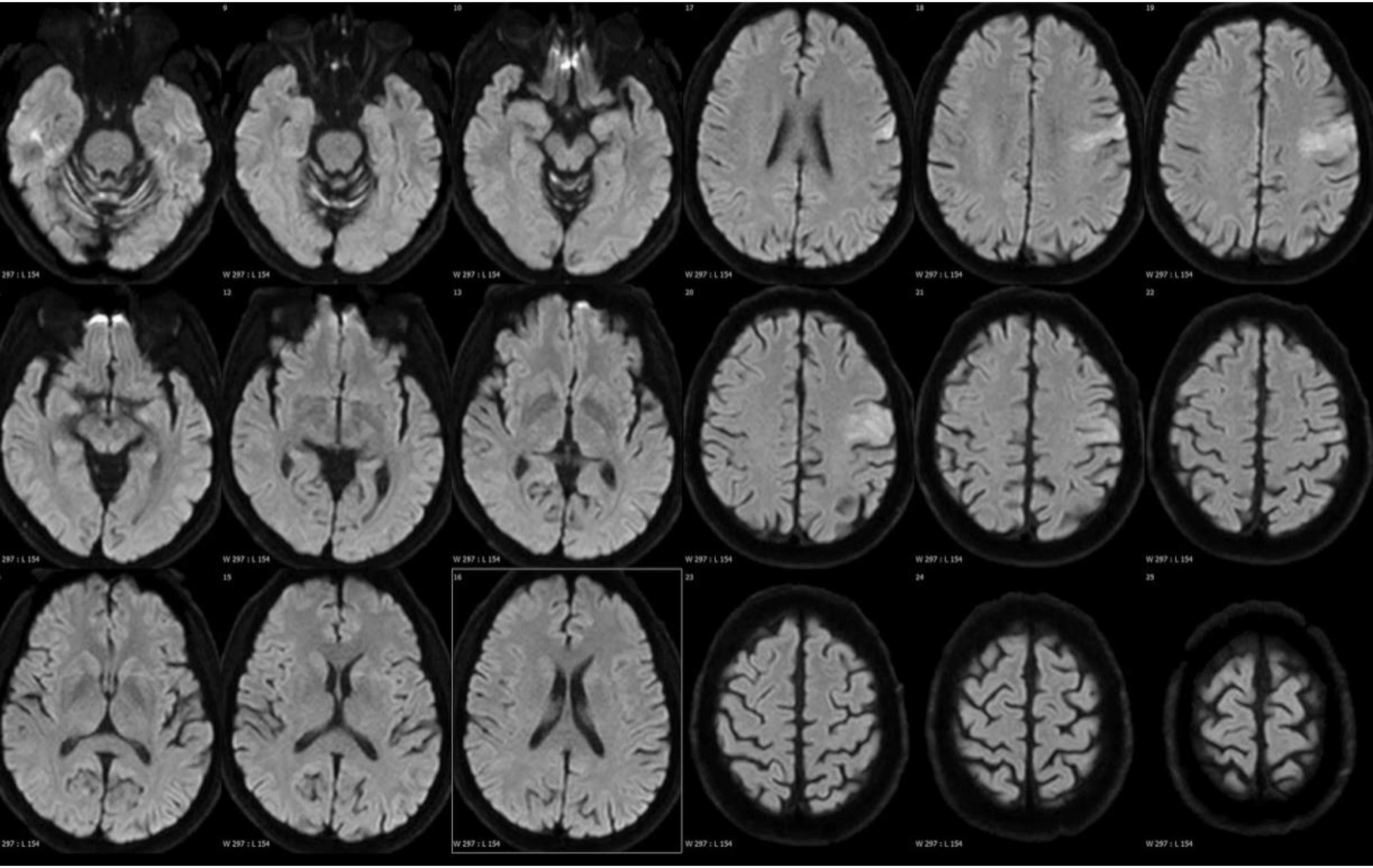
# AngioTC 3.11 h 18.40



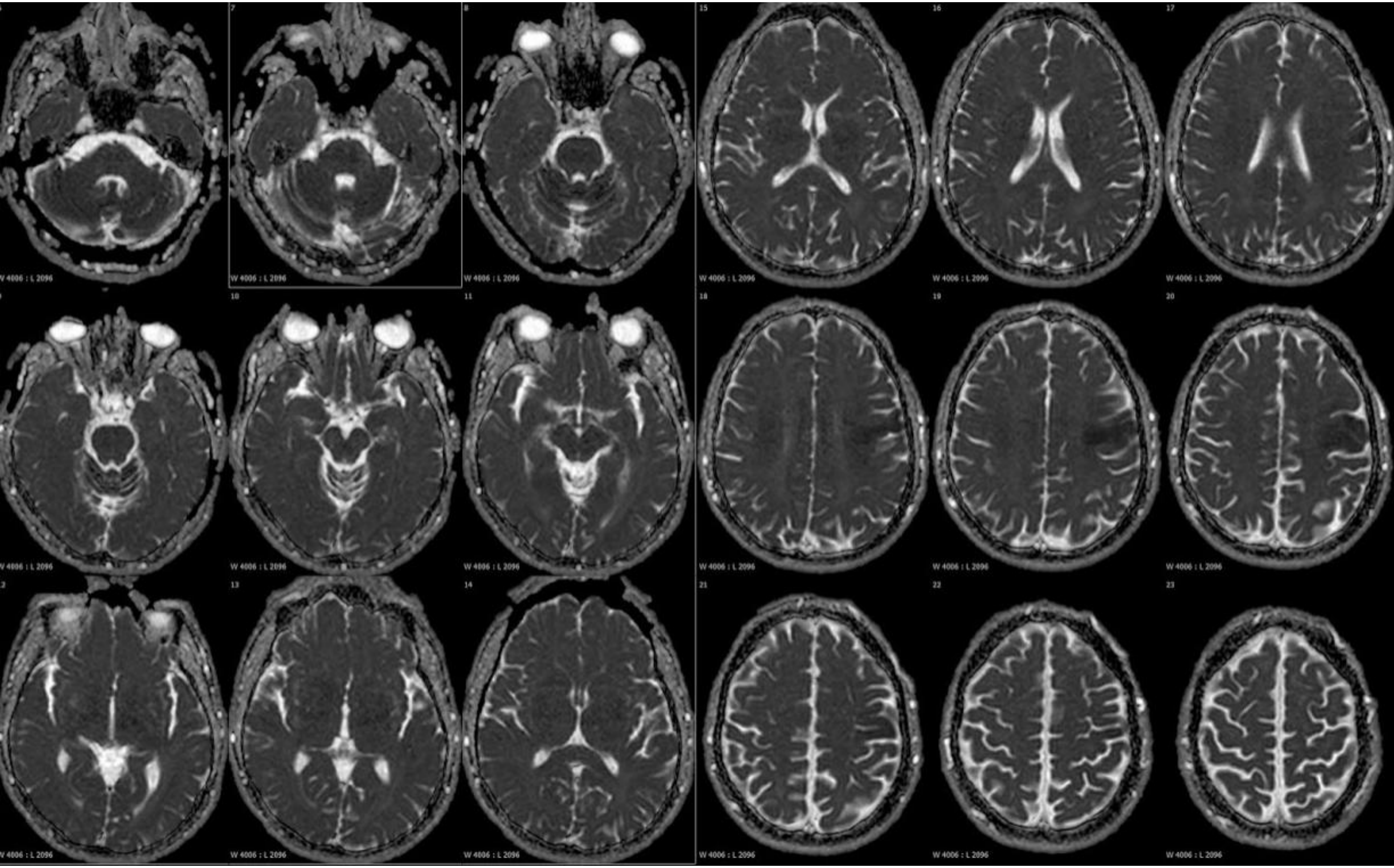
# AngioTC 3.11 h 18.40



# RM 3.11 h 18.50



# RM 3.11 h 18.50



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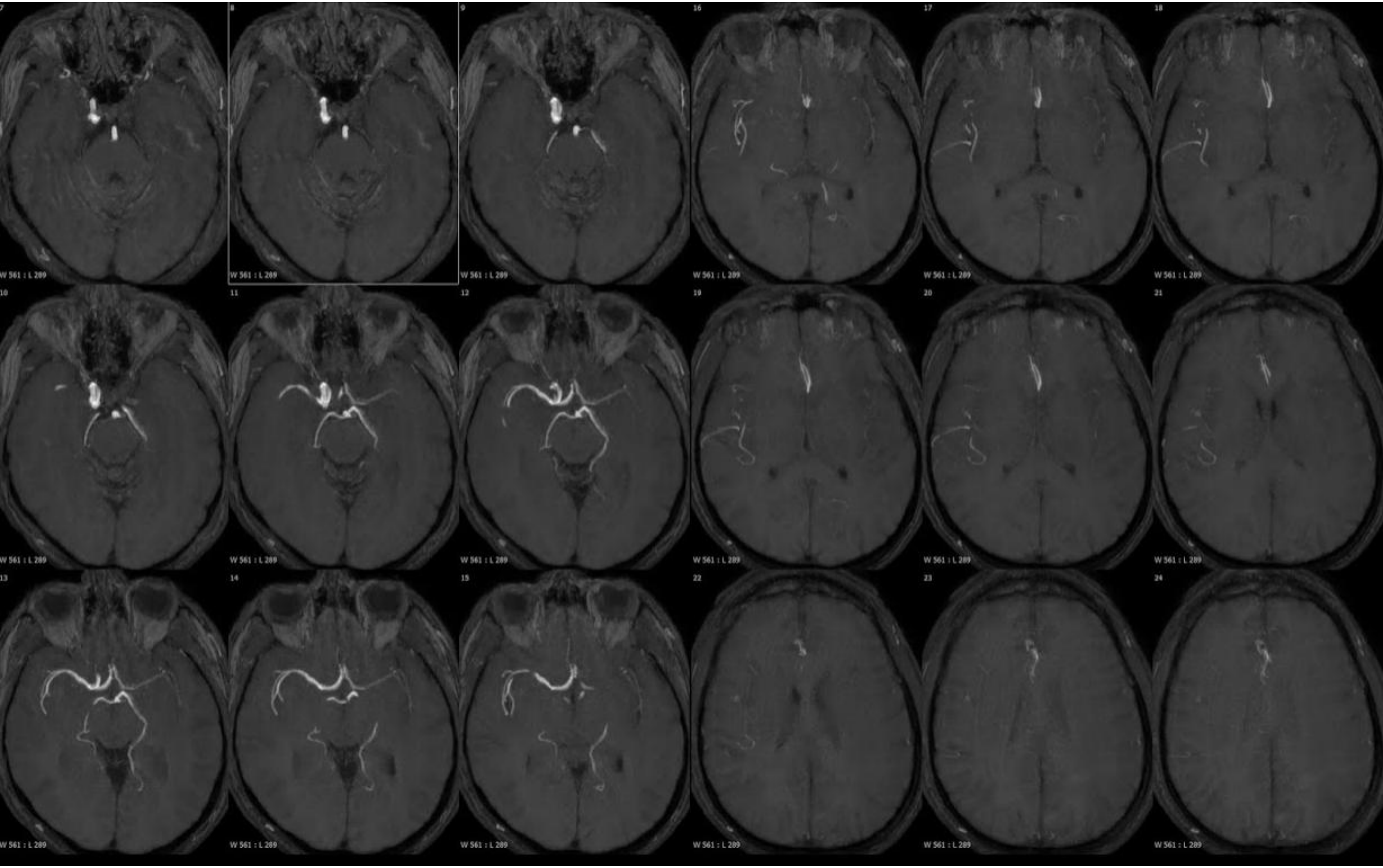

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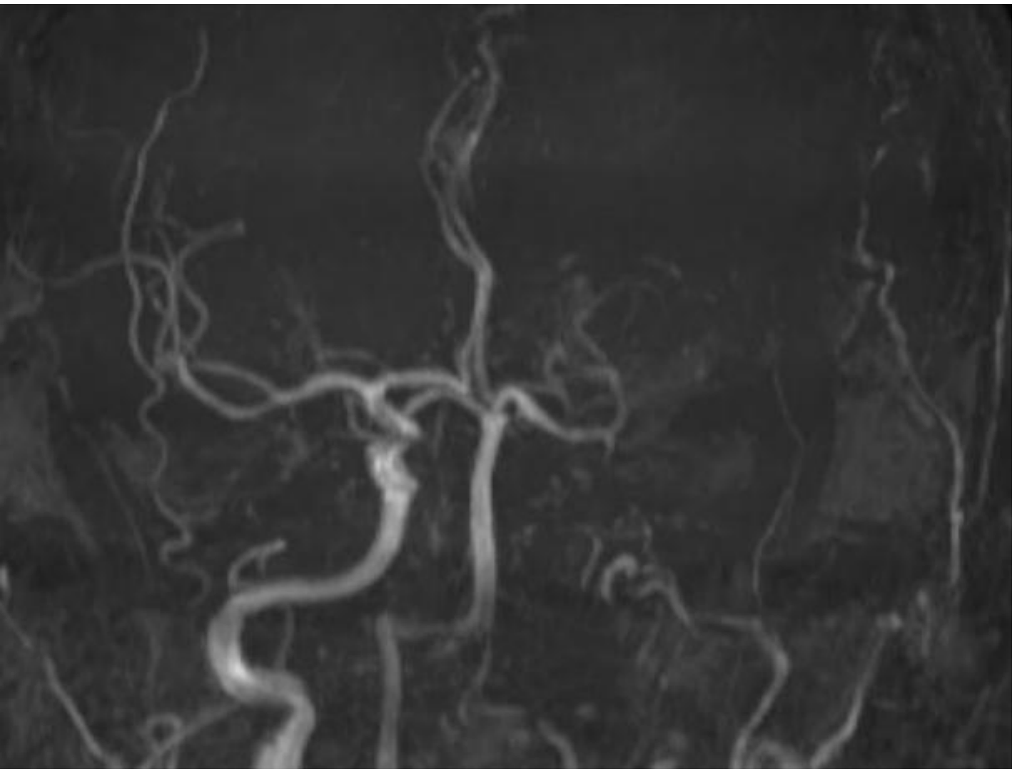

