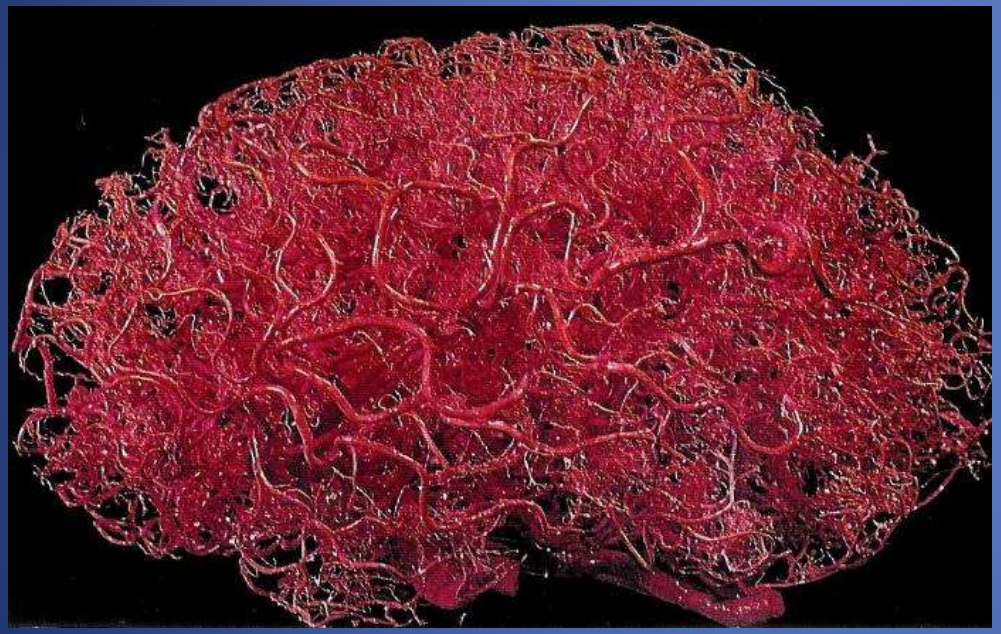
Interventional neuroradiology new techniques and beyond

In endovascular therapy

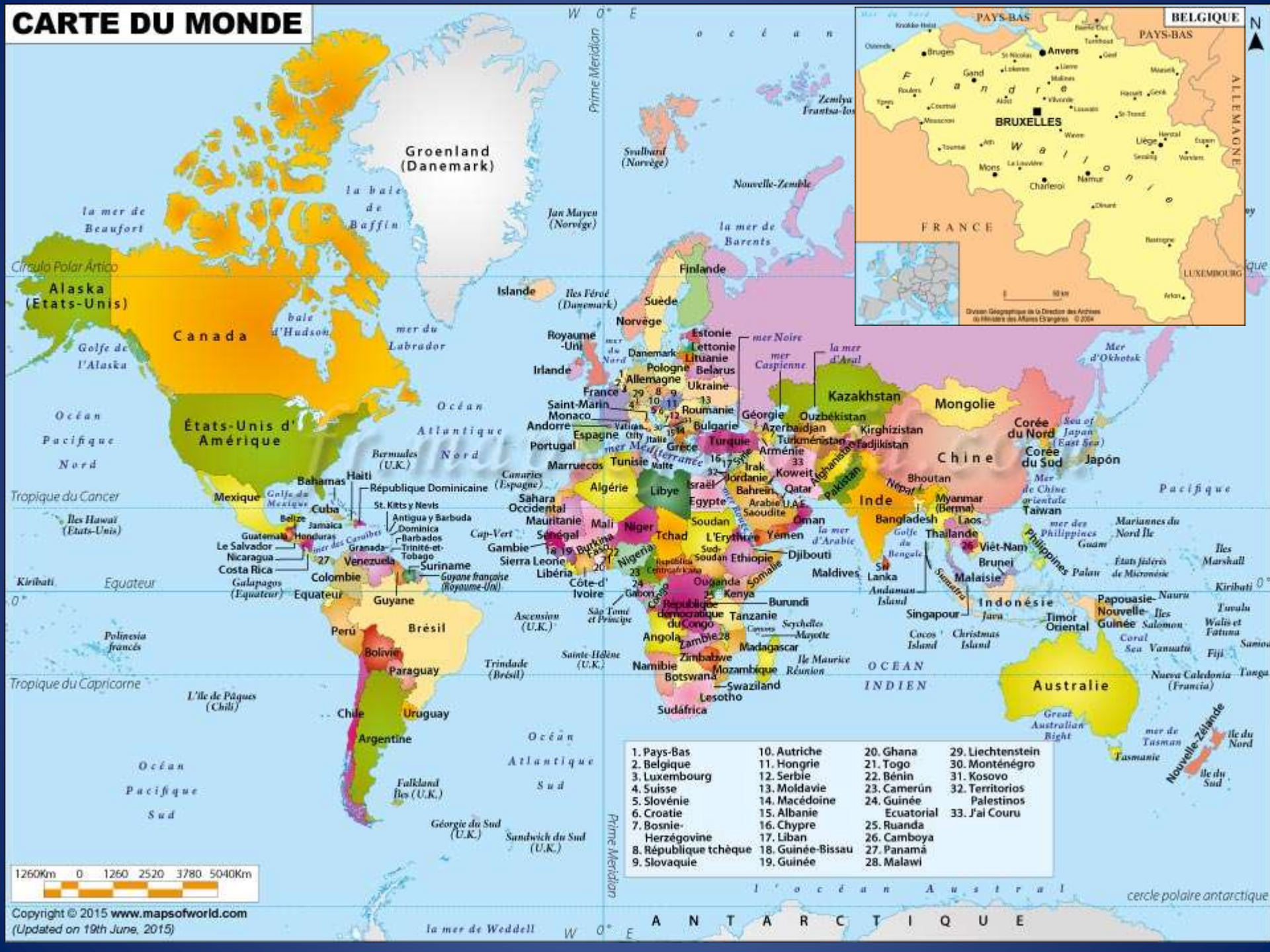


Thierry Boulanger*
Luc Stockx
Jan Vanrusselt

The medical update group
University of Mauritius 2016

Interventional centrum ZOL Belgium
**Consultant neuroradiologist CHL*

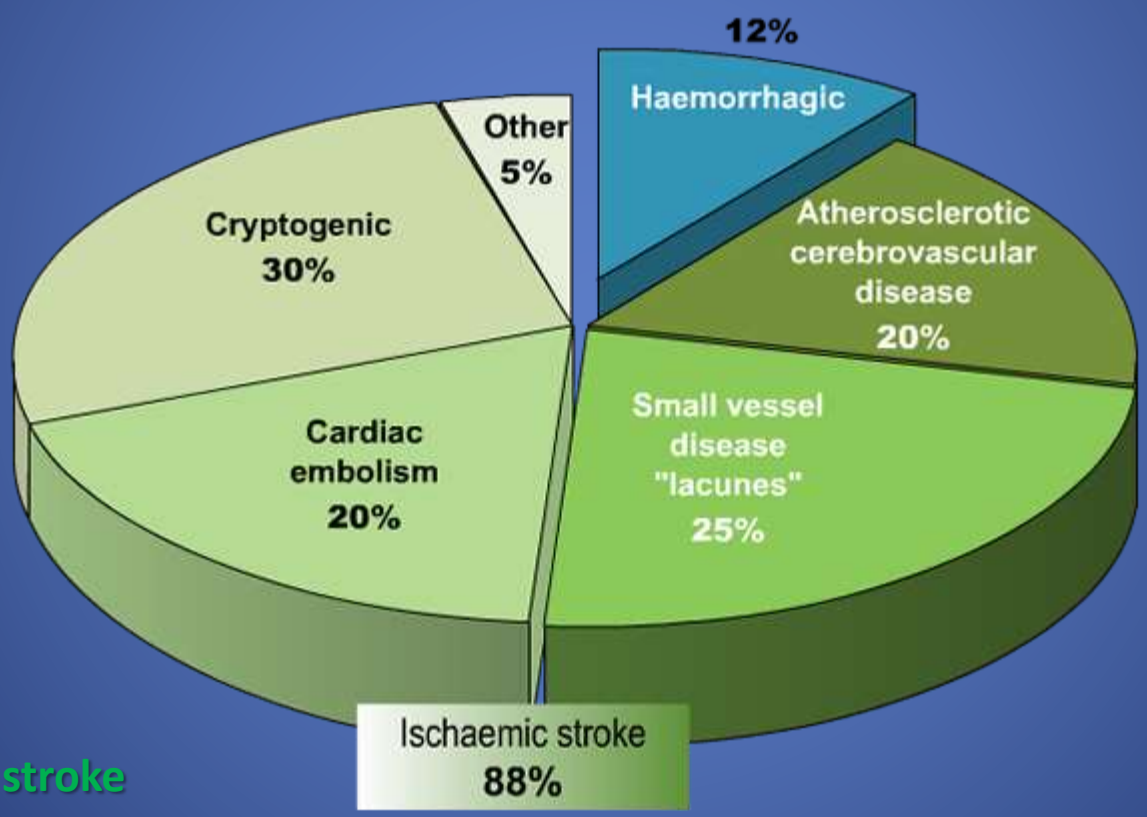
CARTE DU MONDE




Le goût
des Belges

Types of stroke

I.Haemorrhagic stroke



II.Ischemic stroke

INR in haemorrhagic stroke

>prevent further bleeding(in the acute phase)by obliteration of a potentially hemorrhagic lesion

Vascular malformations ***NEW TOOLS***

vascular traumas

(vascular tumors)

recanalisation of sinovenous thrombosis

>improve the outcome of complications as a result of hemorrhage

treatment of vasospasm

Vascular malformations

>aneurysms

>parenchymal /pial arteriovenous (AV) malformations(AVM)

New tools

>dural arteriovenous(AV) malformations(dAVM)

>venous angiomas*

>cavernous malformations*

>capillary telangiectasias*

*occult cerebrovascular malformations:

---> angiographically cryptic

Vascular malformations

Parenchymatous/pial AV malformations
Dural AV malformations

New tools

Onyx liquid embolic system

- Ethylene-vinyl alcohol copolymer (EVOH)
- Dimethyl Sulfoxide (DMSO) solvent
- Micronized tantalum powder

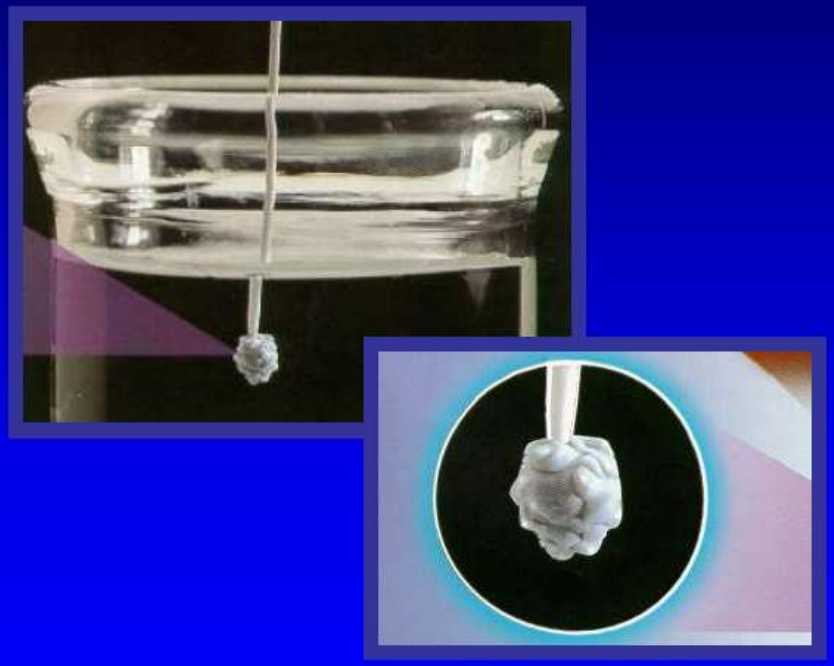
Vascular malformations

Parenchymatous/pial AV malformations
Dural AV malformations

New tools

Onyx liquid embolic process

- Contact with blood = "Precipitation"
- Solvent diffuses away
- Forms a spongy polymeric cast
- Forms a skin - solidifies from the outside in
- Liquid center continues to flow