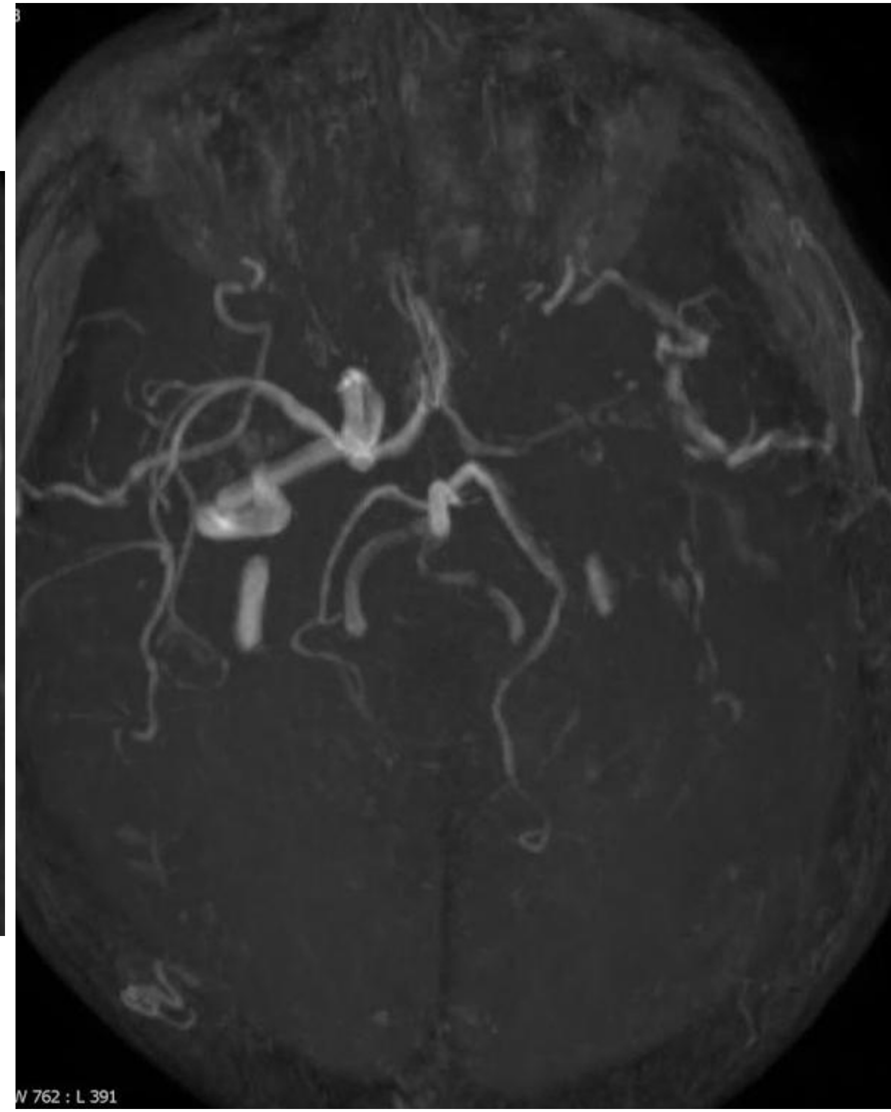

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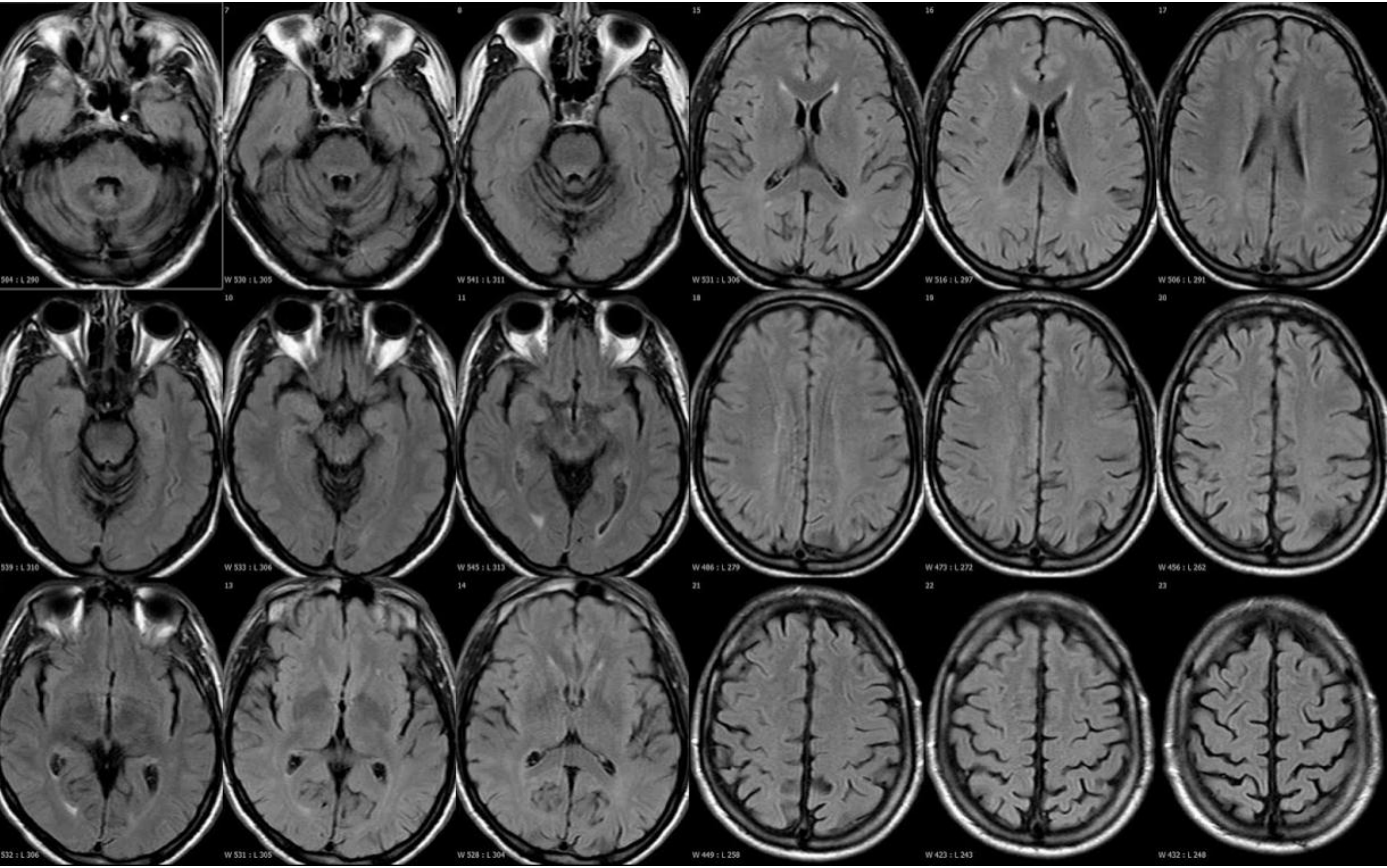

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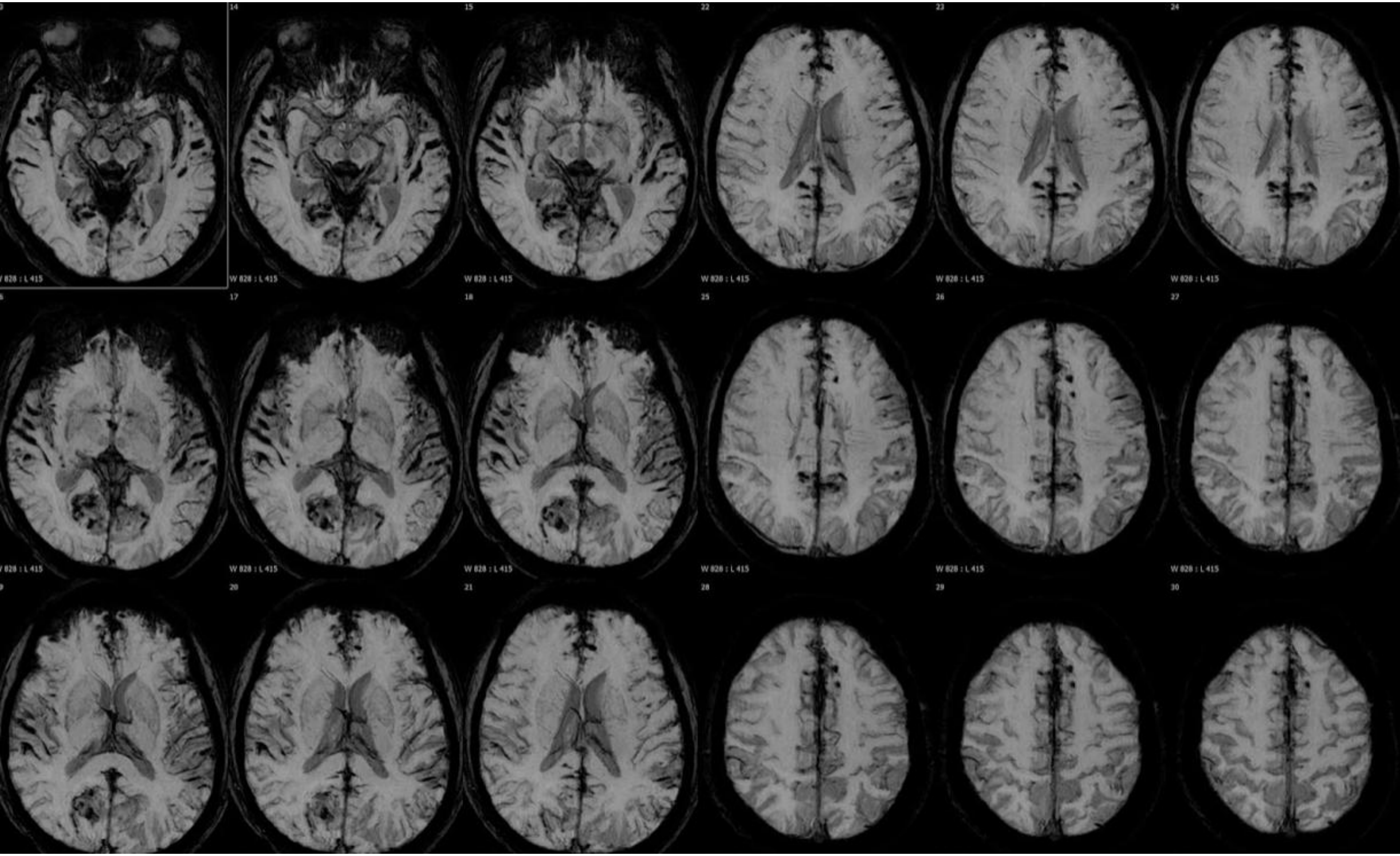
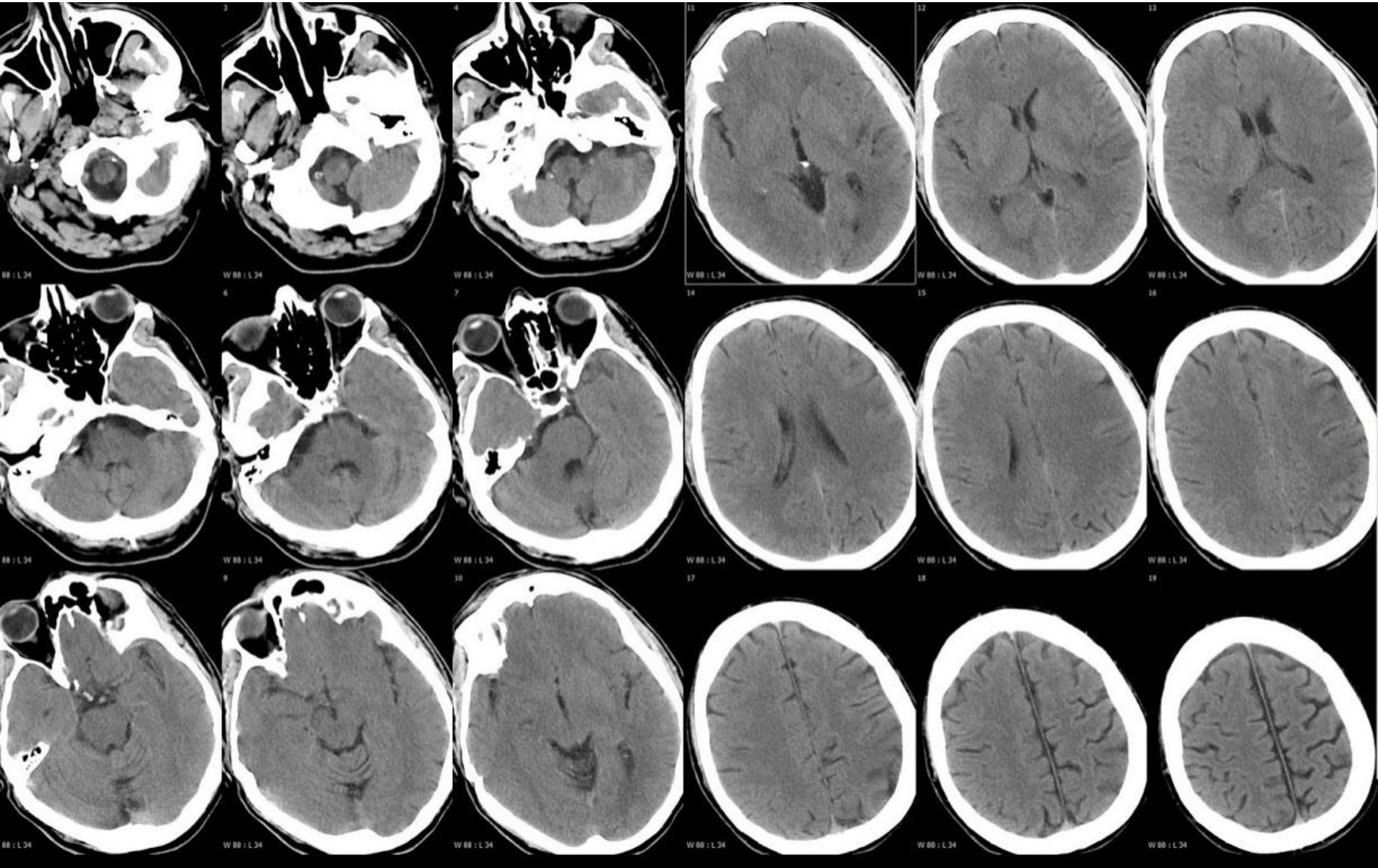
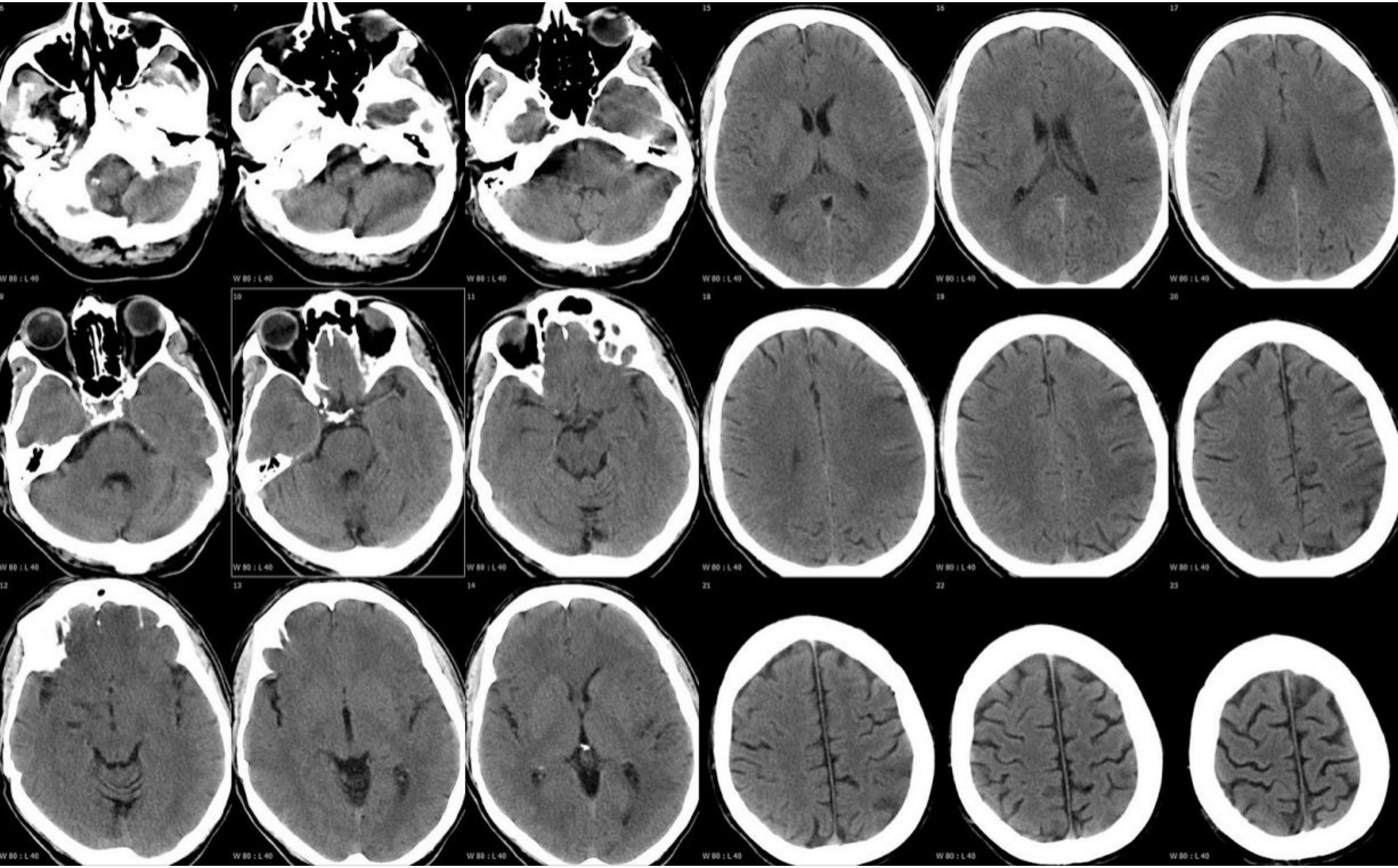


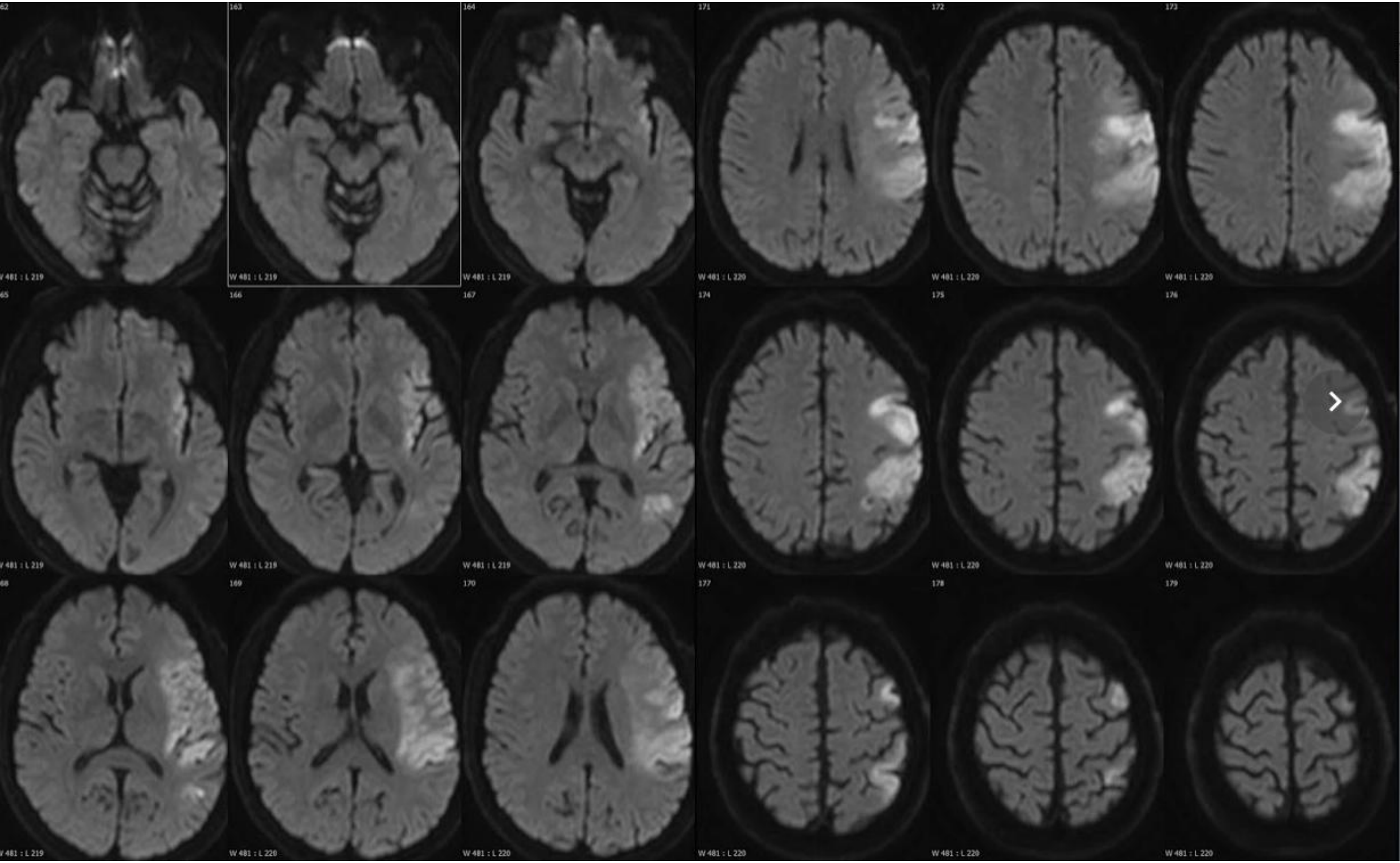
# Peggioramento clinico: ipostenia distale a.s. sx
# TC 4.11 h 6.05