Vascular malformations

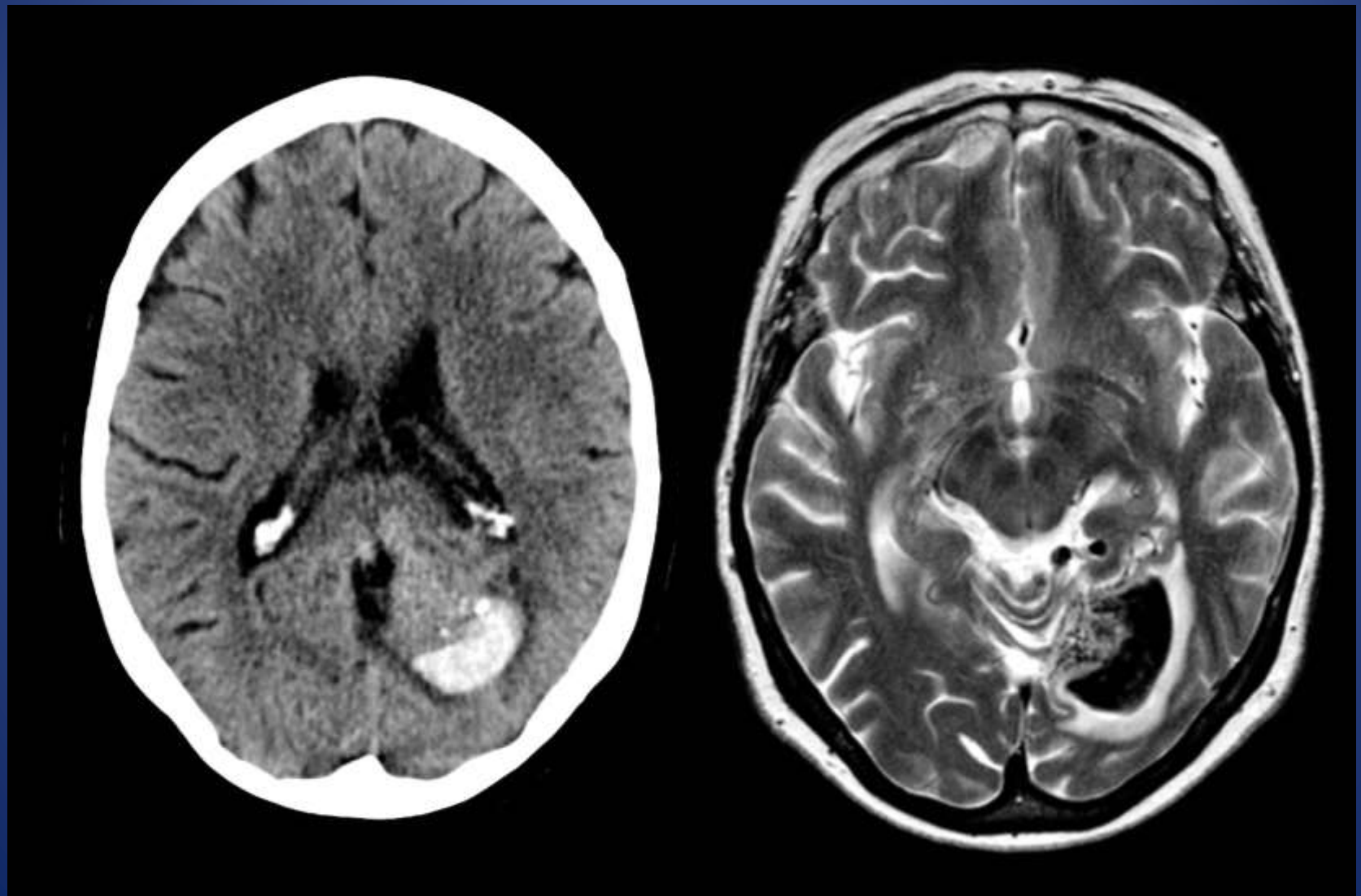
Parenchymatous/pial AV malformations
Dural AV malformations

Onyx liquid non adhesive embolic agent

New tools

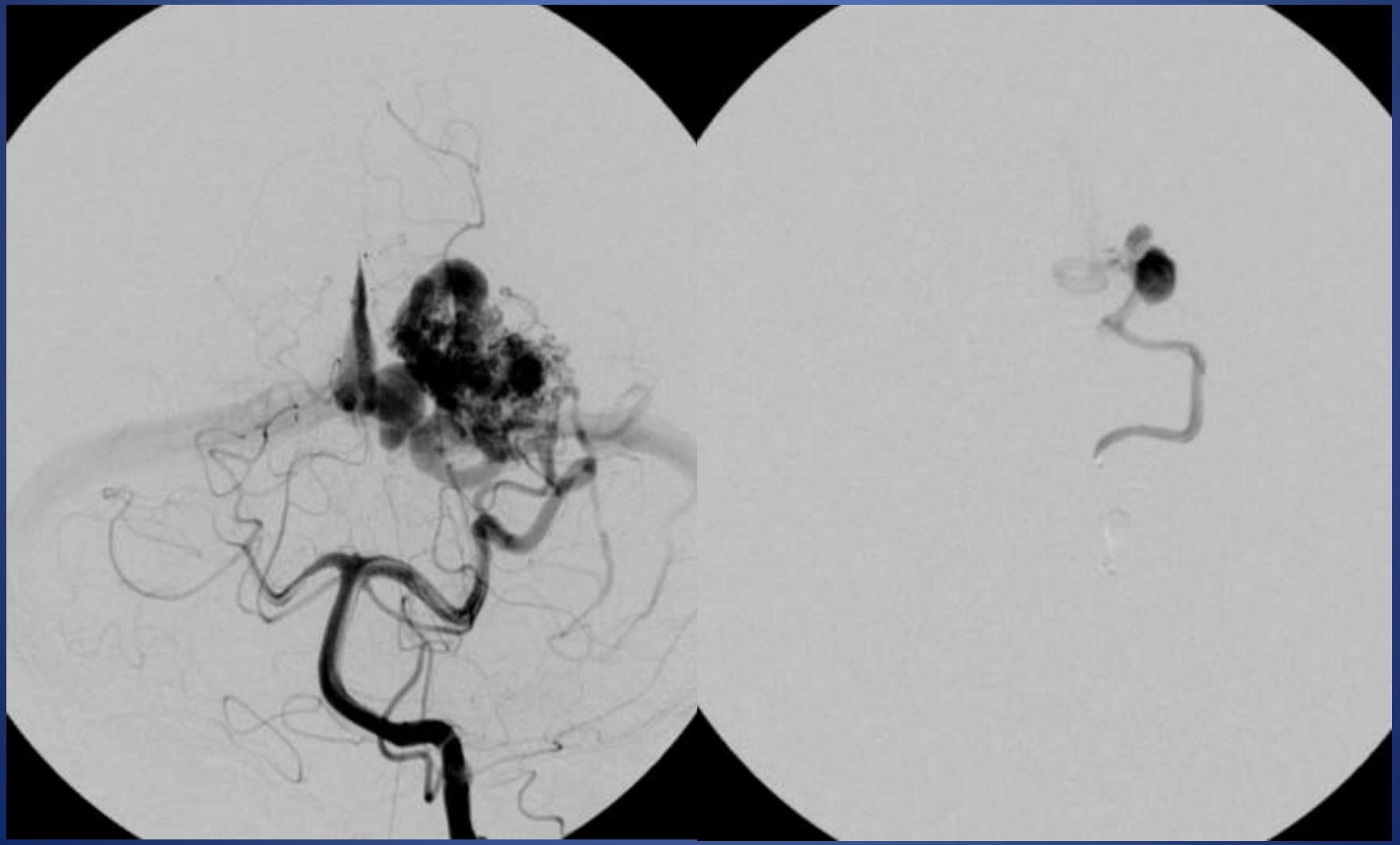
Vascular malformations

Parenchymatous/pial AV malformations



Vascular malformations

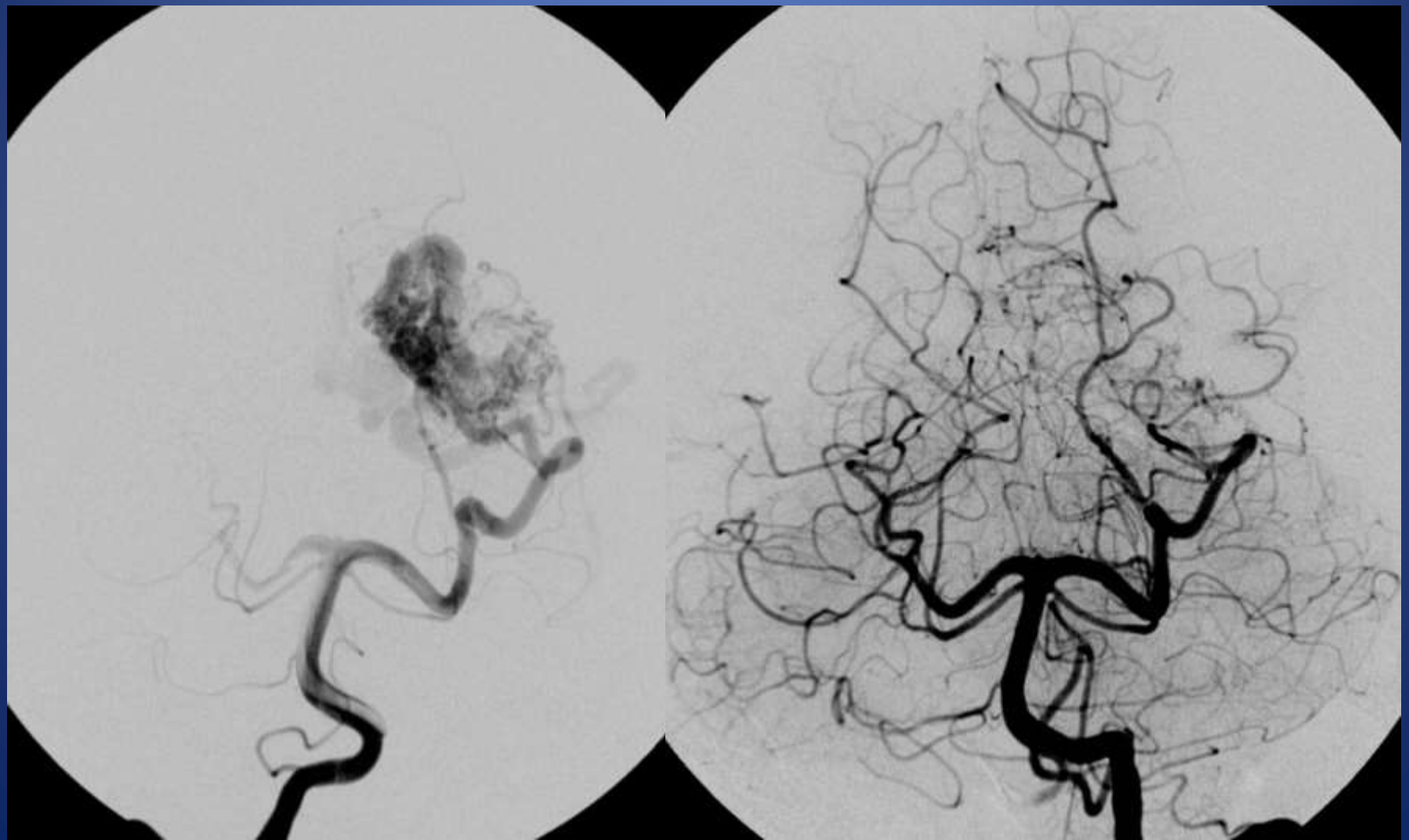
Parenchymatous/pial AV malformations



Vascular malformations

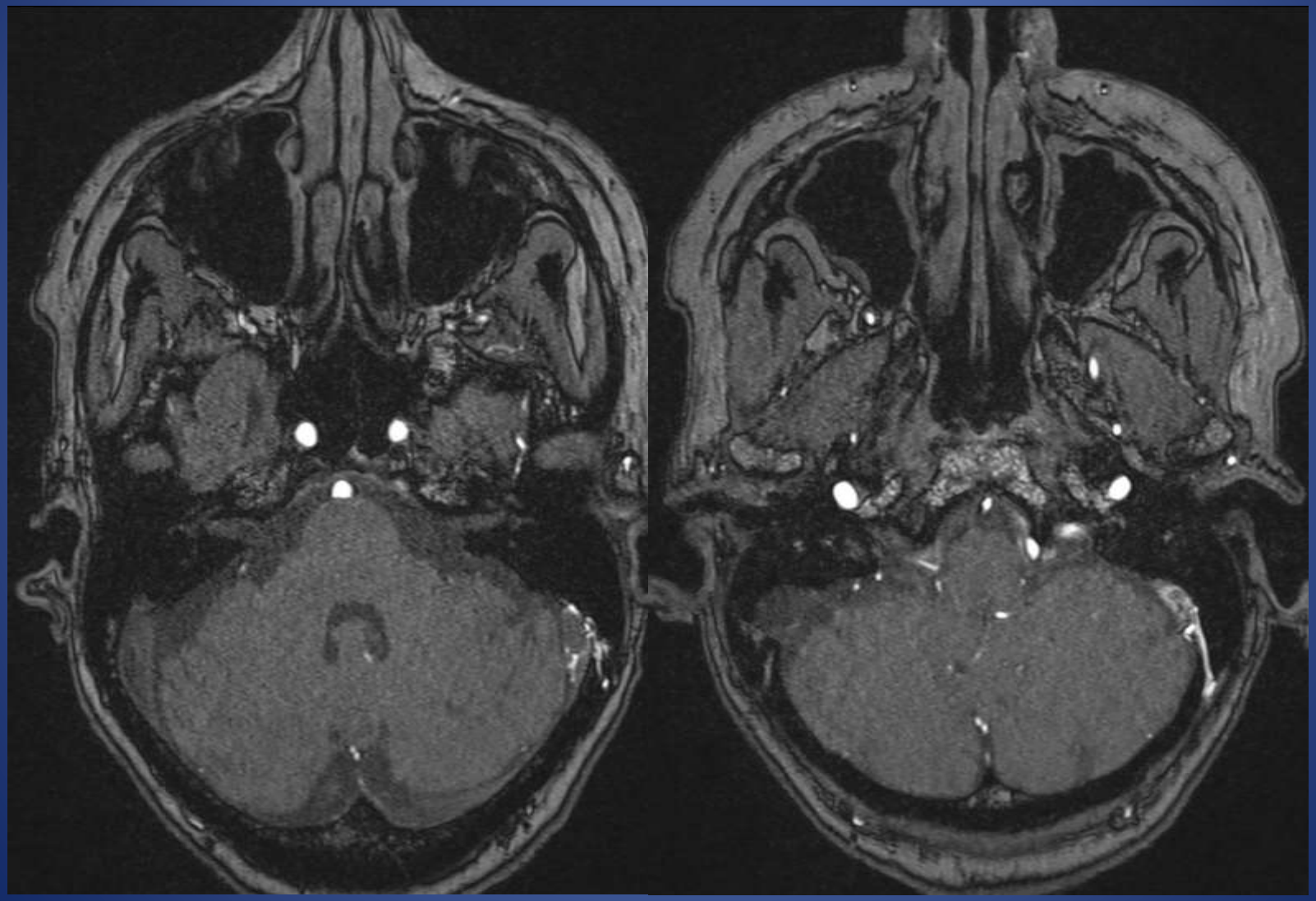
Parenchymatous/pial AV malformations

onyx



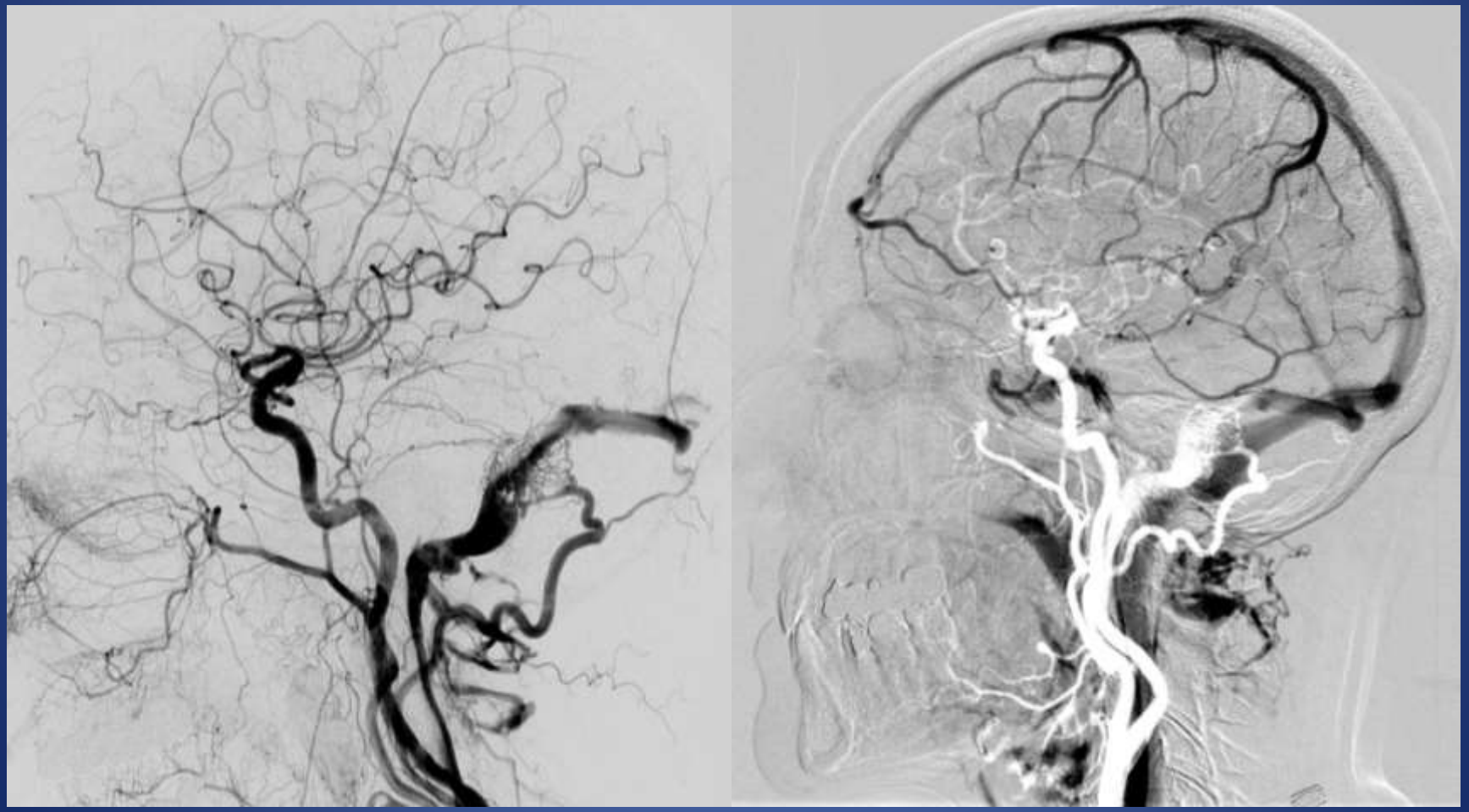
Vascular malformations

Dural AV malformations



Vascular malformations

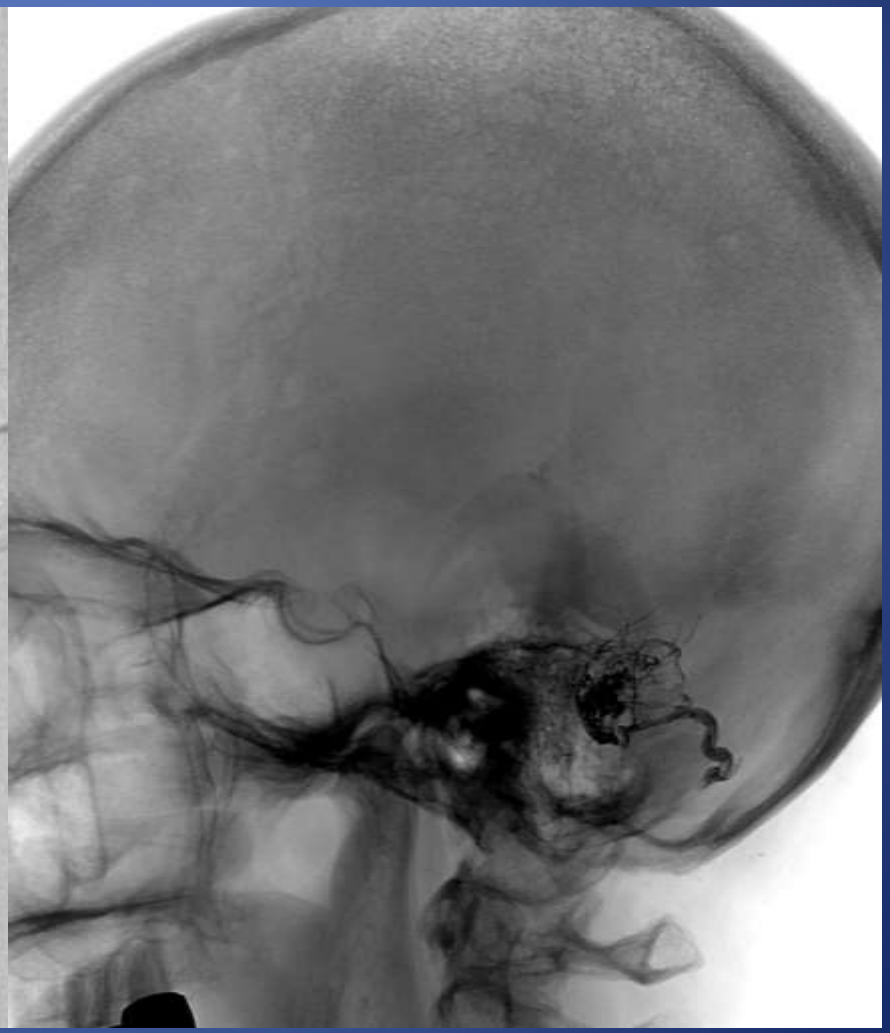
Dural AV malformations



Vascular malformations

Dural AV malformations

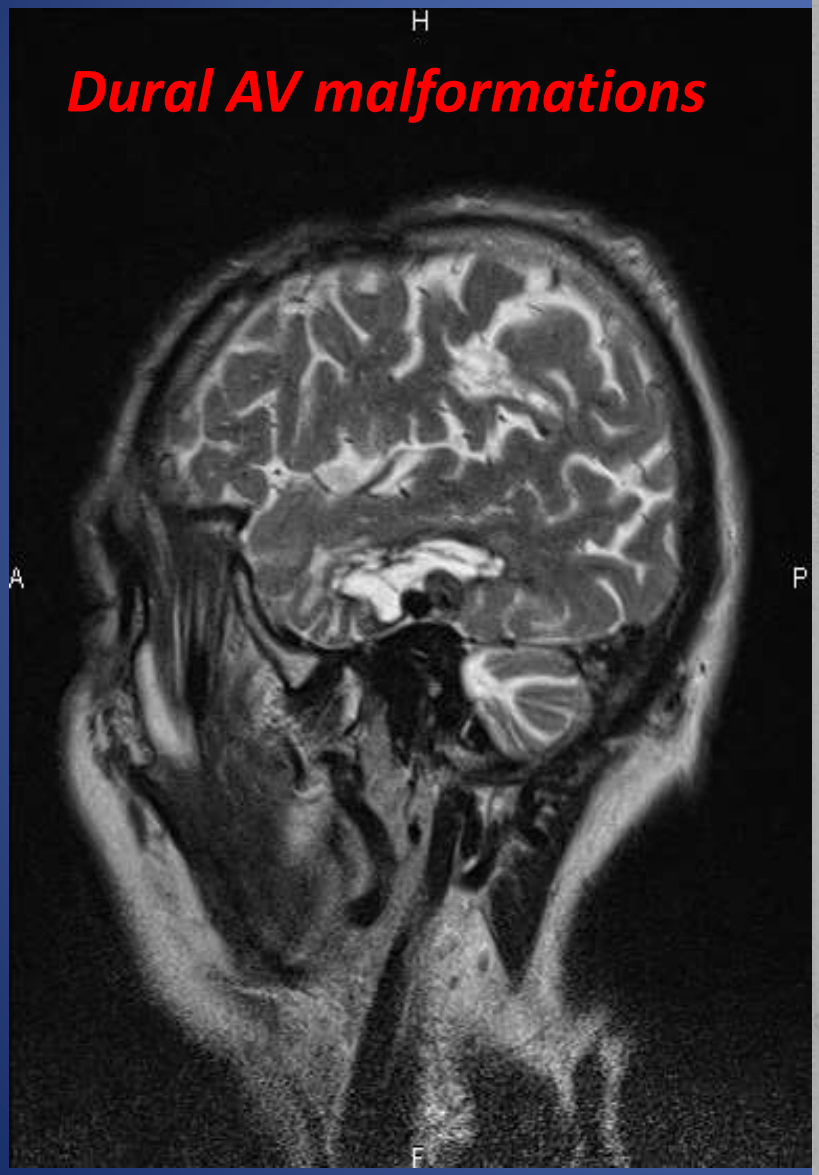
onyx



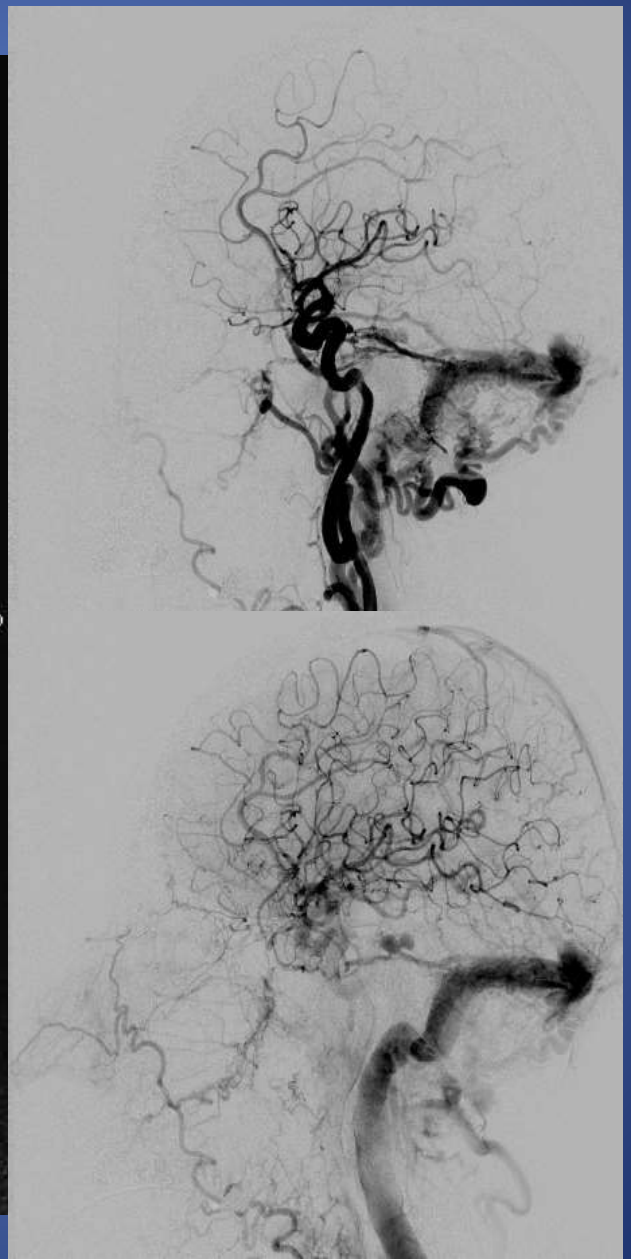
Vascular malformations

Dural AV malformations

Vascular malformations



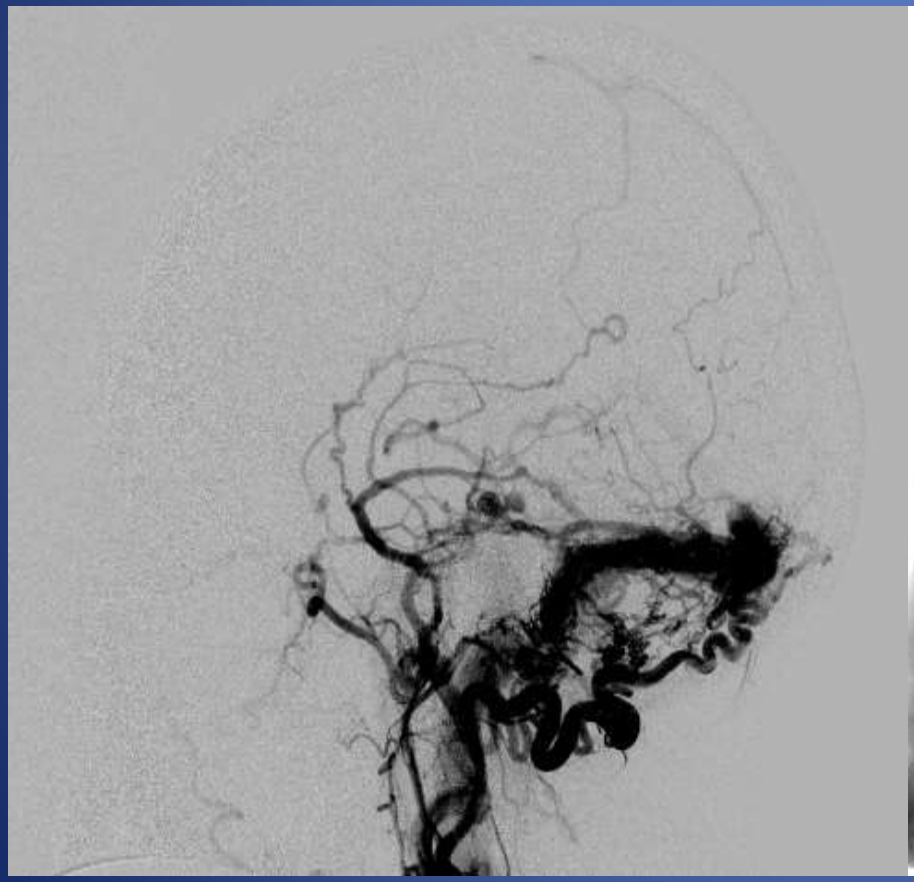
Dural AV malformations



Vascular malformations

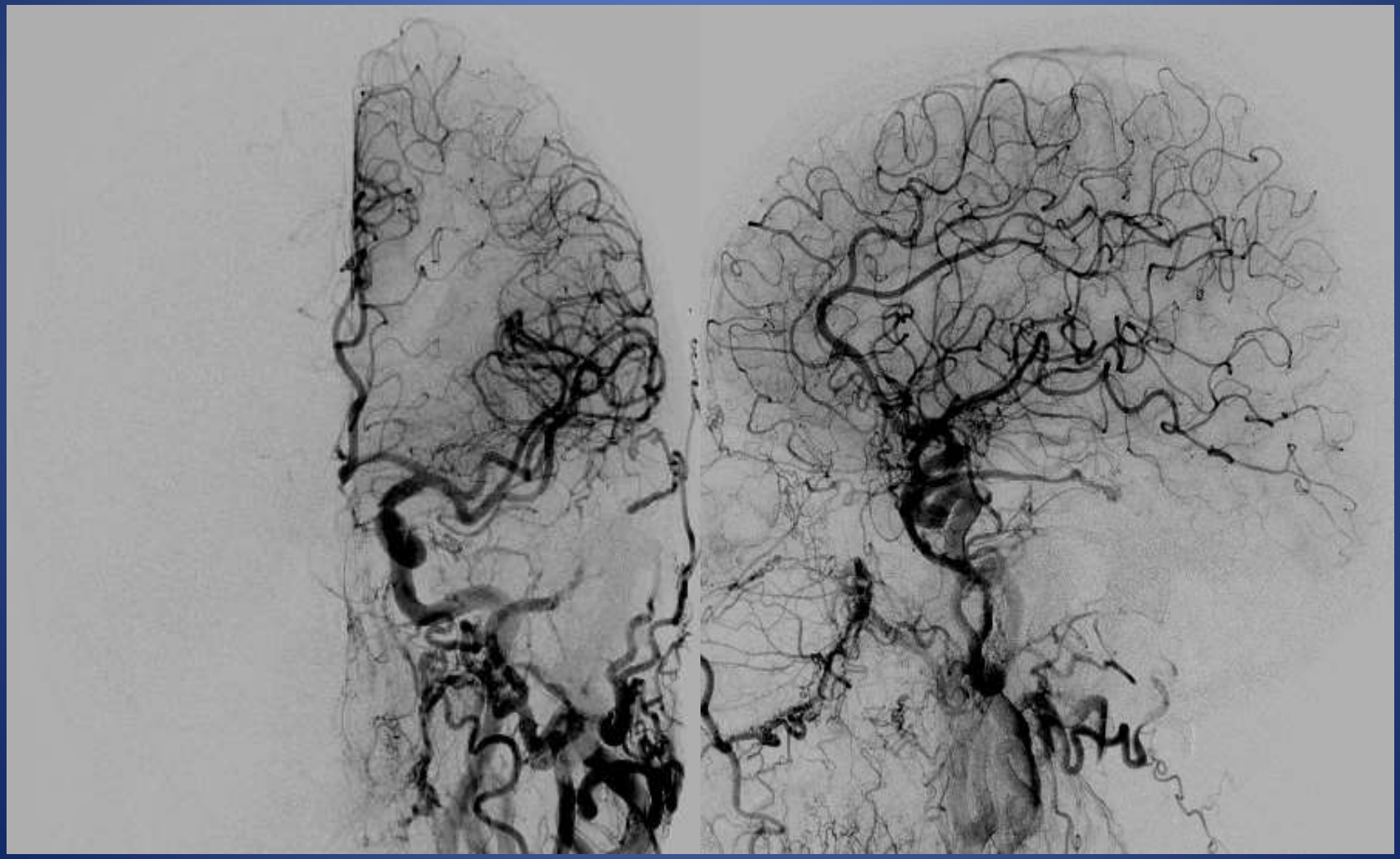
Dural AV malformations

onyx



Vascular malformations

Dural AV malformations

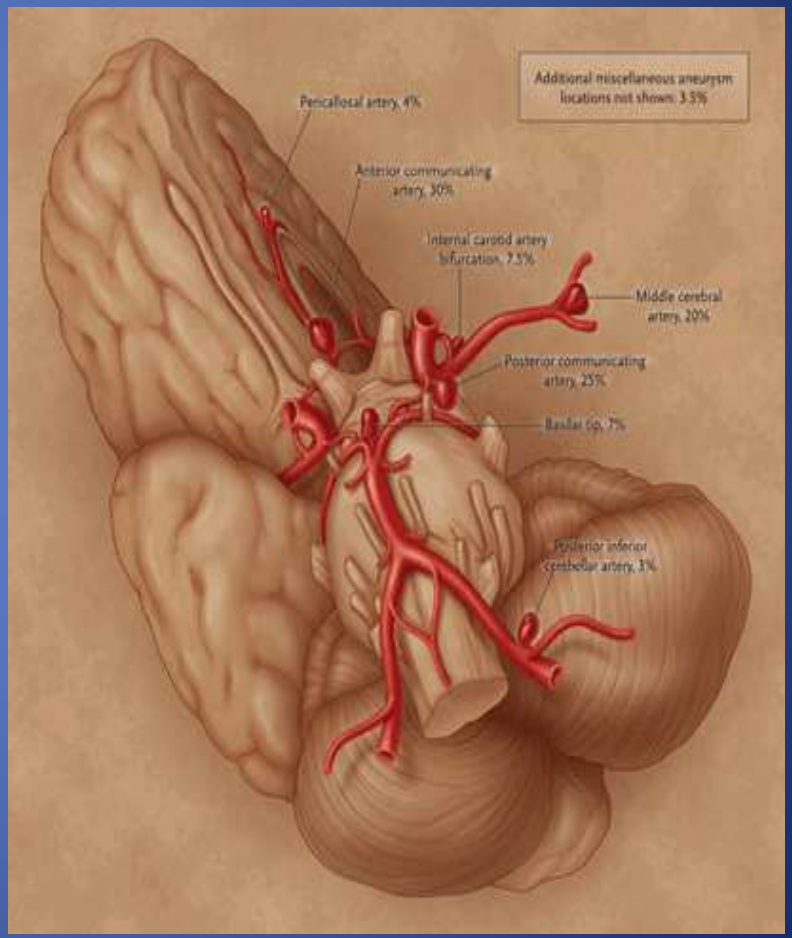


Vascular malformations

aneurysms

focal dilatation of the wall of a cerebral artery

Ant.circ 90%



Post.circ 10%

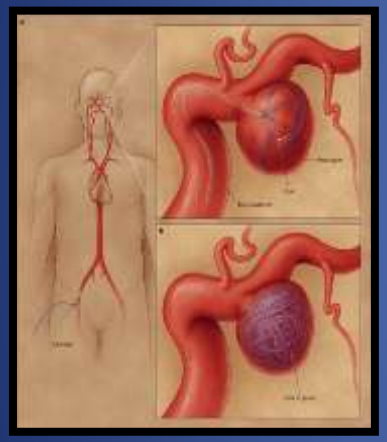