# TC 4.11 h 8.08



# RM 4.11 h 8.11



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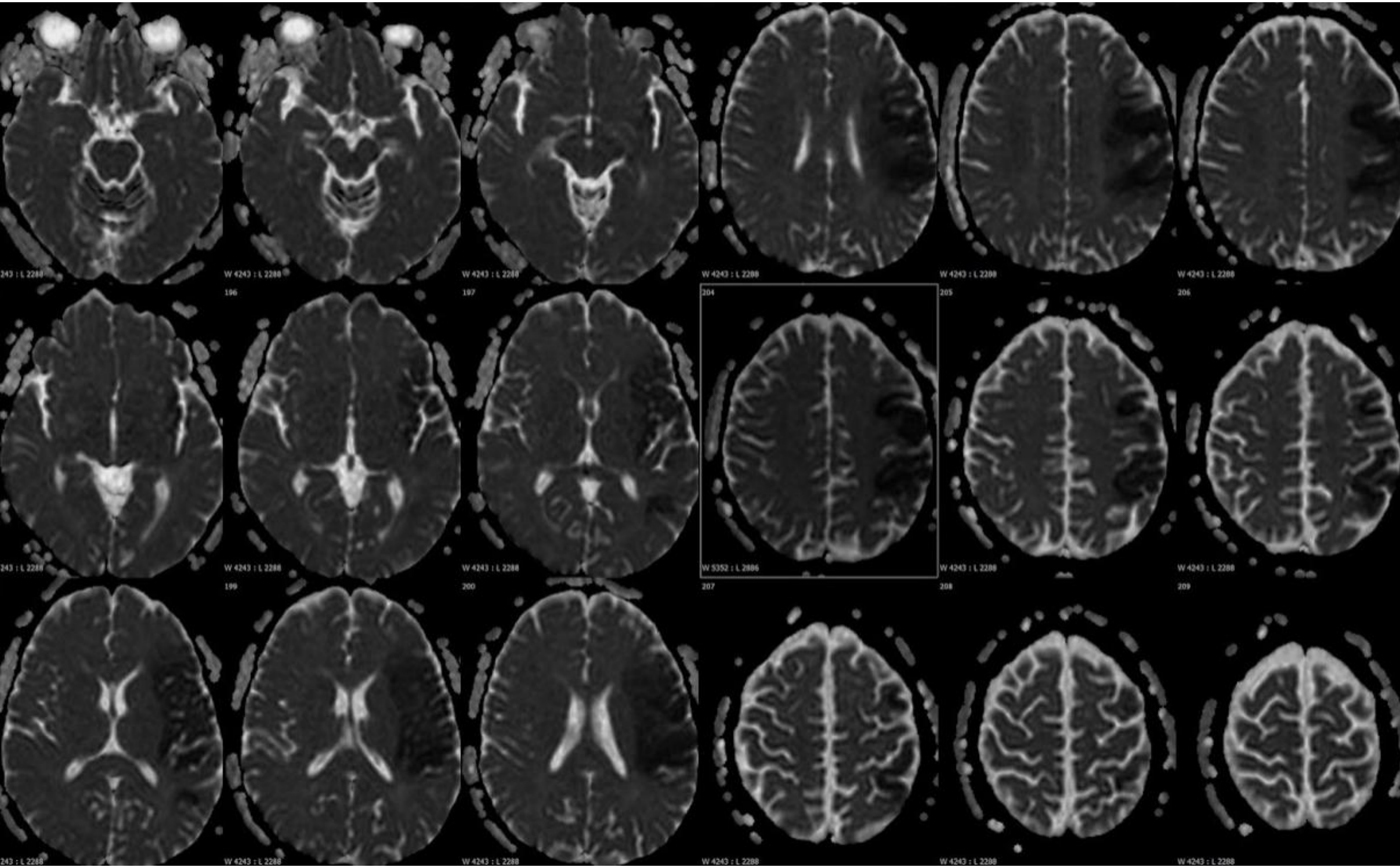
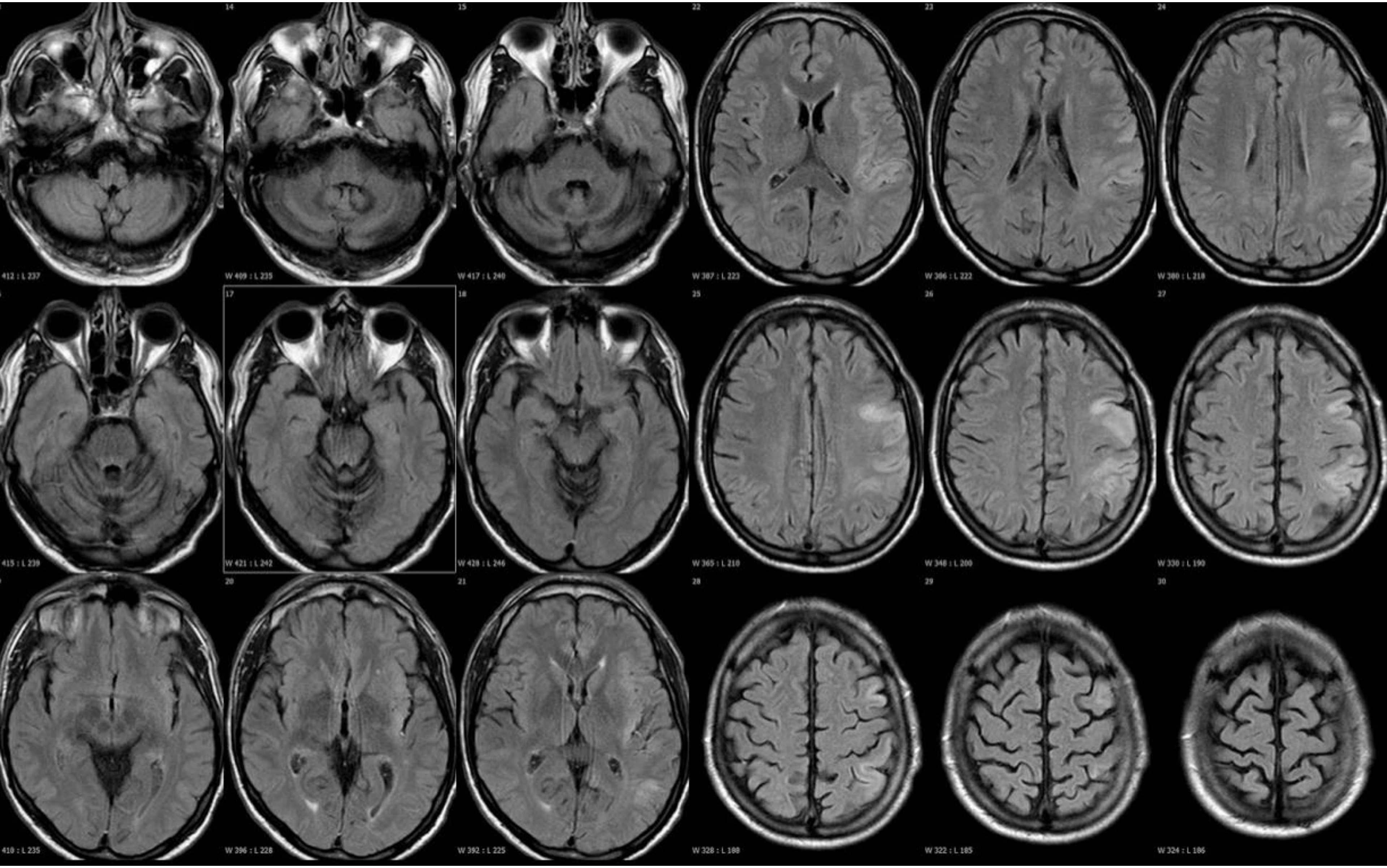
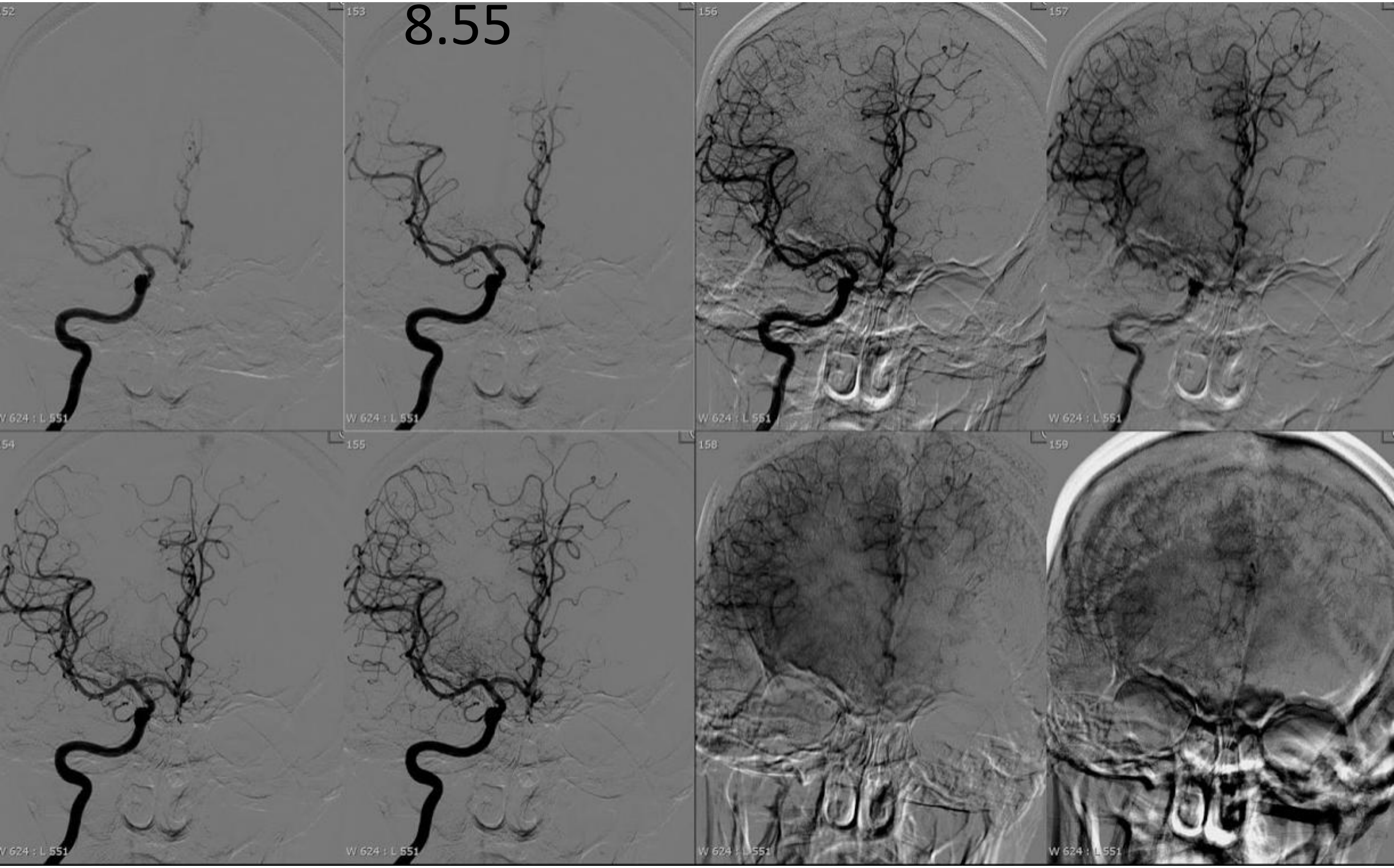