Vascular malformations

aneurysms

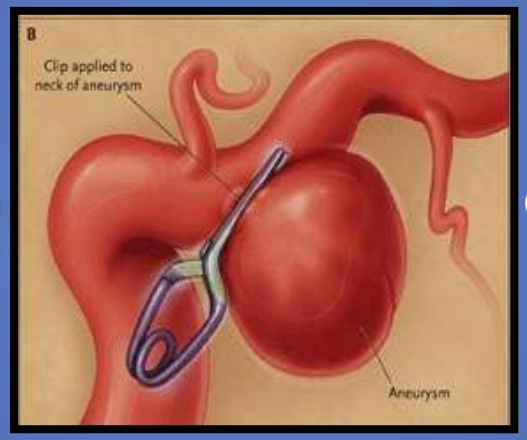
- **Rebleeding : 2 - 4 % in the 24 H**
  15 à 20 % in the15 D

early treatment

Draining off?



New tools?



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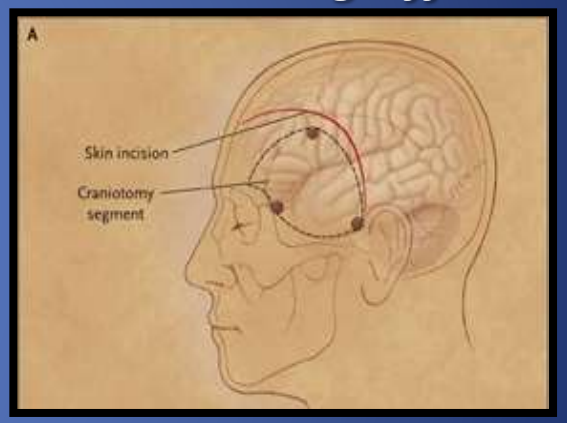


- **Hydrocephaly : 15 à 20 %**
- **Vasospasm: critical period = 3 to 12 d (cause ?)**
- **Systemic complications**

Fever, Anemy, HP, Hypotension, Hyperglycemia, Hyper et Hyponatremia
Cardiac failure, PO, Pneumonia…

Vascular malformations

aneurysms

*International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling**

compare safety-efficacy
of endovascular coiling
with clipping of *such aneurysms* ***judged to be suitable for both R/***

2143 pat:
- *clipping:1070*
- *endovascular:1073*

clinical outcome:at 2months-1year
Modified Rankin scale score 3-6
Trial stopped by steering committee

2002:

ENDOVASCULAR
190/801(23.7%)dependant or dead at 1 y
CLIPPING
243/793(30.6%)dependant or dead at 1 y
The outcome in terms of survival free of disability at 1 year is better with endovascular coiling

2005:

ENDOVASCULAR
250/1063(23.5%)dependant or dead at 1y
CLIPPING
326/1055(30.9%)dependant or dead at 1y

The risk of late rebleeding is low ,but is more common after coiling

Lancet 2002,oct 26;360:1267-74
Lancet 2005,sep 3;366:809-17

Vascular malformations

aneurysms

coiling

New tools?

no manipulation of meninges and brain

no scar

faster recovery and shorter hospitalisation time

Vascular malformations

aneurysms

The anatomic limitations of coiling are becoming exceeded by the new tools…

- *Anatomic pattern:*

  Large or Wide neck aneurysms

  Bifurcation aneurysms

  Giant aneurysms

  Fusiform aneurysms

- *Pathophysiologic pattern:*

  Dissecting aneurysm

  Blister like aneurysm

- *Recurrence:*

Vascular malformations

aneurysms

The new tools:

- >Balloon-assisted coiling
- >Stent-assisted coiling

>Single, double (Y-, X-, T-stent)

- **>the Flowdiverters**
- **>the Flowdisruptors**

Vascular malformations

aneurysms

Balloon-assisted coiling

- *Protection of rupture during treatment of (un)ruptured aneurysms*

- *Anatomic pattern:*

  Stabilisation of microcatheter in the aneurysmal sac (difficult anatomy)

  Patency of parent artery in large neck , bifurcation aneurysms and giant aneurysms.