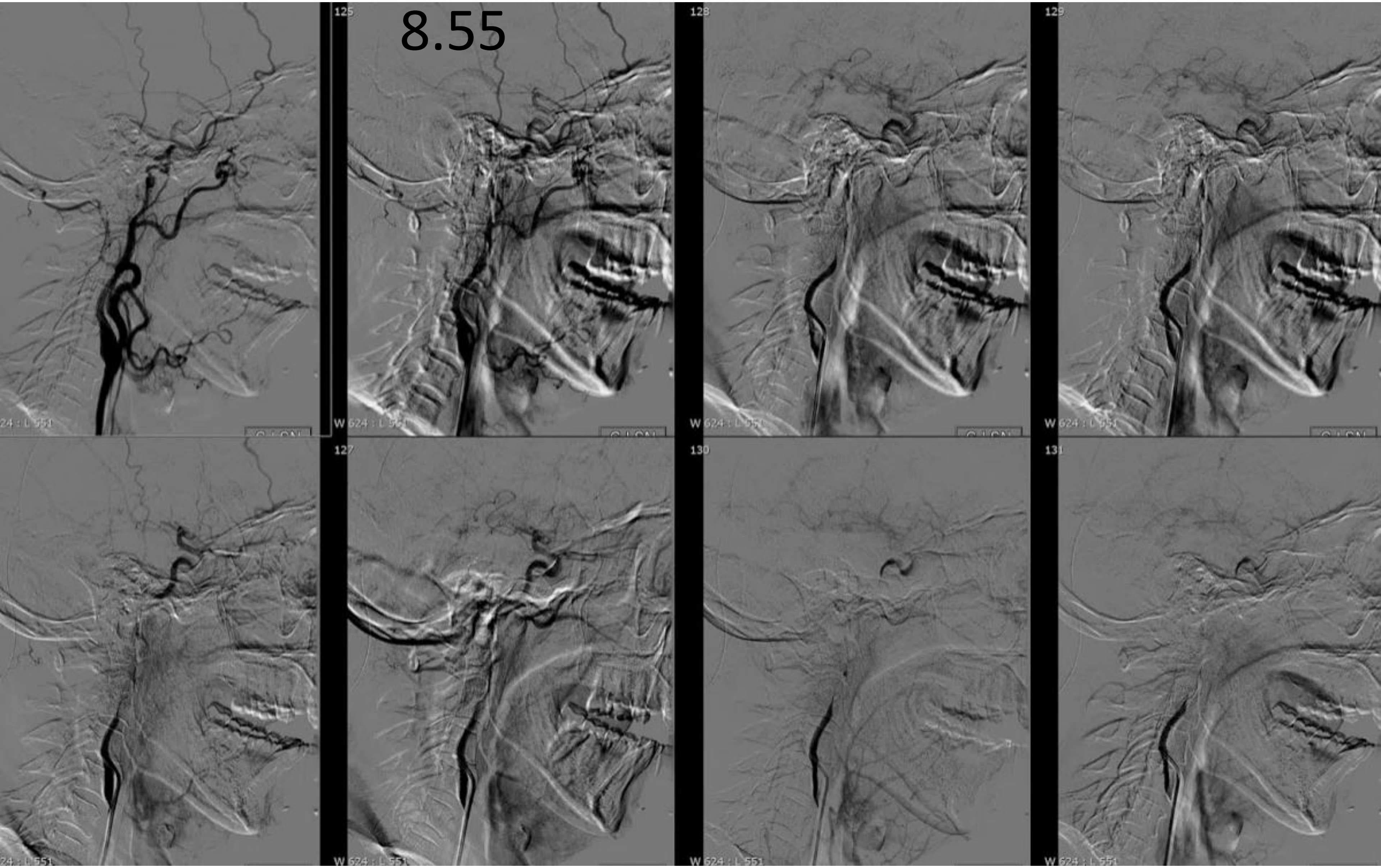
# RM 4.11 h 8.11



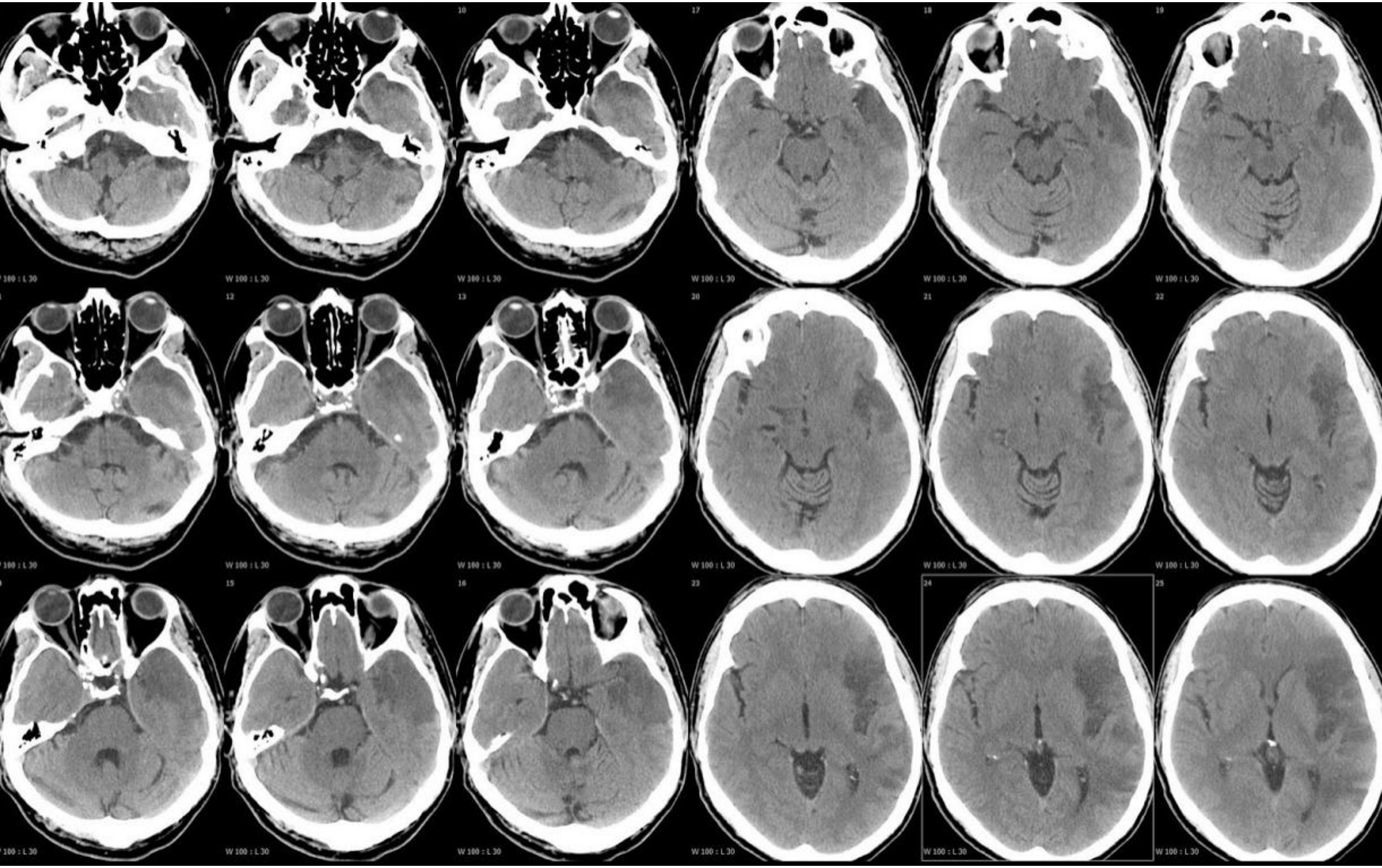
# Angiografia 4.11 h
8.55



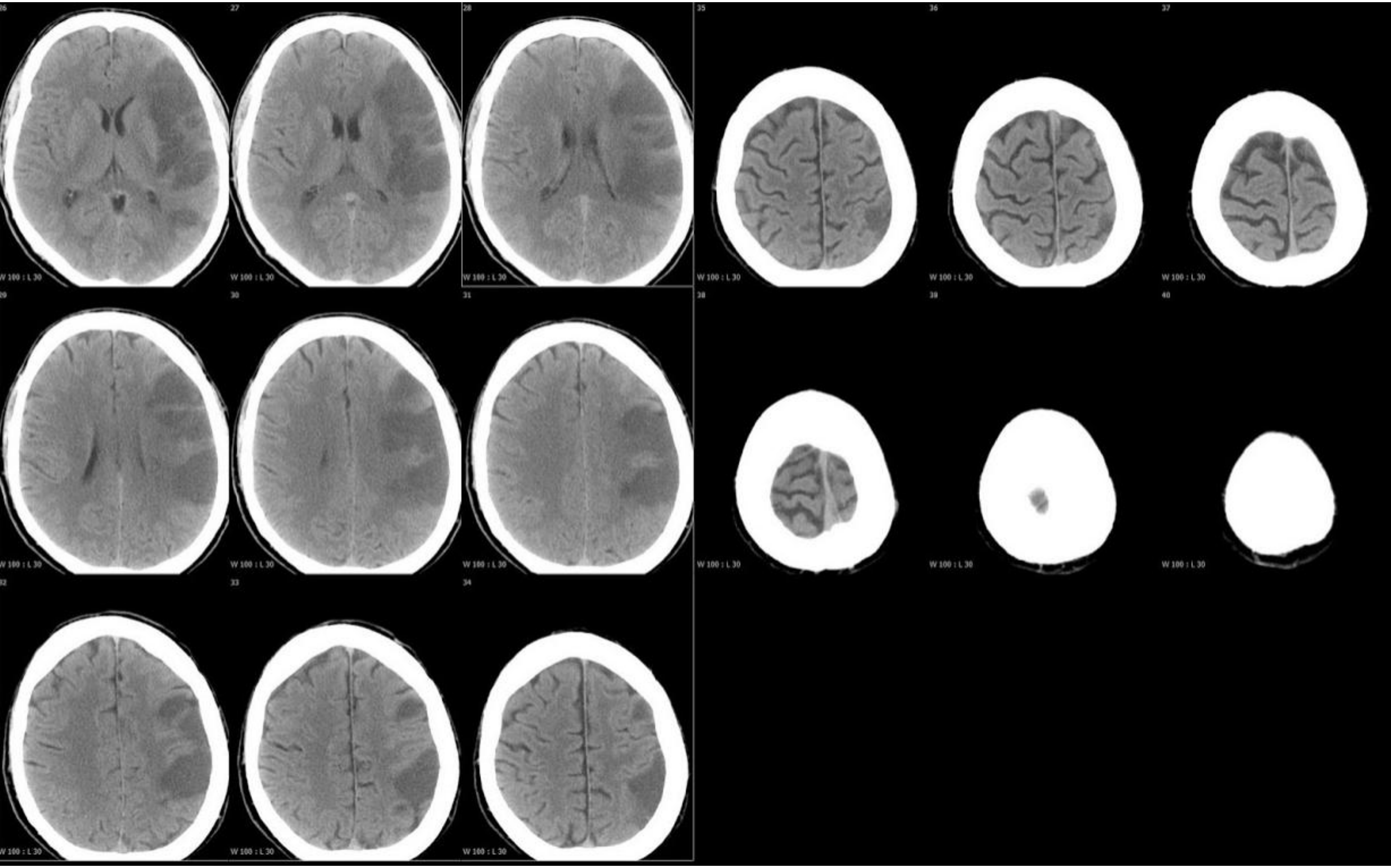
# Angiografia 4.11 h 8.55



# TC 6.11 h 8.26



# TC 6.11 h 8.26



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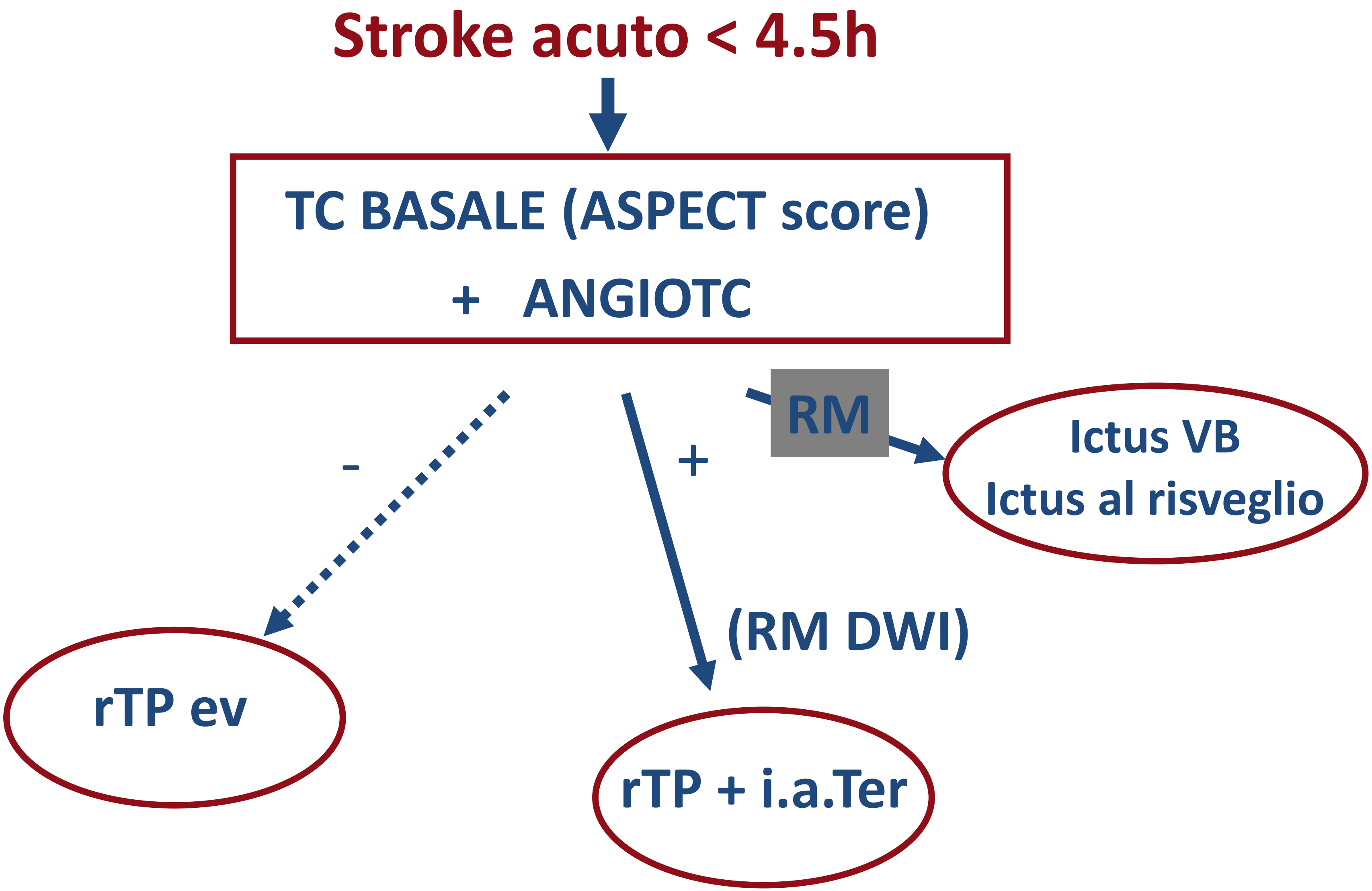
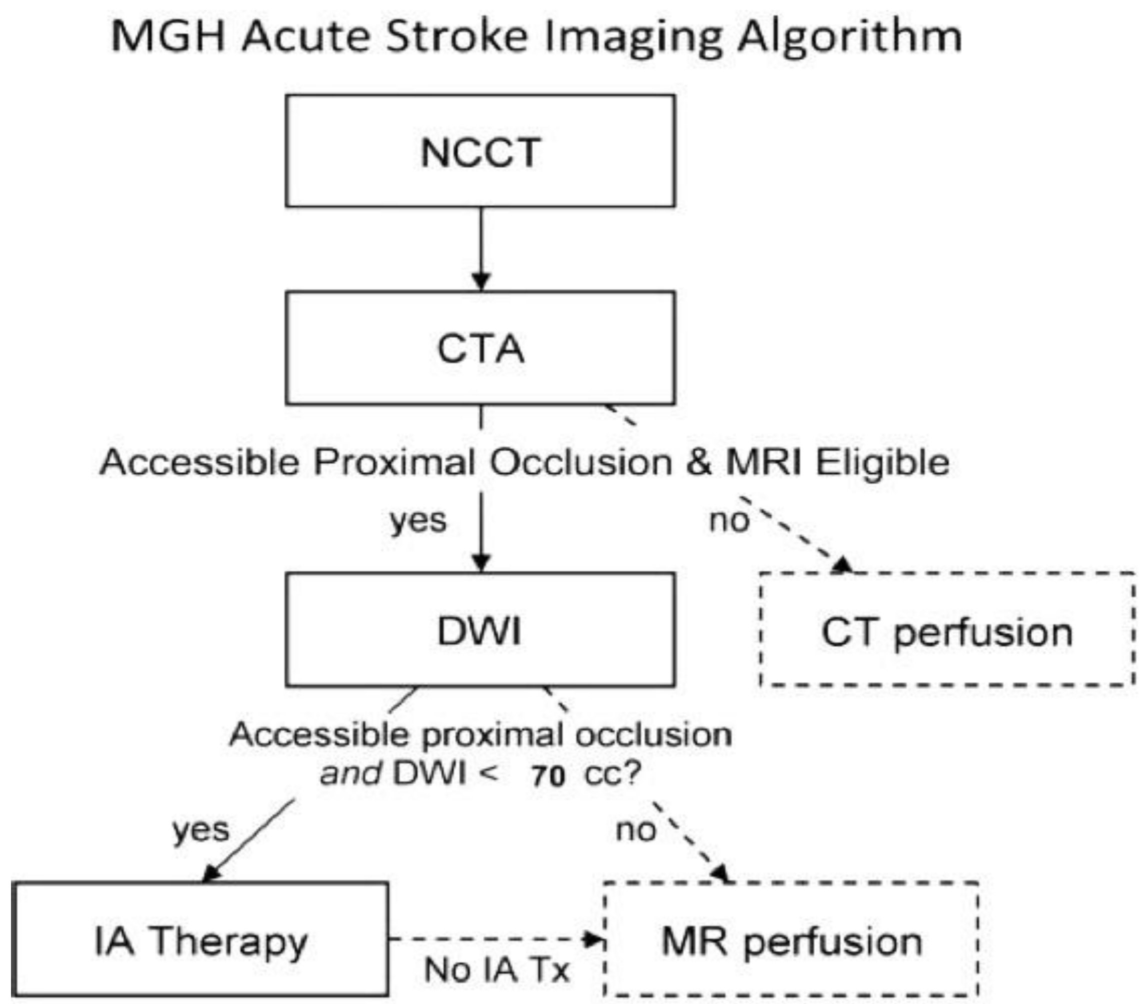
W 100 : L 30

# ALGORITMO STROKE SAN RAFFAELE

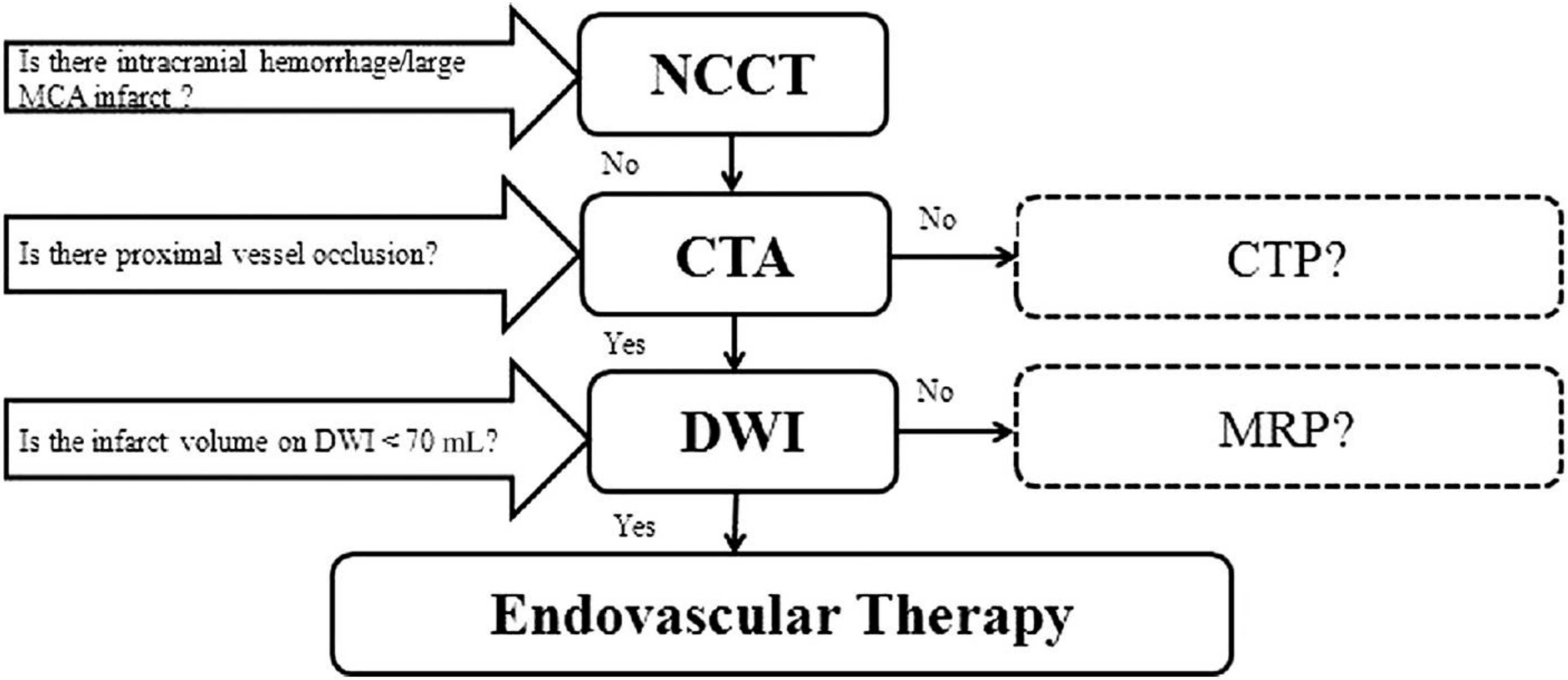


# ALGORITMO STROKE MGH



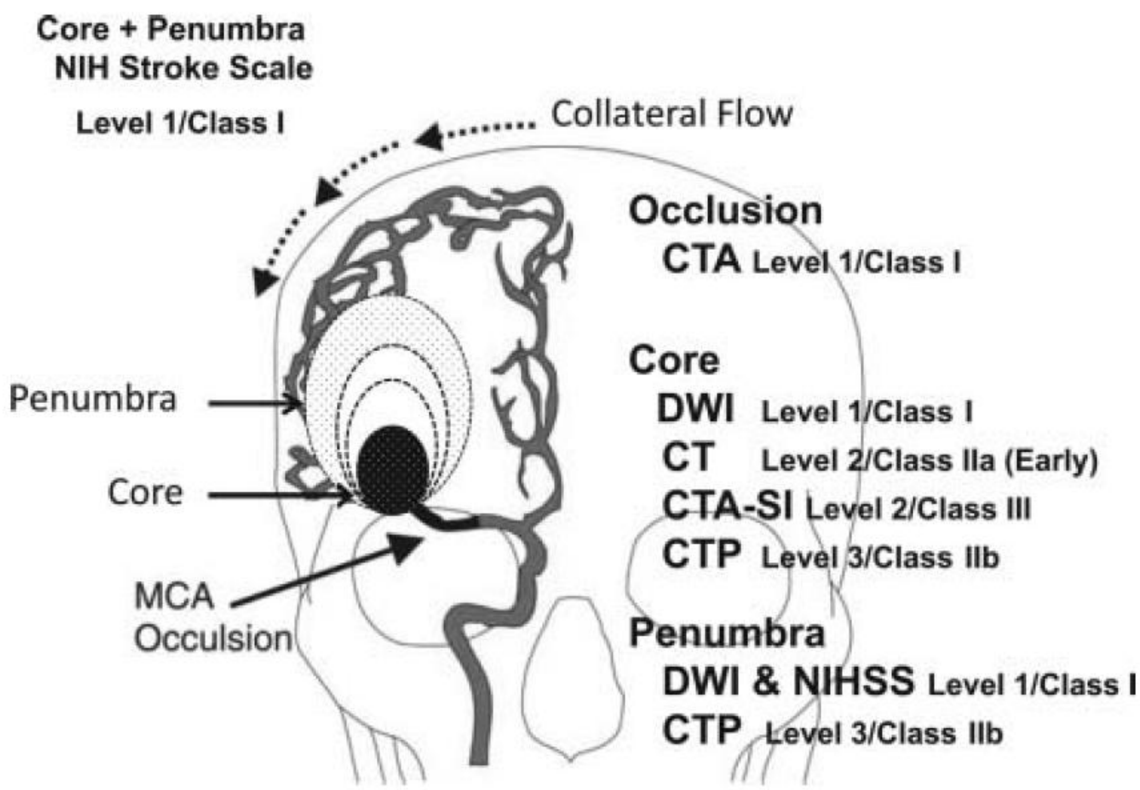

Gonzales GR et al MGH acute stroke algorithm,
*J Neurointervent Surg 2013*

# ALGORITMO STROKE MGH




Gonzales GR et al MGH acute stroke algorithm, *J Neurointervent Surg 2013*

# ALGORITMO STROKE MGH




Gonzales GR et al MGH acute stroke algorithm,
*J Neurointervent Surg 2013*

# TC + Angio-TC

TC + Angio-TC

RM+DWI

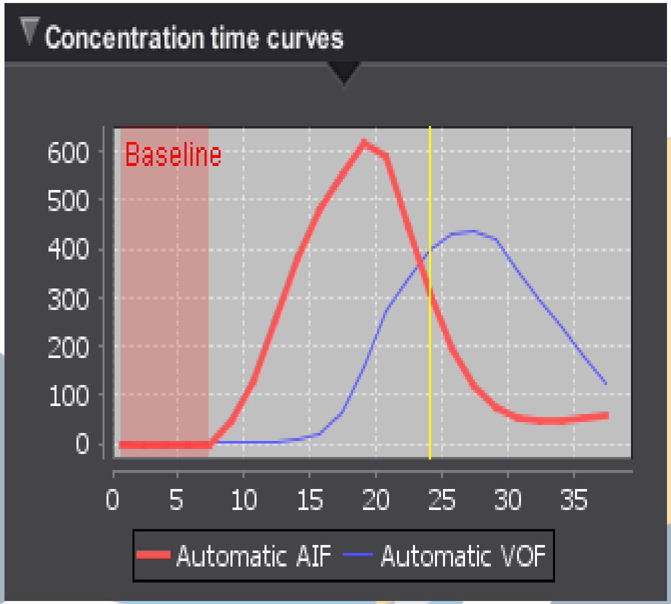
Collat./SWI

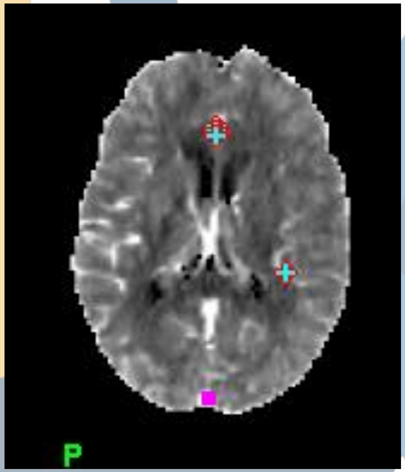
# Perfusione: limiti

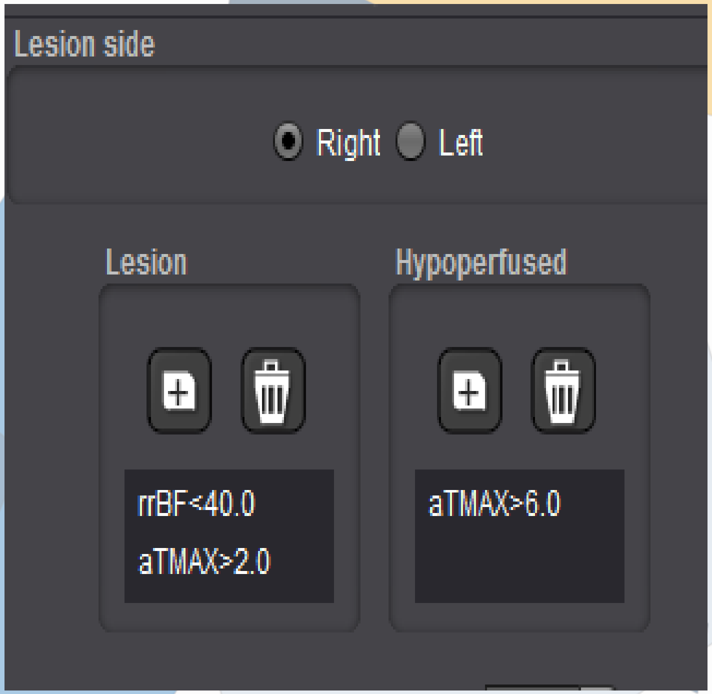
- Il post-processing richiede tempo
- Soglia ischemica tempo-dipendente
- Variabilità valori CBV e CBF
- Errori nelle misurazioni
    - Tecniche di acquisizione, risoluzione temporale, quantità mdc e velocità di iniezione
    - Assenza di standardizzazione dell’analisi dei dati
    - Software e algoritmi matematici

# Pacchetto Stroke CT

- Calcolo mappe di perfusione:
  rBV, rBF, TTP, MTT, Tmax,
- Identificazione Core e Penombra



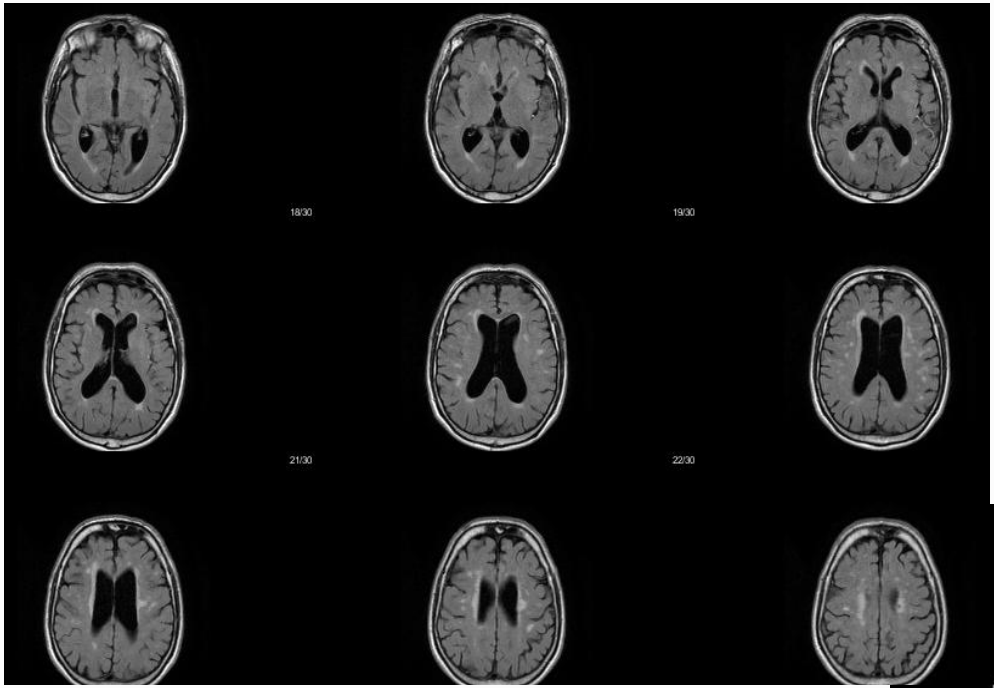



# Pacchetto Stroke MR

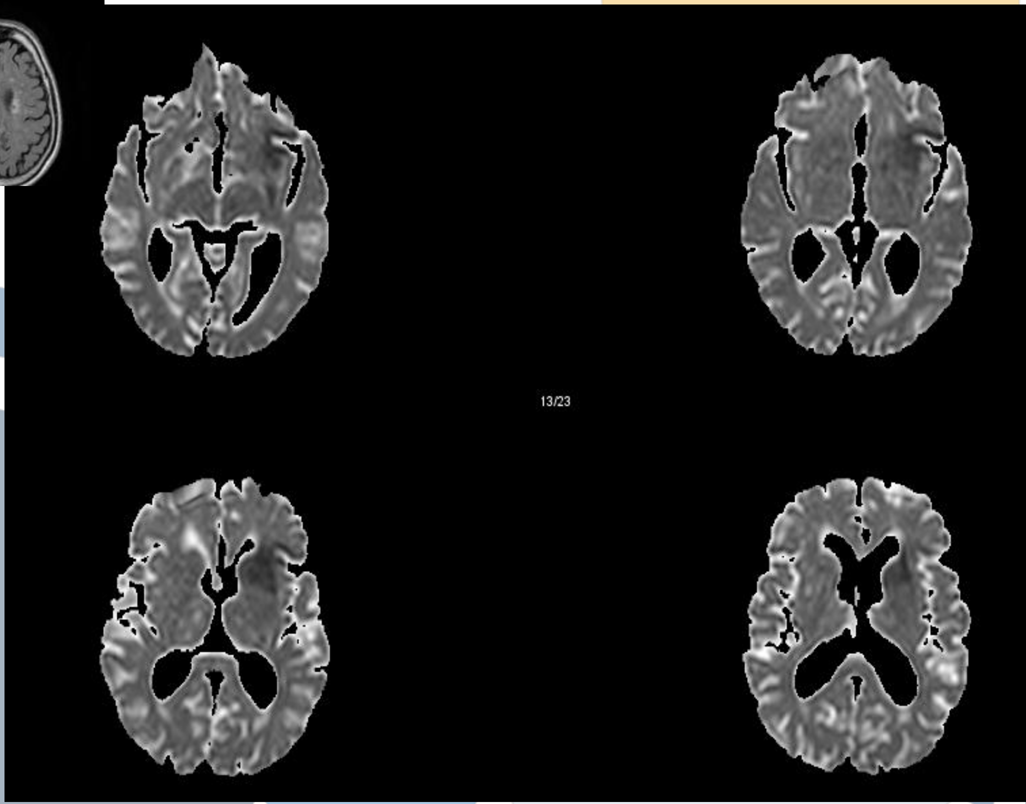
- Workflow dedicato: calcolo in 30 s mismatch fra Core e Penombra
- Core: DWI
- Penombra: DSC - 4 algoritmi di deconvoluzione (sSVD, cSVD, oSVD e Bayesiano)
- Calcolo di tutte le mappe di perfusione
- Identificazione lato lesione
- Soglie configurabili per core e penombra
- Mismatch relativo e percentuale