  Protection of side branch coming from the neck

Vascular malformations

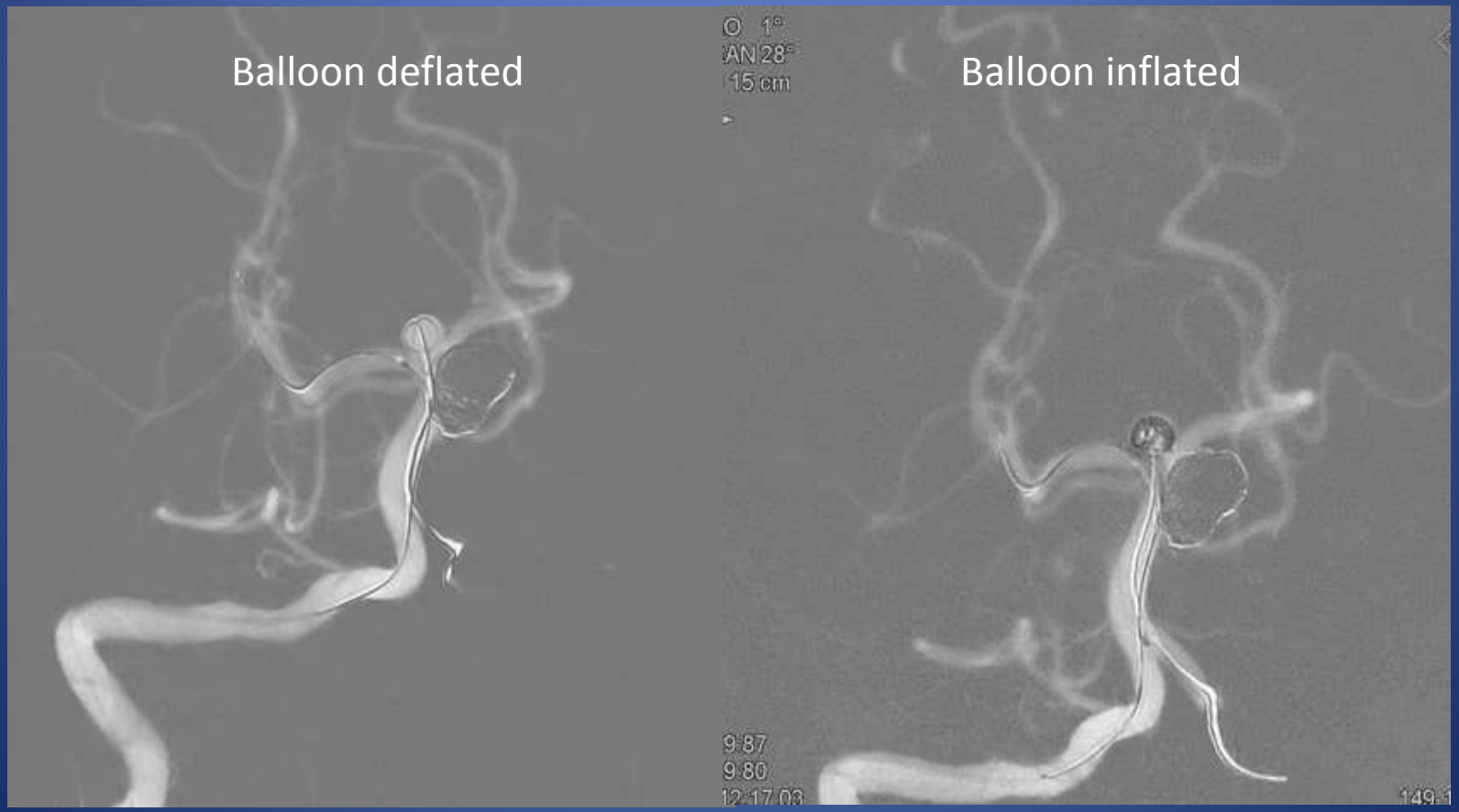
aneurysms

Balloon-assisted coiling

Vascular malformations

aneurysms

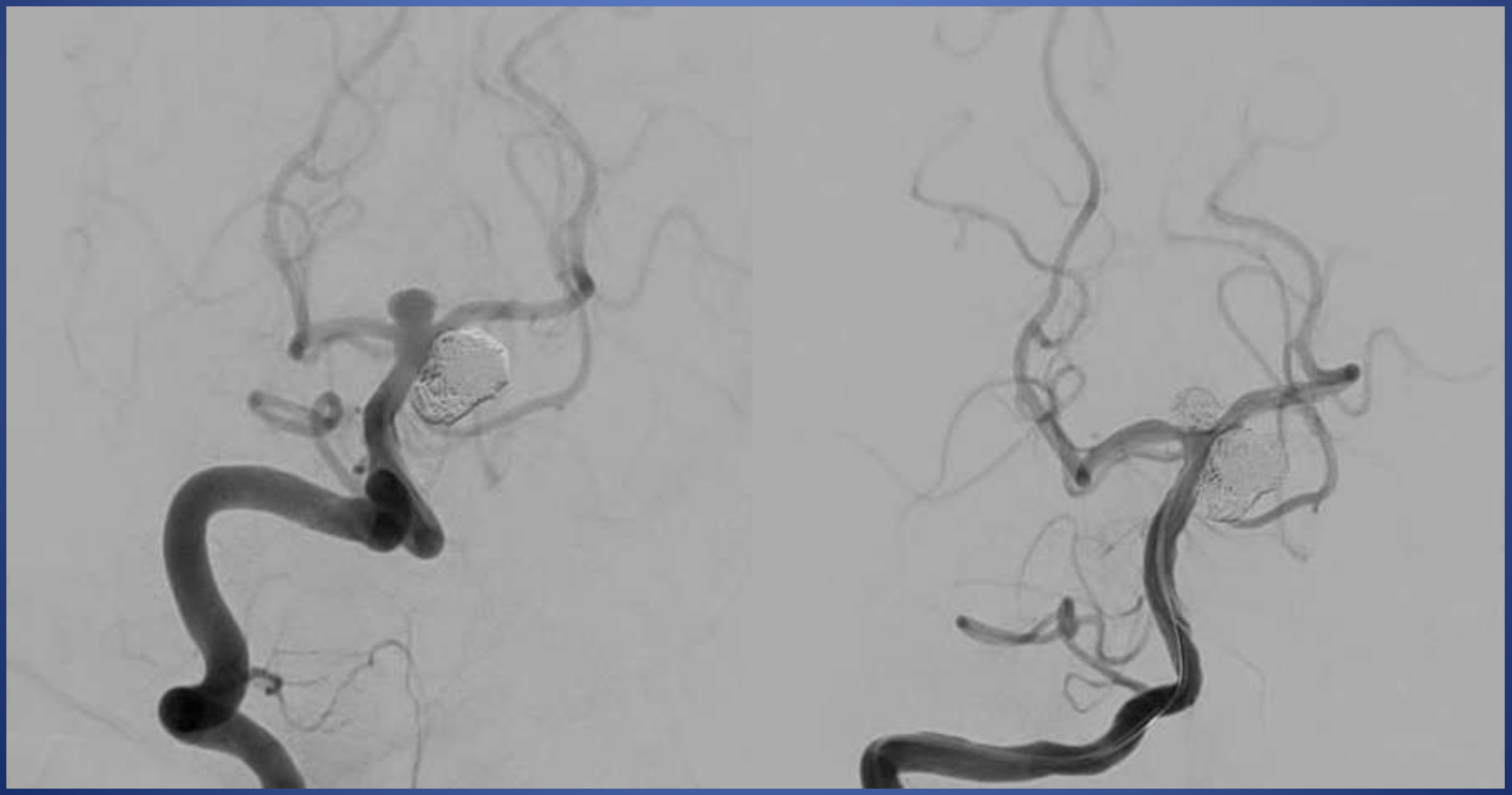
Balloon-assisted coiling



Vascular malformations

aneurysms

Balloon-assisted coiling



Vascular malformations

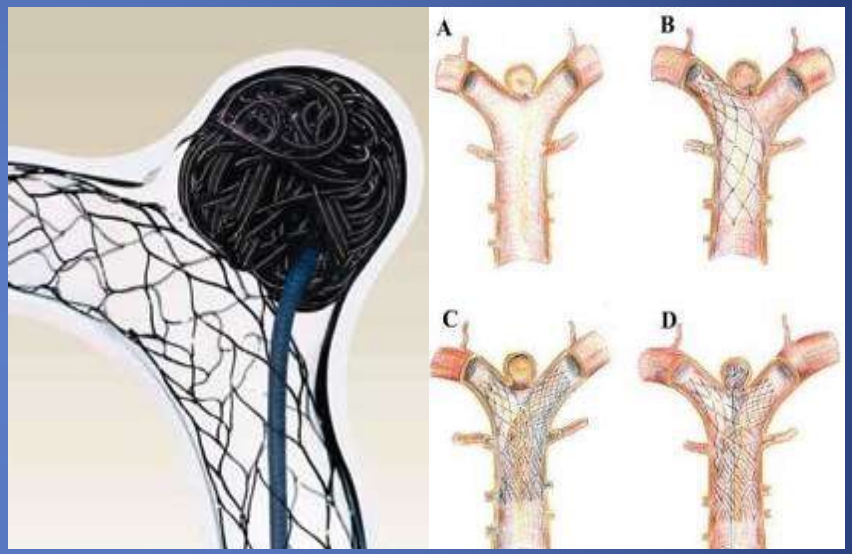
aneurysms

Stent-assisted coiling

Anatomic pattern

broad neck

bifurcation

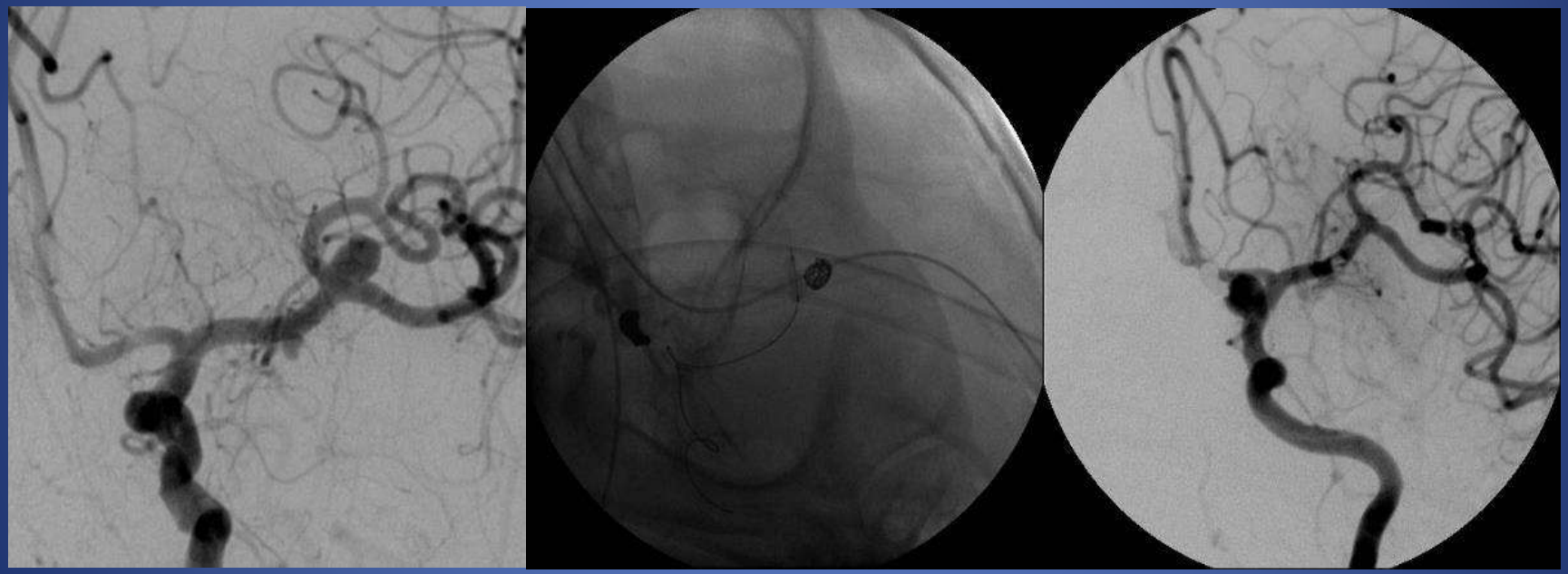


Need for antiplatelet therapy!

Vascular malformations

aneurysms

Balloon-assisted coiling



Vascular malformations

aneurysms

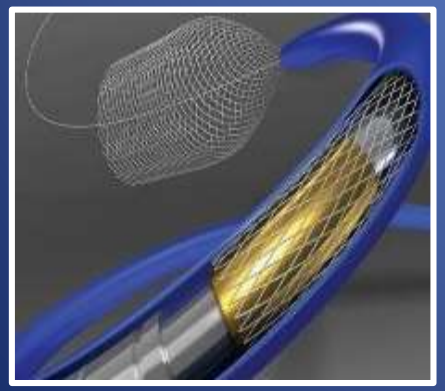
Stent-assisted coiling

Vascular malformations

aneurysms

The flow diverters(FD)

- Endoluminal flexible braided mesh-like implant in the arterial segment bearing the aneurysm
- Changing the hemodynamic forces and vectors in order to induce intra-aneurysmal stasis and progressive aneurysm thrombosis with subsequent clot organisation, retraction and possible shrinkage of the aneurysm



Vascular malformations

aneurysms

The flow diverters(FD)

- *Anatomic pattern:*

  Side wall aneurysms:

  Large and wide neck aneurysms
  (recurrent) Giant aneurysms
  Fusiform aneurysms

- *Pathophysiologic pattern:*

  Blister like aneurysms
  Dissecting aneurysms

- *"Difficult-to-treat "peripheral aneurysms:*

  Need for *dual antiplatelet therapy*

  Pipeline™, p64™, Silk™, Surpass™, Derivo™, ...

Vascular malformations

aneurysms

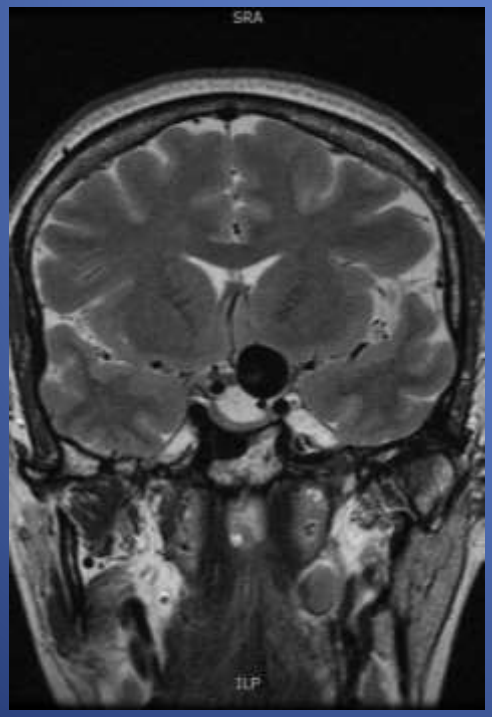
The flow diverters(FD)

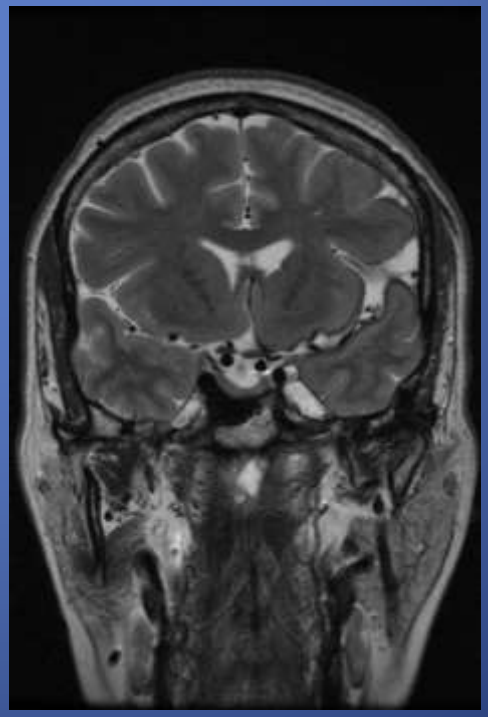
the device works as a scaffold for endothelialisation:

> *delayed* occlusion

> *complete* and ***permanent*** occlusion(***80-85%***)

unrelative to *shape* and *size* of ***side*** aneurysm





6 months

Vascular malformations

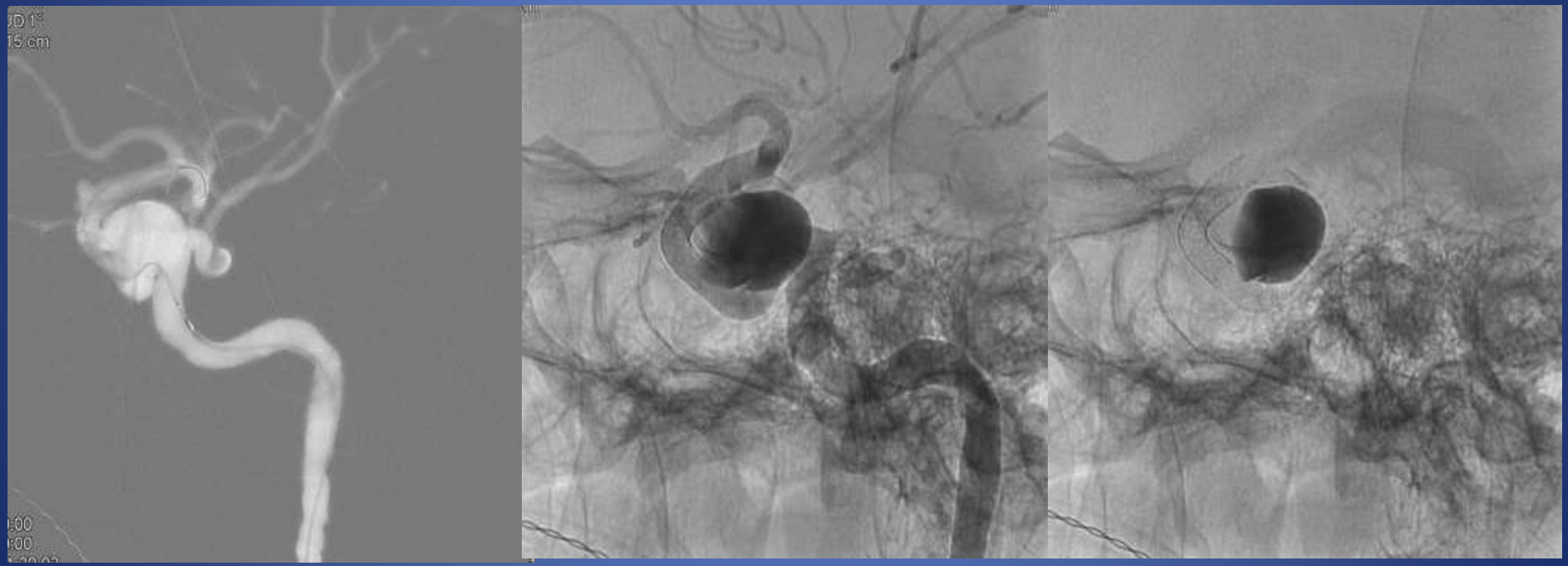
The flow diverters(FD)

aneurysms

Vascular malformations

aneurysms

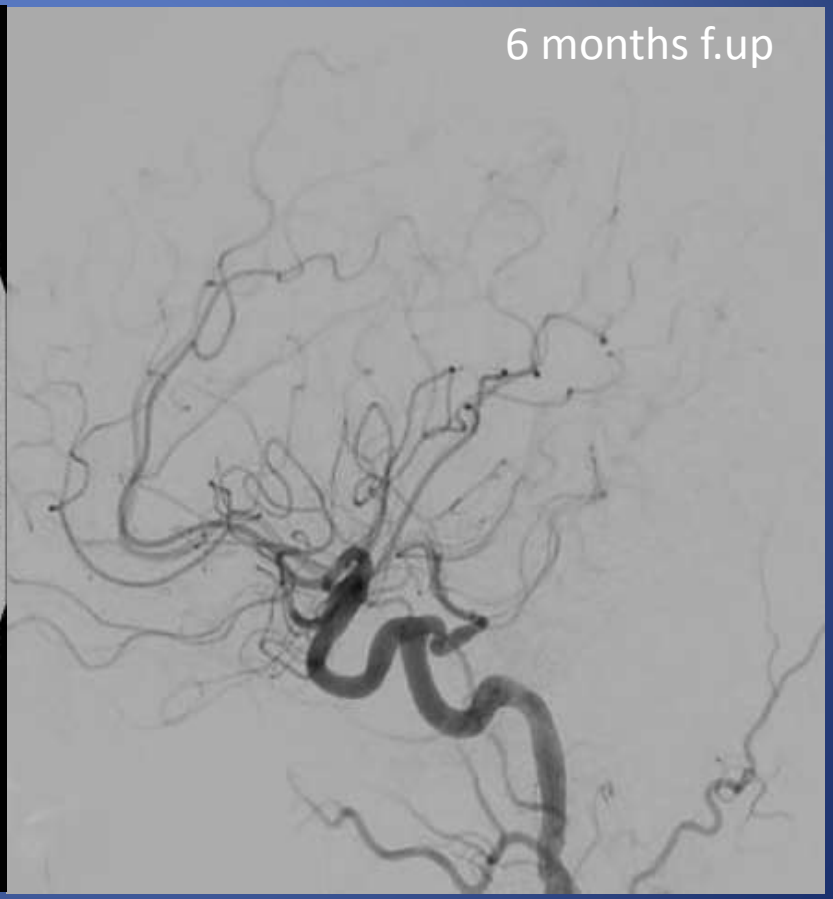
The flow diverters(FD)



Vascular malformations

aneurysms

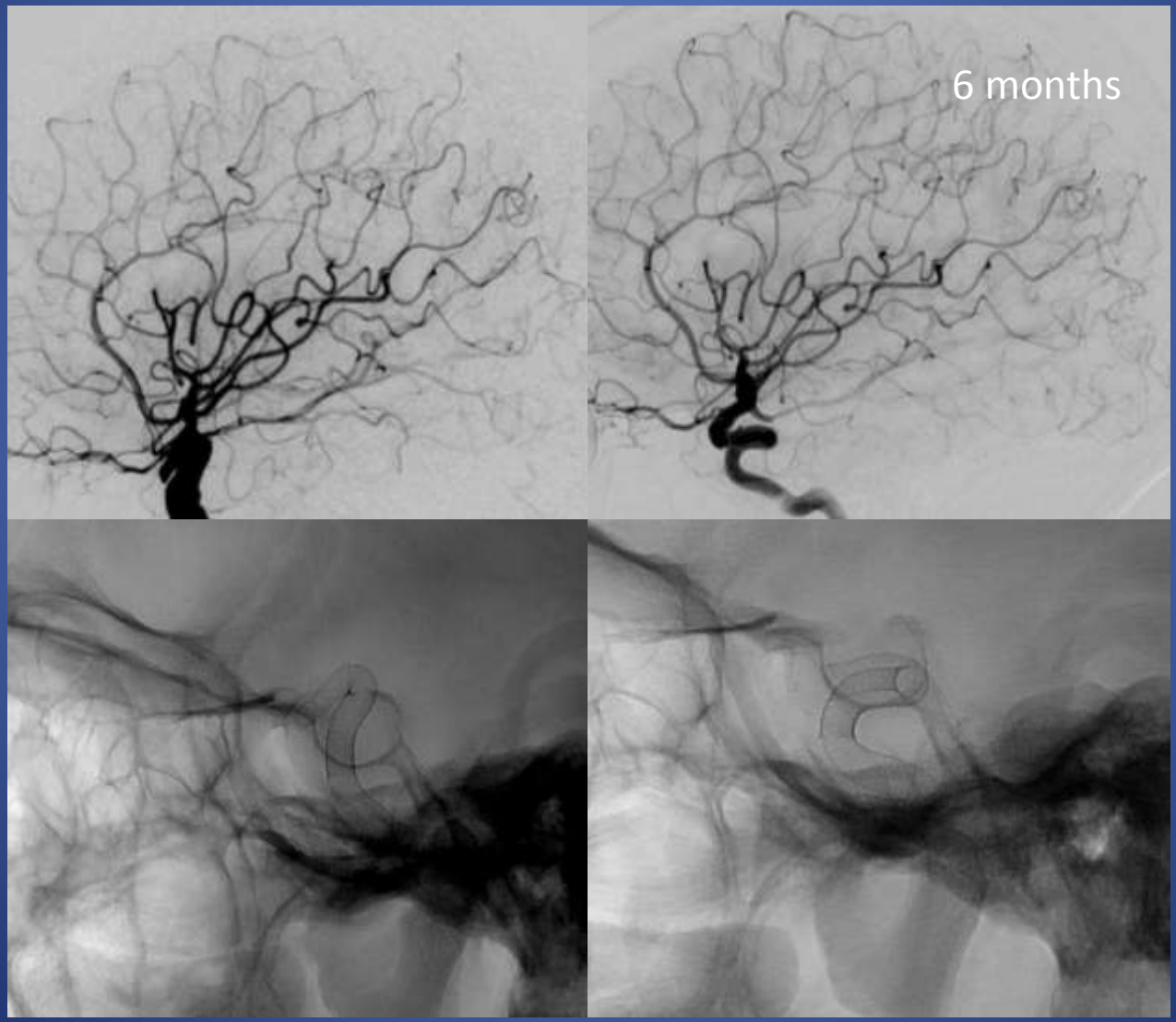
The flow diverters(FD)



Vascular malformations

aneurysms

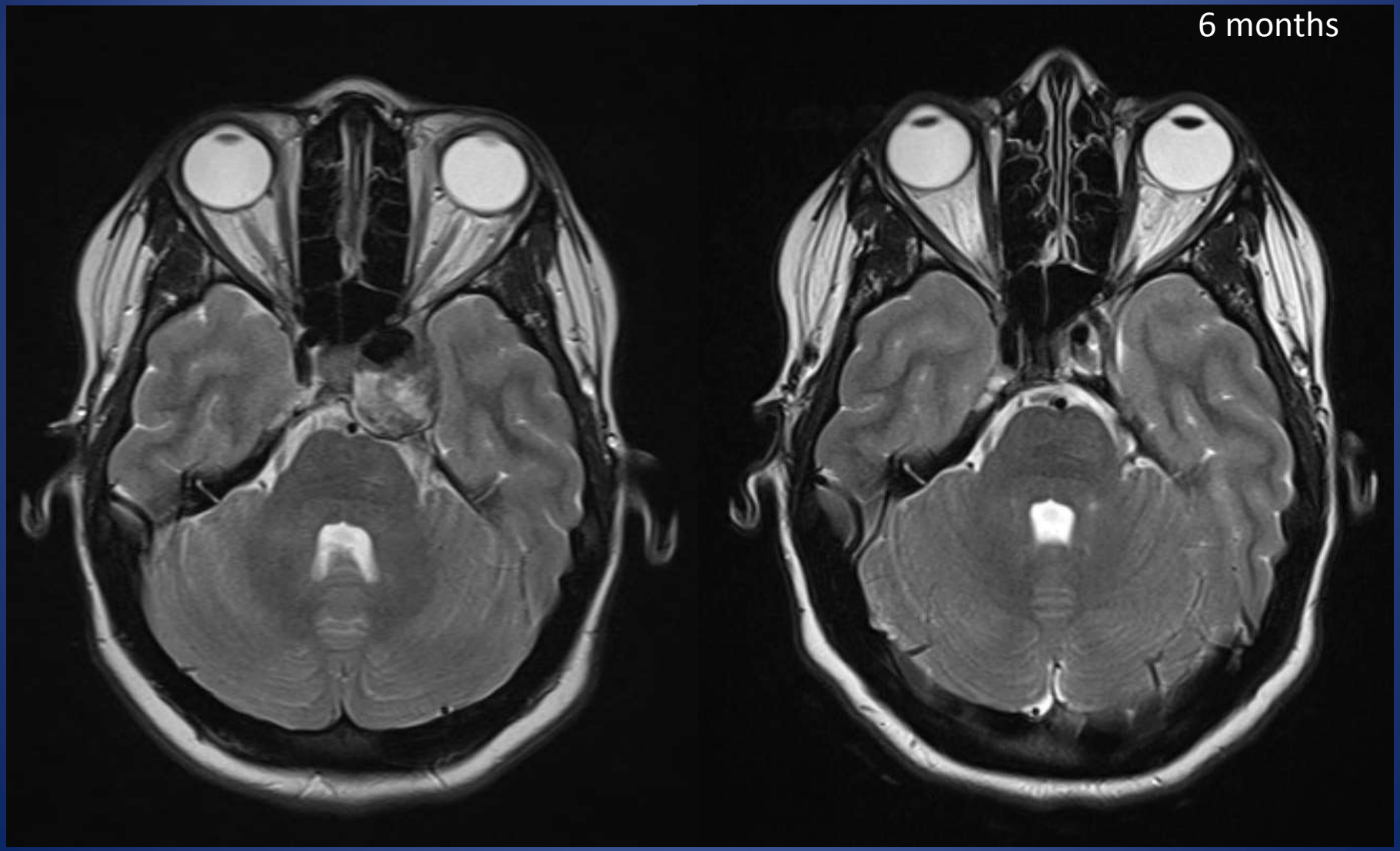
The flow diverters(FD)