# FLAIR

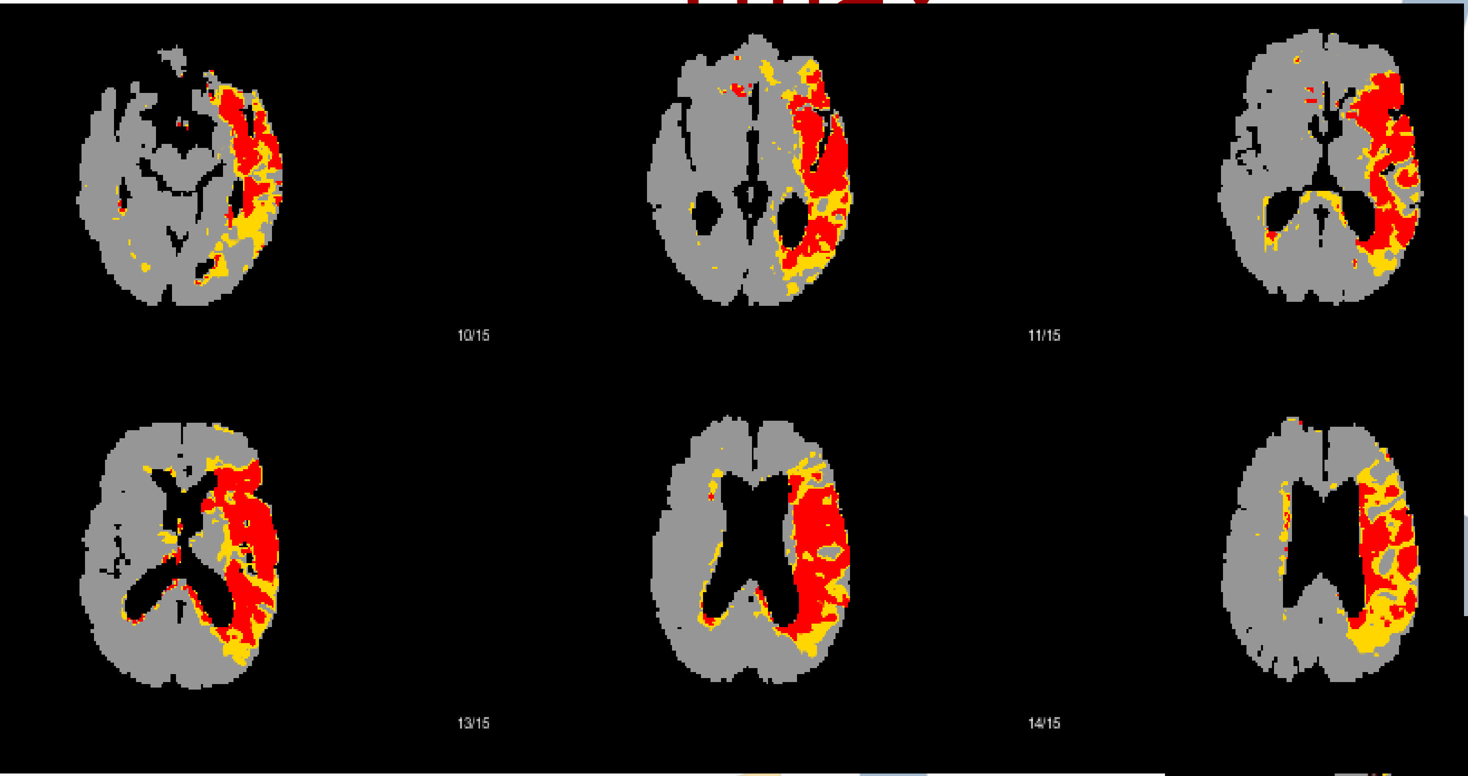

18/30
19/30
21/30
22/30

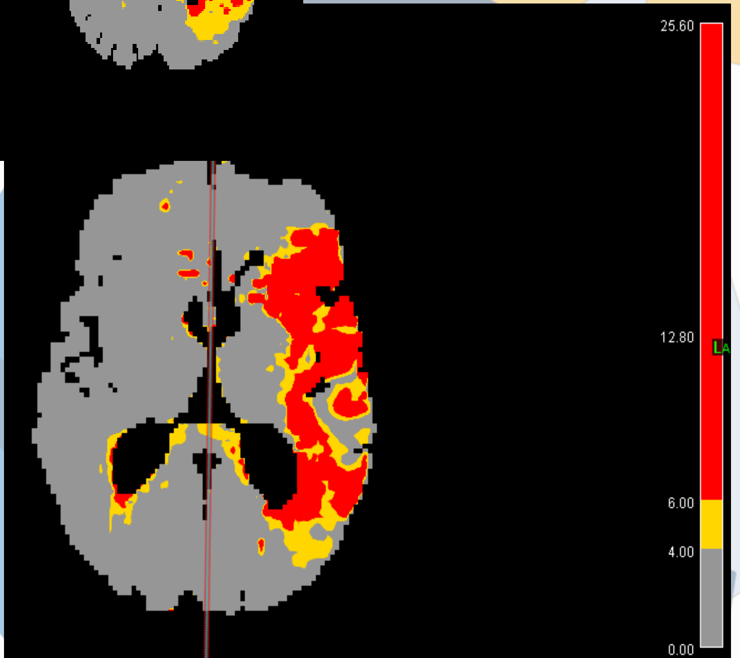

Lesion side
Right
Left
Lesion
Hypoperfused
aADC<0.6
aTMAX>6.0

# ADC

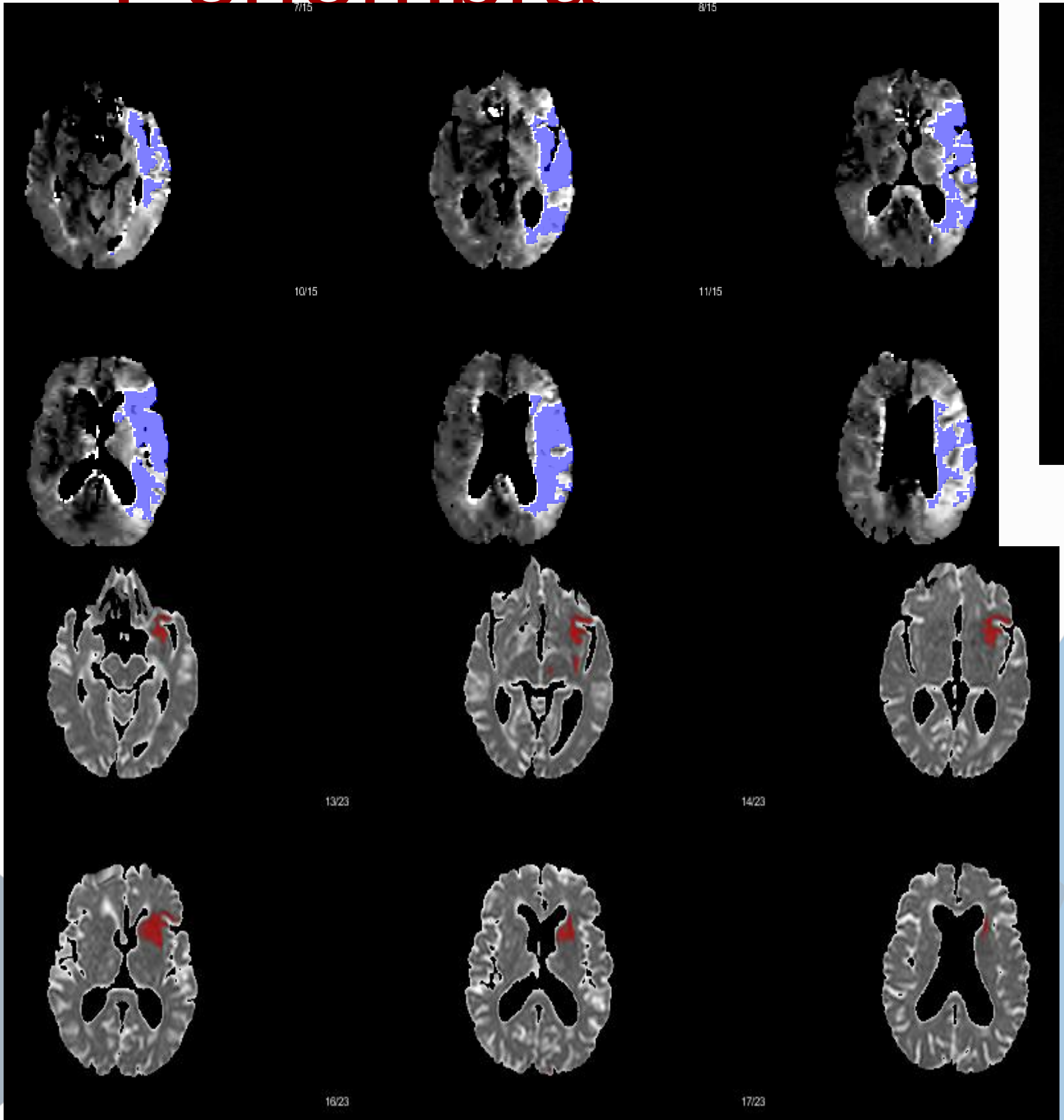

13/23

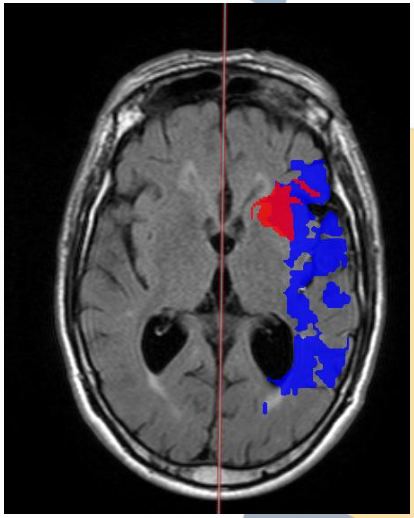
# Mappa Tmax



# Identificazione Core e Penombra



hypoperfused
88.51 cc
lesion
7.41 cc

Mismatch ratio 11.94
Relative mismatch: 91.63%

# IMAGING E OUTCOME

*JAMA Neurol*. doi:10.1001/jamaneurol.2015.3000
Published online November 2, 2015.

Original Investigation

## Endovascular Stroke Treatment Outcomes After Patient Selection Based on Magnetic Resonance Imaging and Clinical Criteria

Thabele M. Leslie-Mazwi, MD; Joshua A. Hirsch, MD; Guido J. Falcone, MD, MPH; Pamela W. Schaefer, MD; Michael H. Lev, MD; James D. Rabinov, MD; Natalia S. Rost, MD, MPH; Lee Schwamm, MD; R. Gilberto González, MD

**CONCLUSIONS AND RELEVANCE** Prospective classification as LTB by MRI and clinical criteria is associated with likelihood of favorable outcome after thrombectomy, particularly if reperfusion is successful. Selection of patients using MRI compares favorably with selection using computed tomographic techniques with the distinction that a higher proportion of screened patients were treated.

# TEMPO!

October 1, 2015 as 10.3174/ajnr.

REVIEW ARTICLE

## Multimodal Diagnostic Imaging for Hyperacute Stroke

K.D. Vo, A.J. Yoo, A. Gupta, Y. Qiao, A.S. Vagal, J.A. Hirsch, D.M. Yousem, and C. Lum

## Am Heart Association and Am Stroke Association

Target: Stroke," highlights best practice strategies to reduce treatment times. Urging rapid acquisition and interpretation of brain imaging, the authors recommend that 80% of patients with acute stroke evaluated for revascularization should have NCCT or MR imaging within 25 minutes, and 80% of patients should have interpretations within 45 minutes of arrival.

# CONCLUSIONS

Vital to the efficacy of any acute stroke treatment is time; therefore, diagnostic tests must be fast, reliable, and operationally efficient. Current treatment algorithms favor multimodal CT imaging even though MR imaging may be superior in individual diagnostic tasks. MR imaging shows promise in providing signatures for penumbra and core and may one day provide information beyond anatomic large-vessel occlusion to help guide advanced endovascular approaches as our therapeutic and diagnostic technology evolves.

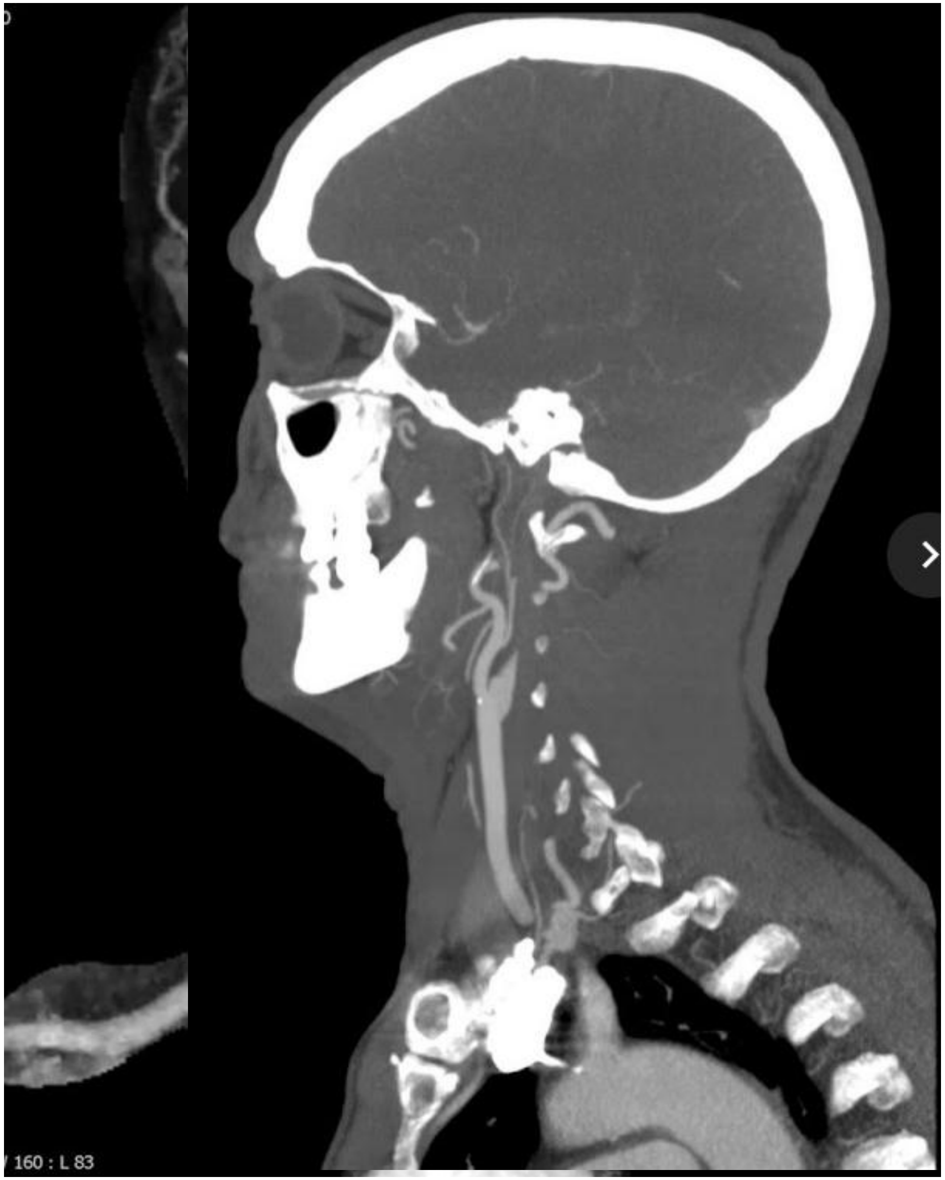
# CONCLUSIONI

- Per la selezione del Paziente il criterio più importante è il volume del core ischemico
- Il limite superiore è ancora da definire (70-100 ml)
- Il metodo da utilizzare è ancora da definire: attualmente CT, CTA (multifase); in futuro probabilmente MR

Qualunque sia la metodica dovrebbe essere in grado di massimizzare i benefici escludendo i pazienti a rischio ed evitando l'esclusione di pazienti con lesioni piccole ma clinicamente importanti, probabilmente anche oltre le 6 ore

# AngioTC 3.11 h 18.40

# AngioRM 10.11 h 10.45

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# Imaging Patterns and Management Algorithms in Acute Stroke

## An Update for the Emergency Radiologist

Behroze A. Vachha, MD, PhD, Pamela W. Schaefer, MD, FACR*

Radiol Clin N Am 53 (2015) 801–826
http://dx.doi.org/10.1016/j.rcl.2015.02.012

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Francesco Scomazzoni
Claudio Righi
Nicoletta Anzalone

## Unità Operativa di Neurologia HSR

Prof. G Comi e Colleghi

CERMAC

OSPEDALE SAN RAFFAELE

UNIVERSITÀ VITA-SALUTE SAN RAFFAELE
UniSR
QUID EST HOMO?

DIVISION OF NEUROSCIENCE

# DECRETO 70

SERIE GENERALE

Spediz. abb. post. - art. 1, comma 1
Legge 27-02-2004, n. 46 - Filiale di Roma

Anno 156° - Numero 127

GAZZETTA UFFICIALE DELLA REPUBBLICA ITALIANA

PARTE PRIMA

Roma - Giovedì, 4 giugno 2015

SI PUBBLICA TUTTI I GIORNI NON FESTIVI

SOMMARIO

**8.2.3 Rete per l'ictus**

Per garantire il miglior approccio alle problematiche dell'ictus e pervenire ad una presa in carico complessiva del paziente, si individua un percorso che prevede 3 fasi:

- -fase pre-ospedaliera
- -fase ospedaliera
- -fase post-ospedaliera

Vengono in questo decreto definiti gli standard delle Unità ospedaliere per il trattamento dei pazienti con ictus (*Stroke unit*) e le strutture dedicate alla gestione dei pazienti con ictus cerebrale acuto, prevedendo 2 livelli.

# DECRETO 70

**8.2.3.1 Unità ospedaliere per il trattamento dei pazienti con ictus, c.d. *Stroke Unit* (SU) di I livello o area *stroke***

Sono necessarie per rispondere diffusamente, a livello territoriale, al fabbisogno di ricovero e cura della maggior parte dei pazienti con ictus cerebrale. Si caratterizzano per la presenza, in area di degenza specializzata per pazienti con ictus, dei seguenti standard:

- Competenze multidisciplinari incluse o presenti nella struttura
- Un neurologo dedicato e Personale infermieristico dedicato
- Almeno un posto letto con monitoraggio continuo
- Riabilitazione precoce (fisioterapia, logopedia, terapia occupazionale)
- Terapia fibrinolitica endovenosa
- Pronta disponibilità neurochirurgica (anche in altra sede con supporto tecnologico telediagnostico)
- Disponibilità h.24 di Tomografia computerizzata (TC) cerebrale e/o angio-TC con apparecchio volumetrico multistrato ad almeno 16 strati e/o Risonanza magnetica (RM) encefalo, Risonanza magnetica con immagini pesate in diffusione (RM DWI), angio-RM
- Diagnostica neurosonologica epiaortica e intracranica, ecodoppler dei tronchi sovra-aortici (TSA) ed ecocardiografia
- Collegamento operativo con le *Stroke Unit* di II livello per invio immagini e consultazione collegamento operativo (protocolli condivisi di valutazione del danno e della disabilità, di indicatori di processo riabilitativo e di esito) con il territorio e con una o più strutture riabilitative.

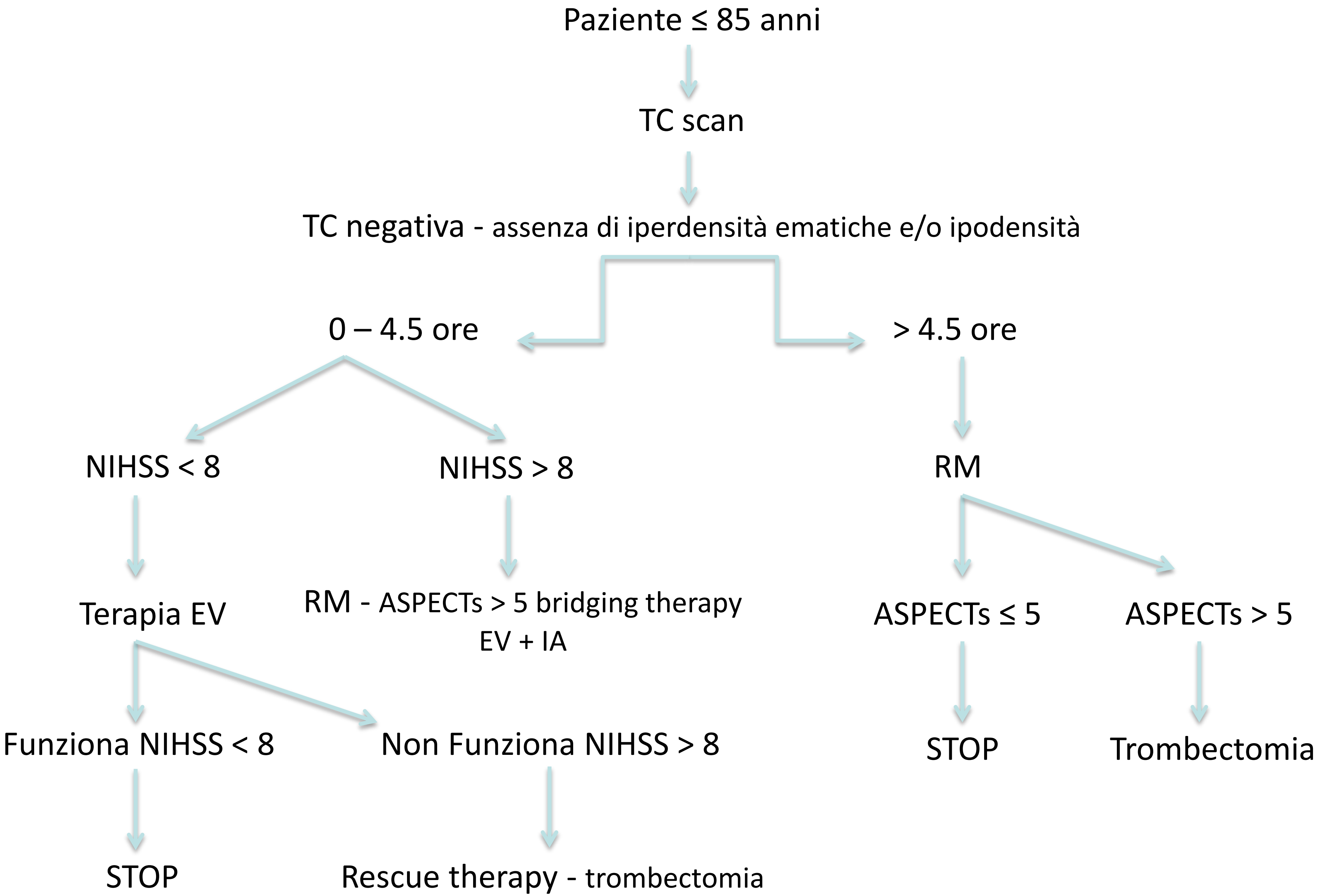
# DECRETO 70

**8.2.3.2 Unità ospedaliere per il trattamento dei pazienti con ictus, c.d *Stroke Unit* di II livello**

La *Stroke Unit* di II livello deve trattare almeno 500 casi/anno di ictus e, oltre a quanto previsto per le *Stroke Unit* di I livello, deve garantire i seguenti standard:

- Personale dedicato h.24
- Neuroradiologia h.24 con TC volumetrica multistrato a 64 strati, con programmi di ricostruzione angiografica e perfusionale. Apparecchio da 1,5 Tesla per Risonanza magnetica (RM), Risonanza magnetica con immagini pesate in diffusione (RM DWI), Risonanza magnetica con immagini pesate in perfusione (RM-PWI) e angio-RM con pacchetto a rapida effettuazione
- Interventistica endovascolare con camera con angiografo digitale con arco a C e con *Flat Panel* h.24
- Neurochirurgia h.24
- Chirurgia vascolare h.24
- Angiografia cerebrale
- Fibrinolisi intra-arteriosa (urgenza), trombectomia meccanica (urgenza), stent extra- e intracranico,
- Embolizzazione di malformazioni artero-venose, aneurismi, endoarteriectomia (urgenza)
- Craniotomia decompressiva

# Protocollo gestione STROKE Messina

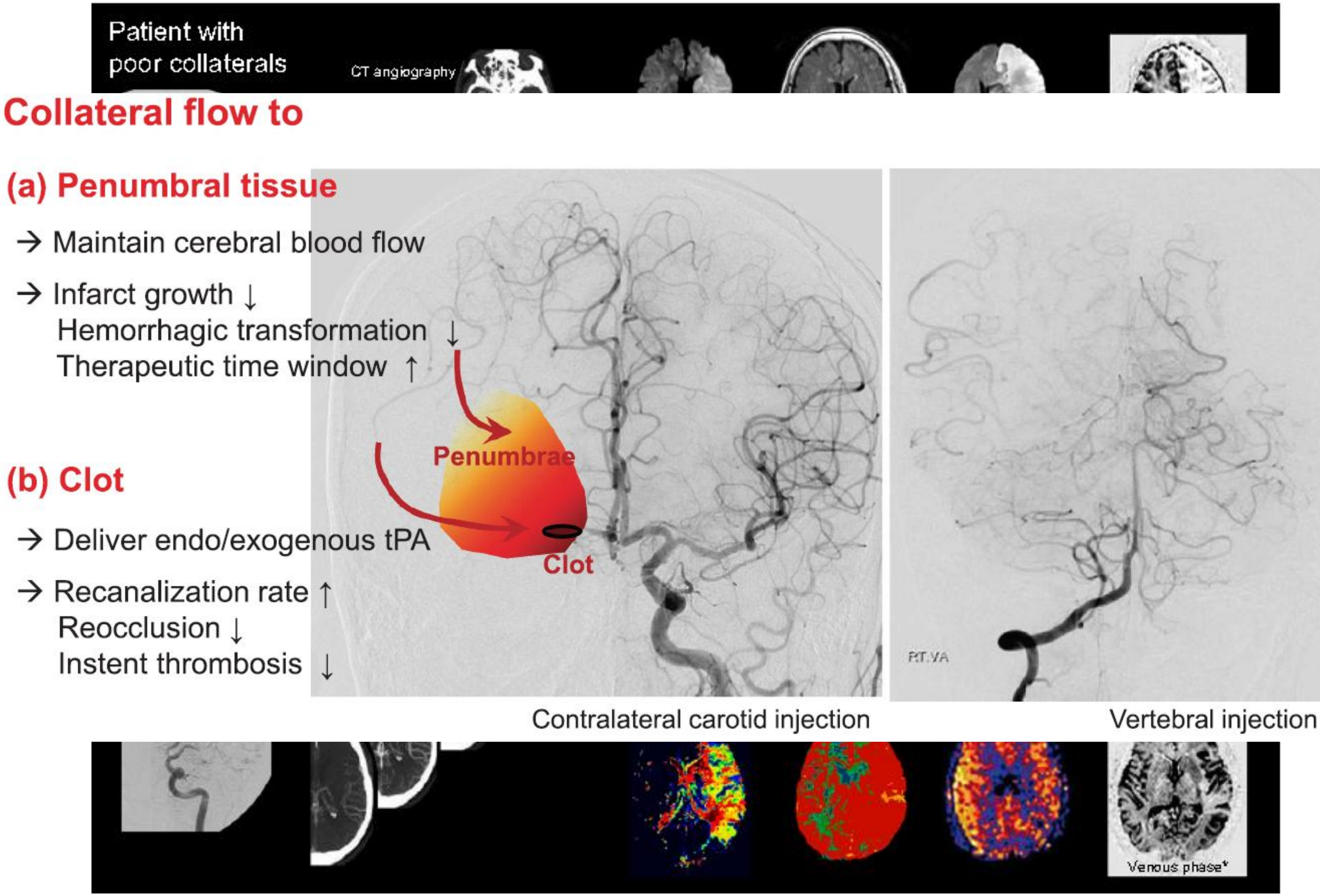


# Collateral Circulation in Ischemic Stroke

## Assessment Tools and Therapeutic Strategies

Oh Young Bang, MD, PhD; Mayank Goyal, MD; David S. Liebeskind, MD

*Stroke*. 2015;46:3302-3309. DOI: 10.1161/STROKEAHA.115.010508.)



# MR Perfusion

MR perfusion
MRP was deemed preferable to CTP because there is no radiation
exposure and it has a generally superior workflow.
However, the repeatability, reliability, and clinical efficacy of MRP raise similar concerns to those of CTP, including:

- Quantification using MR perfusion maps is not validated.
- There is high inter-vendor variability.
- The variability of MRP maps with respect to physiologic variables (eg, heart rate, blood pressure, ejection fraction) and scan parameters (eg, rate of infusion, osmolality of IV contrast, rotation time, etc) is unknown.

MGH

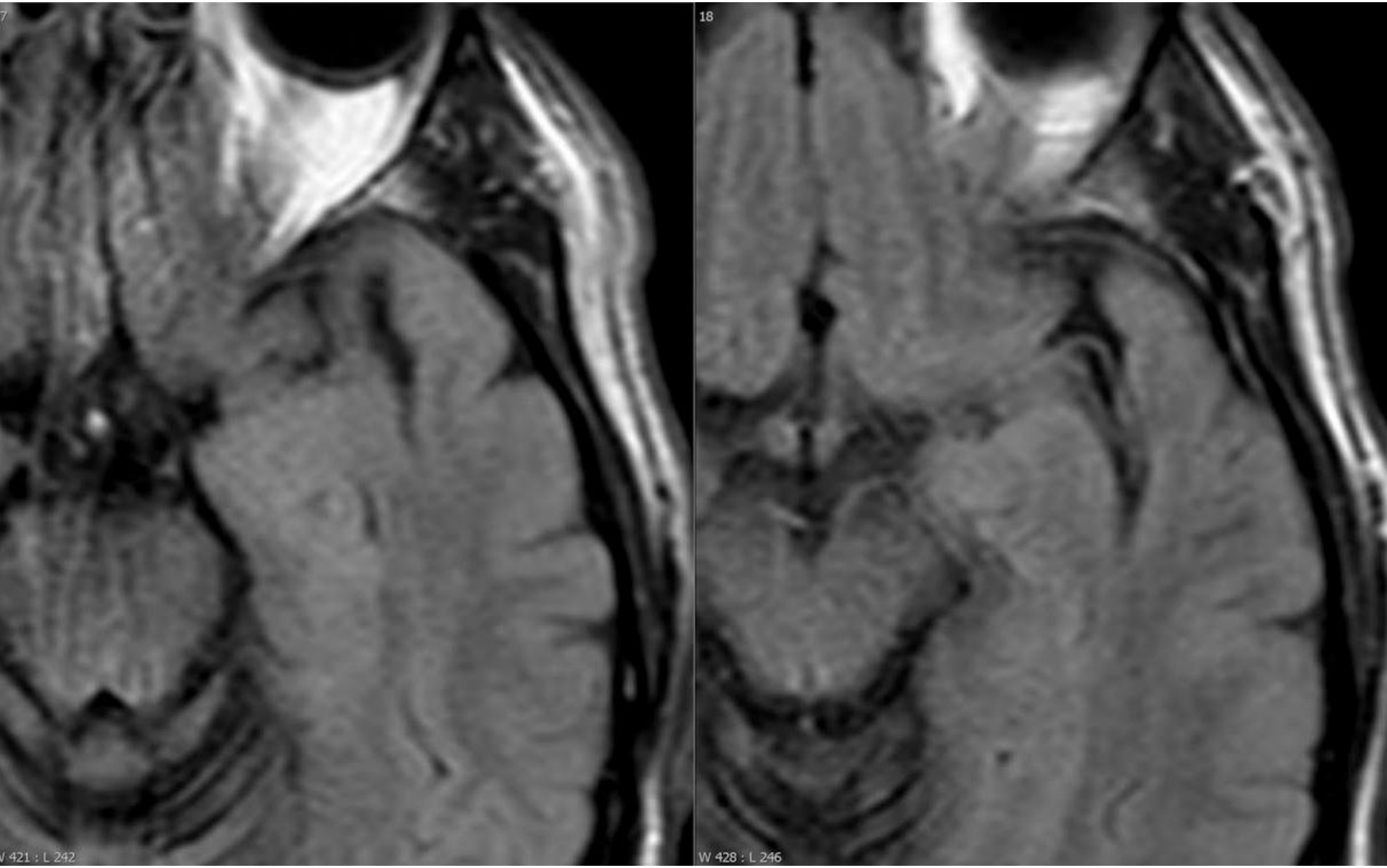
# PRESUPPOSTI

The hyperdense vessel sign is seen in approximately 30% of patients with an M1 occlusion (see Fig. 3) and less commonly in patients with an MCA insular branch, ICA, or basilar artery occlusion.

Hypodensity on NCCT is thought to represent infarct core, or tissue that is destined to progress to infarction. CT hypodensity is thought to be owing to an increase in tissue water content with a resultant reduction in x-ray attenuation.33 Shortly after vascular occlusion, cell hypoxia leads to depletion of cellular ATP, failure of the Na1–K1– ATPase and other ionic pumps, a net migration of ions from the extracellular to the intracellular space with water following by osmosis, and the development of cytotoxic edema. Because there is no overall increase in tissue water, NCCT is insensitive for the detection of acute ischemia at very early time points. Within a few hours, there is breakdown of the blood–brain barrier and vasogenic edema begins develop. The progressive increase in total tissue water results in increasing hypodensity on NCCT and the increased sensitivity of NCCT to detect acute ischemia. The sensitivity for detection of acute ischemia within the first 3 hours after stroke onset is reported as 67% or less in most trials, but improved to 71% by using narrow window width and center level settings.

# SWI

Prominent asymmetric hypointense cortical veins have been identified within the ischemic region using SWI and are likely owing to an increase in the deoxyhemoglobin to oxyhemoglobin ratio caused by hypoperfusioninduced increases in the oxygen extraction fraction. 73,74 It has been hypothesized that, because SWI is sensitive to oxygen extraction fraction– associated changes in deoxygenated hemoglobin seen in hypoperfused tissue, it may be used to provide metabolic information similar to mean transit time (MTT) on perfusion-weighted images (PWI).75 Several recent studies have reported that the DWI–SWI mismatch in acute stroke is similar to the DWI–PWI mismatch, suggesting that the DWI–SWI mismatch may demarcate the ischemic penumbra and have a similar ability to predict stroke evolution as the DWI–PWI mismatch.73,75–77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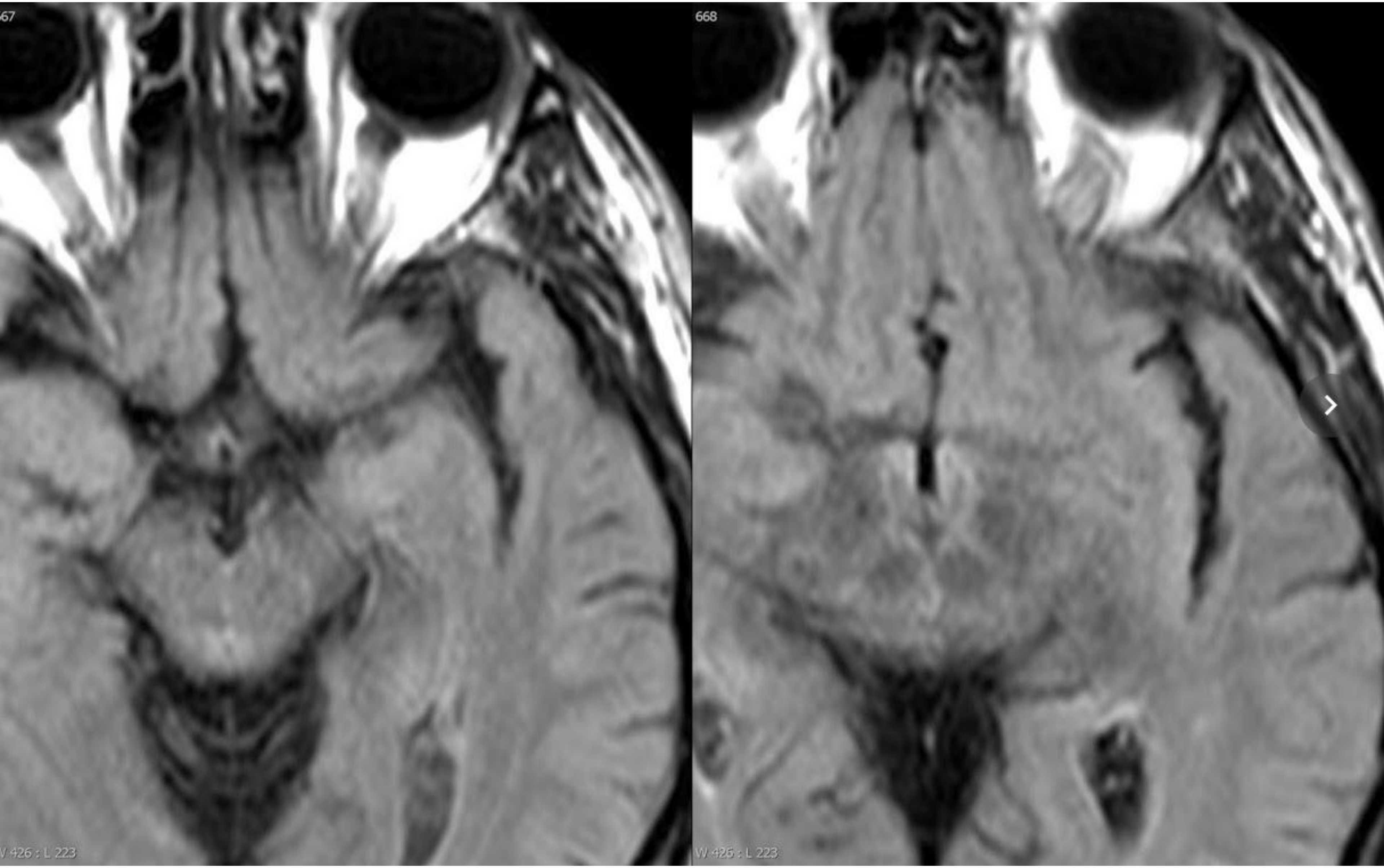
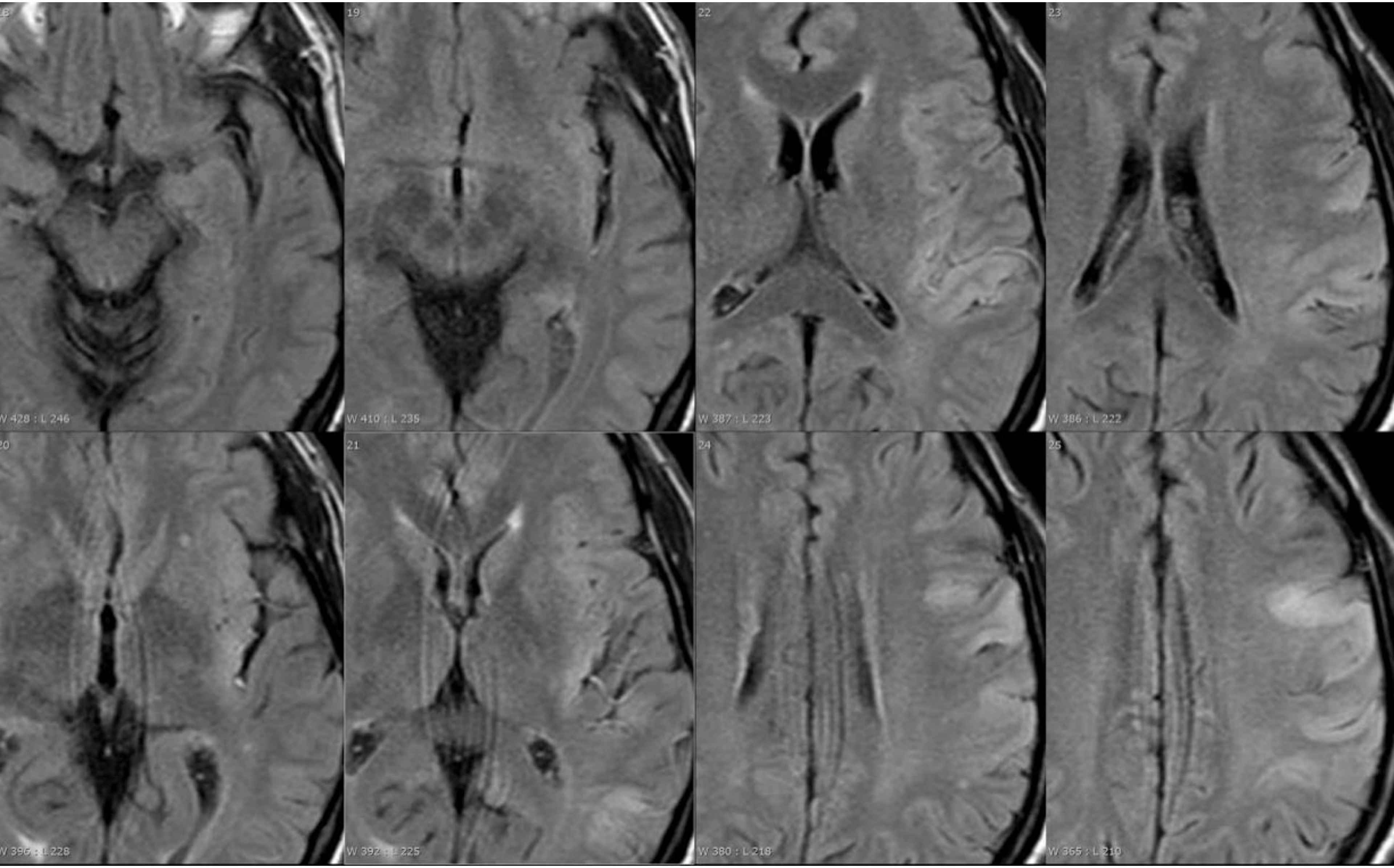
W 421 : L 242
W 428 : L 246




3.11 h 18.50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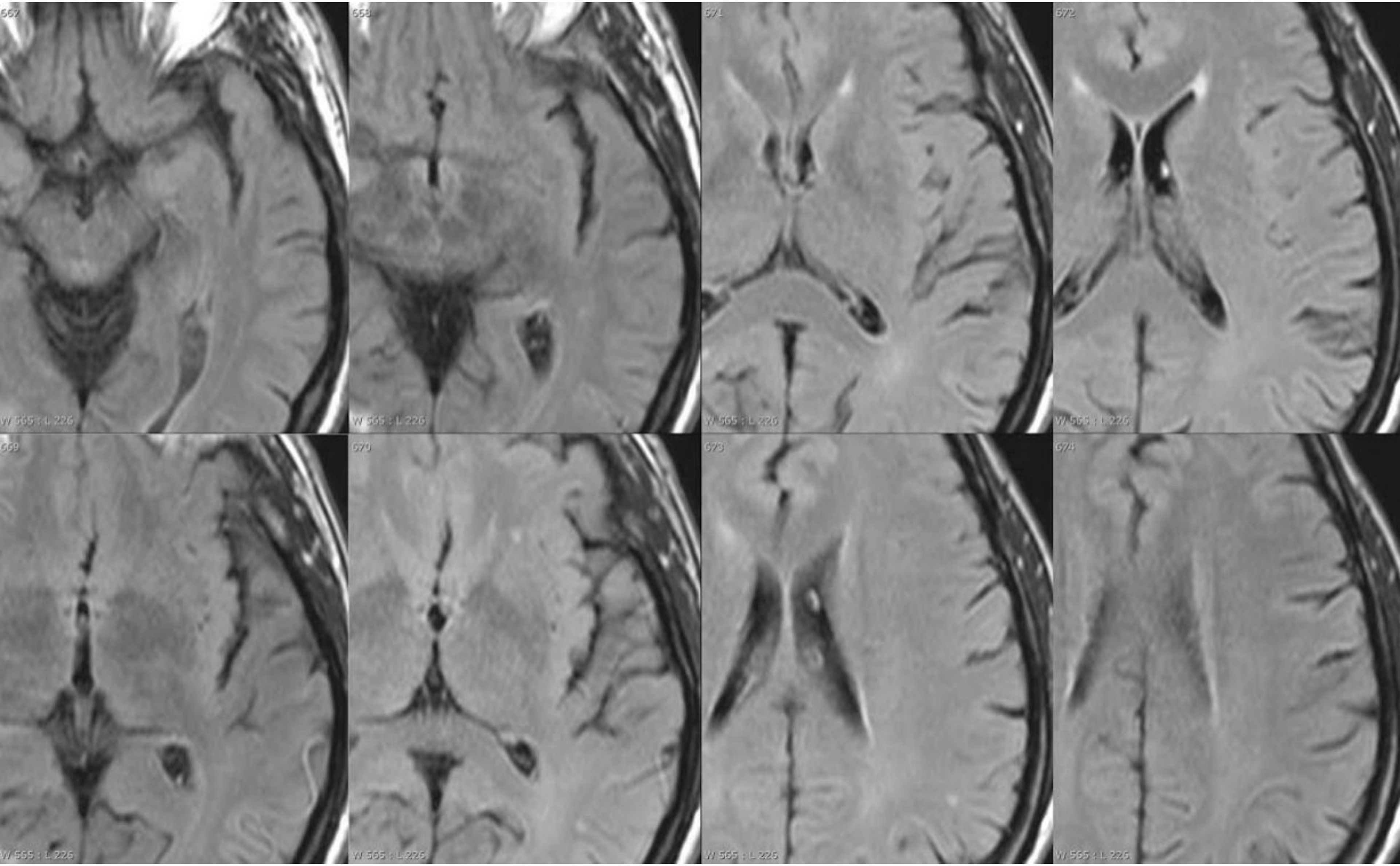
W 380 : L 218
W 365 : L 210

4.11 h 8.11



3.11 h 18.50

# PRESUPPOSTI

**Time course of infarction on CT and MR imaging**

| Stage | CT | MR–DWI | MR-ADC | MR-FLAIR |
|---|---|---|---|---|
| Hyperacute (0–6 h) | Hyperdense artery sign; subtle decreased attenuation | Hyperintense | Hypointense | Hyperintense clot, hyperintense collateral vessels, isointense to mildly hyperintense parenchyma |
| Acute (6–24 h) | Decreased attenuation | Hyperintense | Hypointense | Hyperintense |
| Early subacute (1–7 d) | Decreased attenuation, progressive swelling | Hyperintense | Hypointense | Hyperintense |
| Late Subacute (1–4 wk) | Decreased attenuation and progressive swelling up to 1–2 wk, after which edema progressively resolves | Hyperintense (owing to T2 shine through) | Progressive increase of ADC - Isointense at 1–2 wk (pseudonormalization) then hyperintense | Hyperintense |
| Chronic | Hypodense encephalomalacia | Hypointense | Hyperintense | Hyperintense in periphery, centrally hypointense owing to cavitation |

# PRESUPPOSTI

Reported specificities for detection of acute ischemia on NCCT are high, ranging from 89% to 95%.
Hypodensity on NCCT has important clinical applications. If the NCCT demonstrates hypodensity involving more than one-third of the MCA territory, the risks of “malignant MCA infarction,” hemorrhagic transformation with attempted revascularization, or both are increased and IV thrombolytic therapy is not administered

The Alberta Stroke Program Early CT Score (ASPECTS) was developed to provide a systematic and standardized approach of assessing early ischemic changes in regions of the MCA territory.39 In ASPECTS, 10 regions in the MCA territory are assigned a binary score of 0 or 1 depending on the presence (1) or absence (0) of hypodensity; the total number of ischemic regions is subtracted from 10 such that a normal CT receives an ASPECTS score of 10 points, and a score of 0 indicates diffuse involvement throughout the MCA territory (Fig. 4). In general, ASPECTS has substantial interreader agreement.

# CTA

CTA is also useful for assessing the extent of leptomeningeal collateral circulation.81 The presence (see Fig. 8) or absence (Fig. 9) of a robust collateral circulation on CTA can predict the final infarct volume after endovascular therapy and the clinical response to treatment.82–84 Souza and colleagues85 demonstrated that in patients with ICA and/or M1 occlusions, absent collaterals in greater than 50% of an MCA M2 branch territory (malignant collateral profile) detected by CTA was highly specific for larger admission DWI infarct core and poor outcome. Furthermore, Puetz and colleagues86 demonstrated that a malignant collateral profile on CTA predicted poor prognosis despite IV thrombolysis within 3 hours from symptom onset.

# PRESUPPOSTI

**1** **Tempo!!!**

**2** **Estensione della lesione infartuale**

*Ridurre il rischio emorragico*
*Evitare inutili ricanalizzazioni*

**3**

- **MR Clean**
- **Extend-IA**
- **Escape**
- **Revascat**
- **Swift prime**

*"Endovascular teraphy is highly beneficial as compared with intravenous t-PA alone, in patients with occlusions of the intracranial internal carotid artery or middle cerebral artery up to 6 hours after stroke onset."*

# RM

Although any prior known intracranial hemorrhage is deemed an absolute contraindication to IV tPA, recent studies have found no increased risk of hemorrhagic conversion of acute ischemic stroke treated with thrombolytic therapy in patients with up to 5 microhemorrhages detected on conventional GRE sequences.

Similar to NCCT, FLAIR requires disruption of the blood–brain barrier and development of vasogenic edema to detect acute ischemia. Edema associated with infarction presents earliest on FLAIR sequences, but still has a sensitivity of only 29% in the first 6 hours from stroke onset.46,60,61 Hyperintense signal on T2-weighted images begins is not usually identified in the first 8 hours and hypointense signal signifying edema on T1-weighted images in the first 16 hours.62 With this approximate guideline in mind, for those patients in whom the time of stroke onset is unknown ("wake-up" strokes), an infarct on DWIand ADC without matching hyperintensity onFLAIR suggests that the stroke likely occurred less than 6 hours previously

# Perfusione

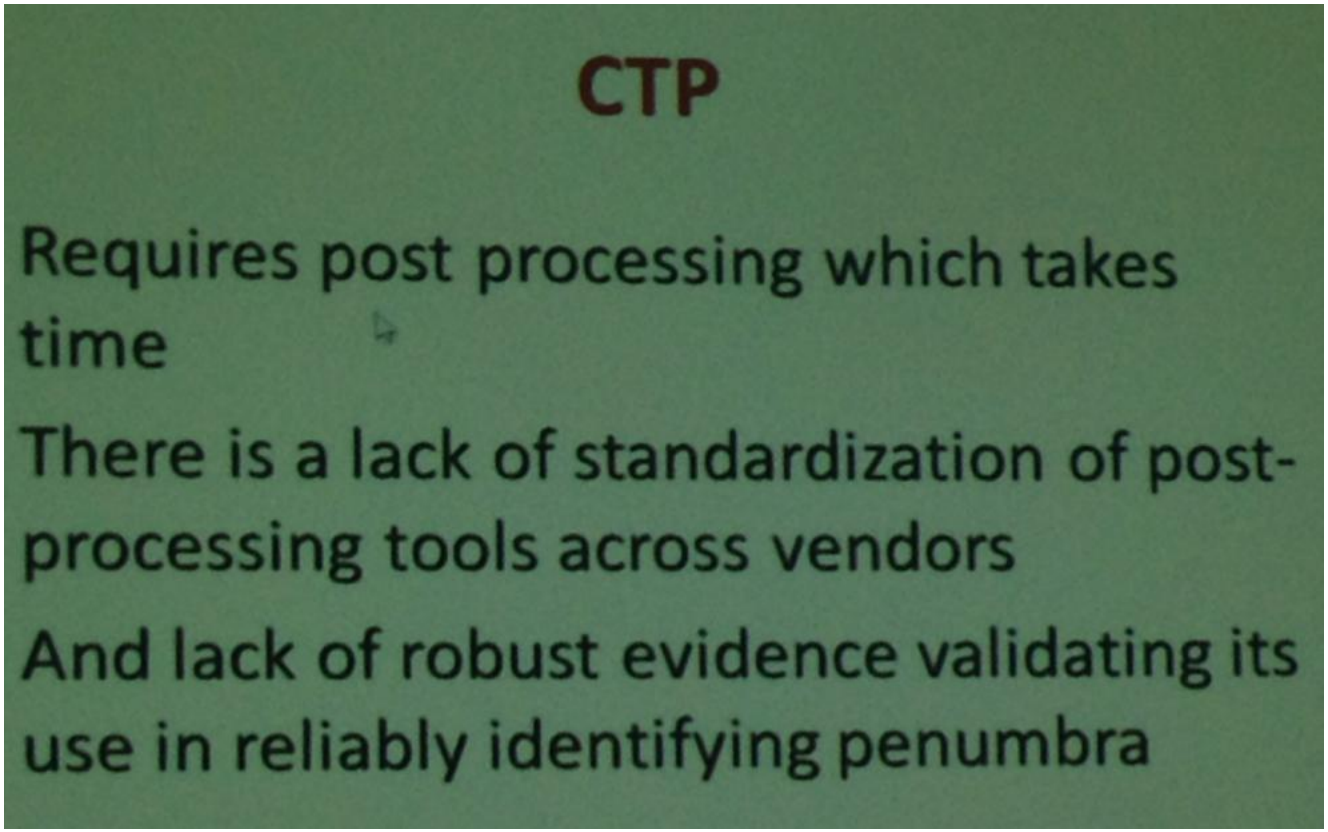
Tissue that seems to be normal on DWI or thresholded CT CBV/CBF images and abnormal on MTT and other transit images such as Tmax is thought to represent the ischemic penumbra. The penumbra represents tissue that may progress to infarction or may recover, depending on the timing of reperfusion and the degree of collateralization. It is tissue that can potentially be salvaged with reperfusion therapy.

The assumption that the thresholded CT CBV/ CBF–MTT/Tmax mismatch and the DWI-MTT/Tmax mismatch represent the ischemic penumbra on CT perfusion and MR PWI, respectively, suggests that patients with a large mismatch would be most likely to benefit from reperfusion therapy. Conversely, it is suggested that patients with little or no mismatch should not receive aggressive therapies because their infarctions are unlikely to increase in size and they should be spared the associated risk of hemorrhage. The concept that the mismatch should be used as selection criteria for IV thrombolysis or endovascular procedures is supported by some recent studies. For example, in the Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution (DEFUSE) trial and the DEFUSE-2 trial, patients receiving reperfusion therapy between 3 and 6 hours were stratified based on predefined DWI–PWI imaging profiles, and both showed favorable clinical response in the patients with “target mismatch” that had early reperfusion relative to those with “no mismatch” or “malignant” profiles.

## Summary of CT and MR imaging techniques for evaluating infarct core, infarct penumbra, and vasculature

| Modality | Infarct Core | Penumbra | Vasculature |
|---|---|---|---|
| CT | Hypodensity defines the infarct core<br>Specific but not sensitive<br>Hypodensity involving one-third of the MCA territory is a contraindication to thrombolysis | Not seen | Hyperdense vessel denotes site of intravascular thrombus |
| MR imaging (DWI, FLAIR, T2, GRE) | DWI/ADC hyperintensity/hypointensity is the most sensitive and specific imaging marker of infarct core - level 1 evidence<br>DWI core >70 mL suggests poor patient prognosis and is a contraindication to IA therapy at many centers<br>FLAIR - little to hyperintensity in first 6 h; used to determine time of stroke onset and treatment in patients with wake up strokes<br>GRE/SWI detects hemorrhagic conversion | SWI - Asymmetric cortical veins with increased deoxyhemoglobin may define the penumbra | FLAIR - hyperintensity in clot and in collateral vessels<br>T2 - loss of normal flow void<br>GRE/SWI - susceptibility artifact in clot |
| CTA | CTA source images improve detection of ischemia but tend to overestimate infarct core | Cannot define | Highly sensitive and specific for the detection of proximal vessel occlusions<br>CTA MIPS increase conspicuity of vascular stenosis and occlusion<br>CTA MIPS - reliable for quantifying degree of collateral circulation |
| MRA | Cannot define | Cannot define | Overall, less sensitive and specific for detecting intracranial stenosis and occlusions compared with CTA<br>Relatively accurate for detecting proximal vessel occlusions.<br>TOF MRA is invaluable alternative for patients with renal insufficiency or IV contrast allergy |
| CTP | Estimated by thresholded CBV or CBF, but large variability in absolute and relative values because techniques and postprocessing methods are not standardized and there is large measurement error.<br>Less sensitive and specific than DWI | Estimated by tissue that is normal on thresholded CBV or CBF but abnormal on thresholded CBF or MTT maps, but large variability in values because techniques and postprocessing methods are not standardized and there is large measurement error. | CTA and CTP can be acquired simultaneously on some scanners |
| MRP | Not used to define infarct core because DWI is far more sensitive and specific | Estimated by CBF reduction and MTT/$T_{max}$/TTP prolongation, but large variability in relative values because techniques and postprocessing methods are not standardized and there is large measurement error.<br>DWI volume - $T_{max}$ >6 volume mismatch has been shown to be useful in some clinical trials | Cannot define |

# CTP


CTP
Requires post processing which takes time
There is a lack of standardization of post-processing tools across vendors
And lack of robust evidence validating its use in reliably identifying penumbra

# RCTs: Clinical data on mechanical thrombectomy

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# European Consensus Statement on Thrombectomy

*(Accepted for publication in International Journal of Stroke)*

Aim:

To provide a broad consensus among European professional organisations on the management on neurothrombectomy, based on a systematic overview of published
or presented trials

# CORE E TROMBECTOMIA