Vascular malformations

aneurysms

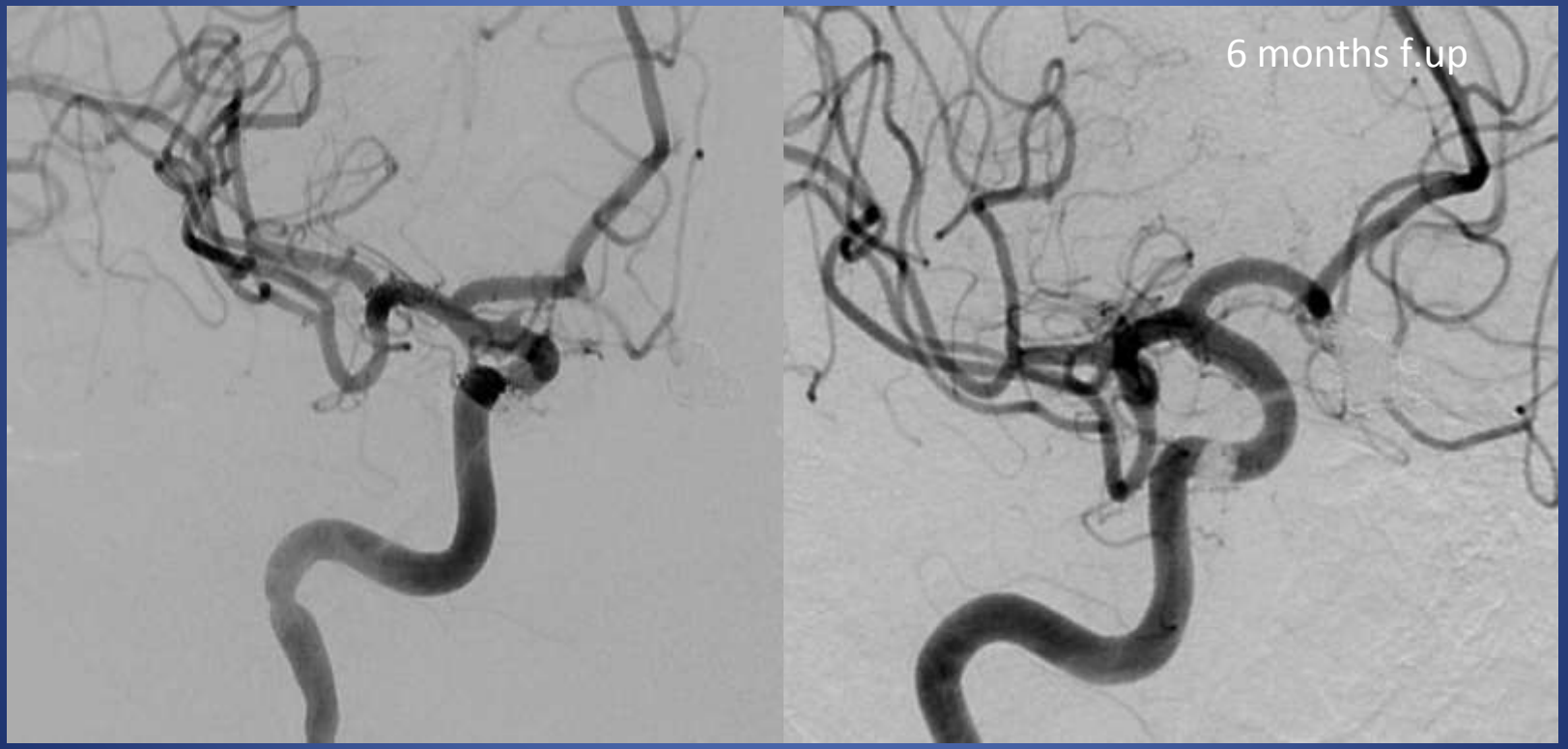
The flow diverters(FD)



Vascular malformations

aneurysms

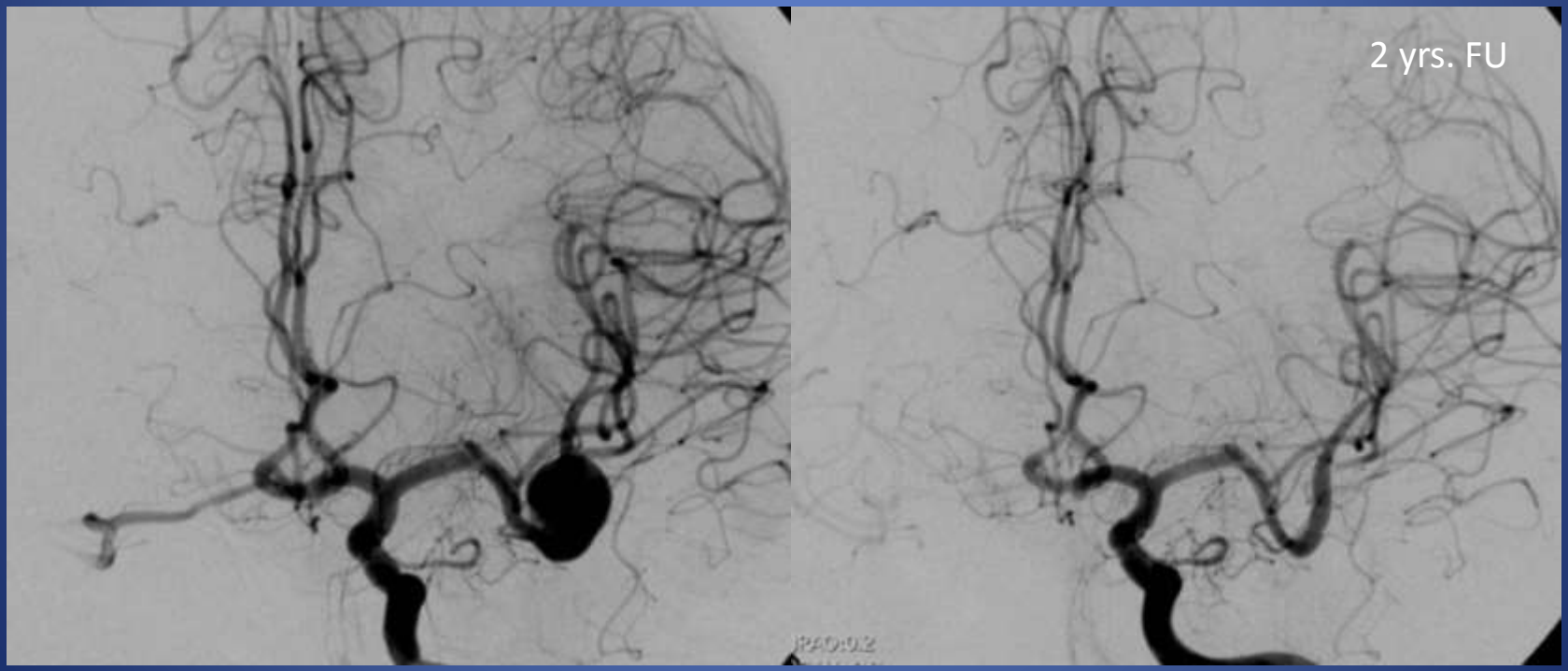
The flow diverters(FD)



Vascular malformations

aneurysms

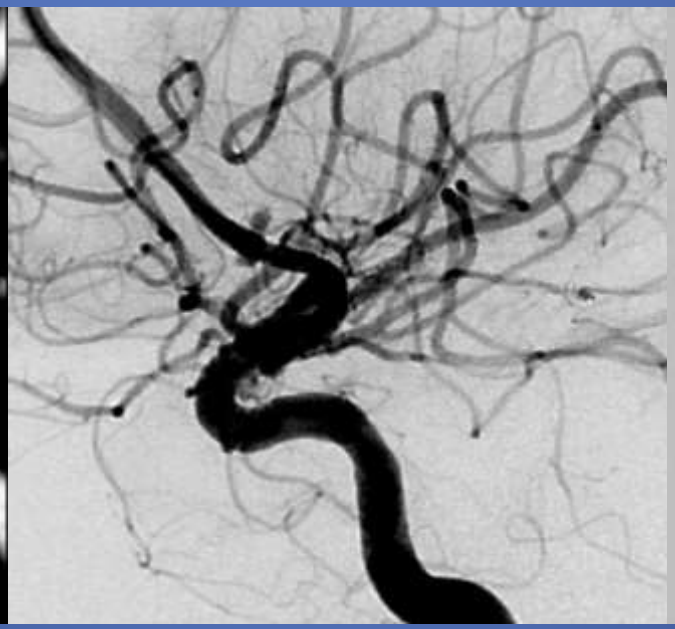
<u>The flow diverters(FD)</u>

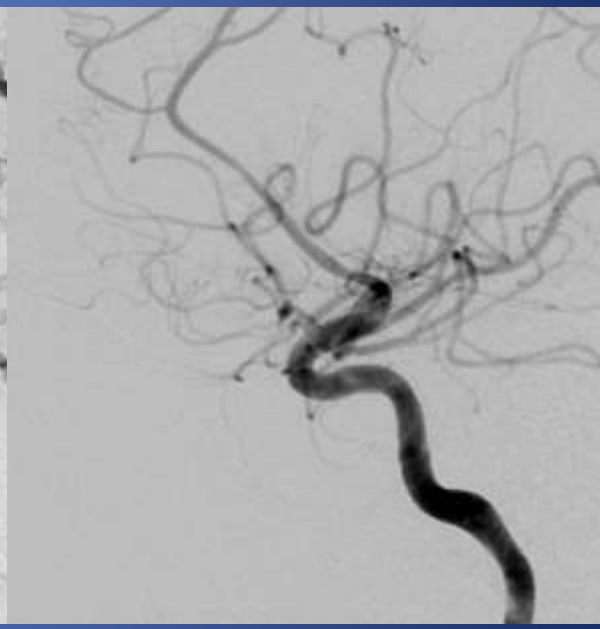


Vascular malformations

aneurysms

The flow diverters(FD)





Vascular malformations

aneurysms

The flow diverters(FD)

FD RESULTS

cure	complete	subtotal	incomplete	ongoing fup
Giant(15)	11(85%)	1(8%)	1(8%)	*1+1death*
Post C(21)	16(84%)	2(10.5%)	1(5%)	*2*
ICA(47)	39(97%)	1(2.5%)	0	*4+3death*
Dissecting(5)	3(100%)	0	0	*2*
Peripheral(18)	12(67%)	1(6%)	5(29%)	0

Vascular malformations

aneurysms

The flow diverters(FD)

Morbidity/Mortality

	Morbidity	Mortality
>at 30 days	1%	3%
>long term	1%	4%

Vascular malformations

aneurysms

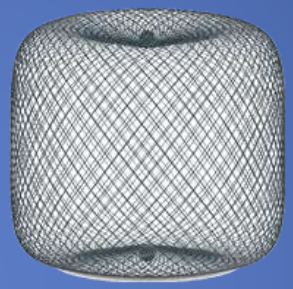
The flow disruptors(FD')

MicroBraid™ Dense mesh of **144-216** Nitinol wires

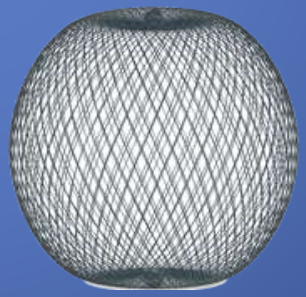
Single fully retrievable, repositionable and detachable implant

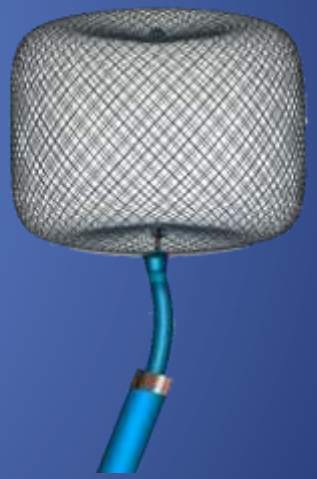
Suitable for a broad range of aneurysms **(3 – 11 mm)**

Disrupts flow, provide rapid intra-procedural stasis in wide neck bifurcation,protects aneurysm dome,and provides scaffold for endothelialisation



WEB SL "single layer"





WEB SLS "single layer sphere"

Vascular malformations

aneurysms

The flow disruptors(FD')

Anatomic pattern:

(Wide neck) **bifurcation** aneurysms:

complex anatomy

-MCA

-BASILAR tip

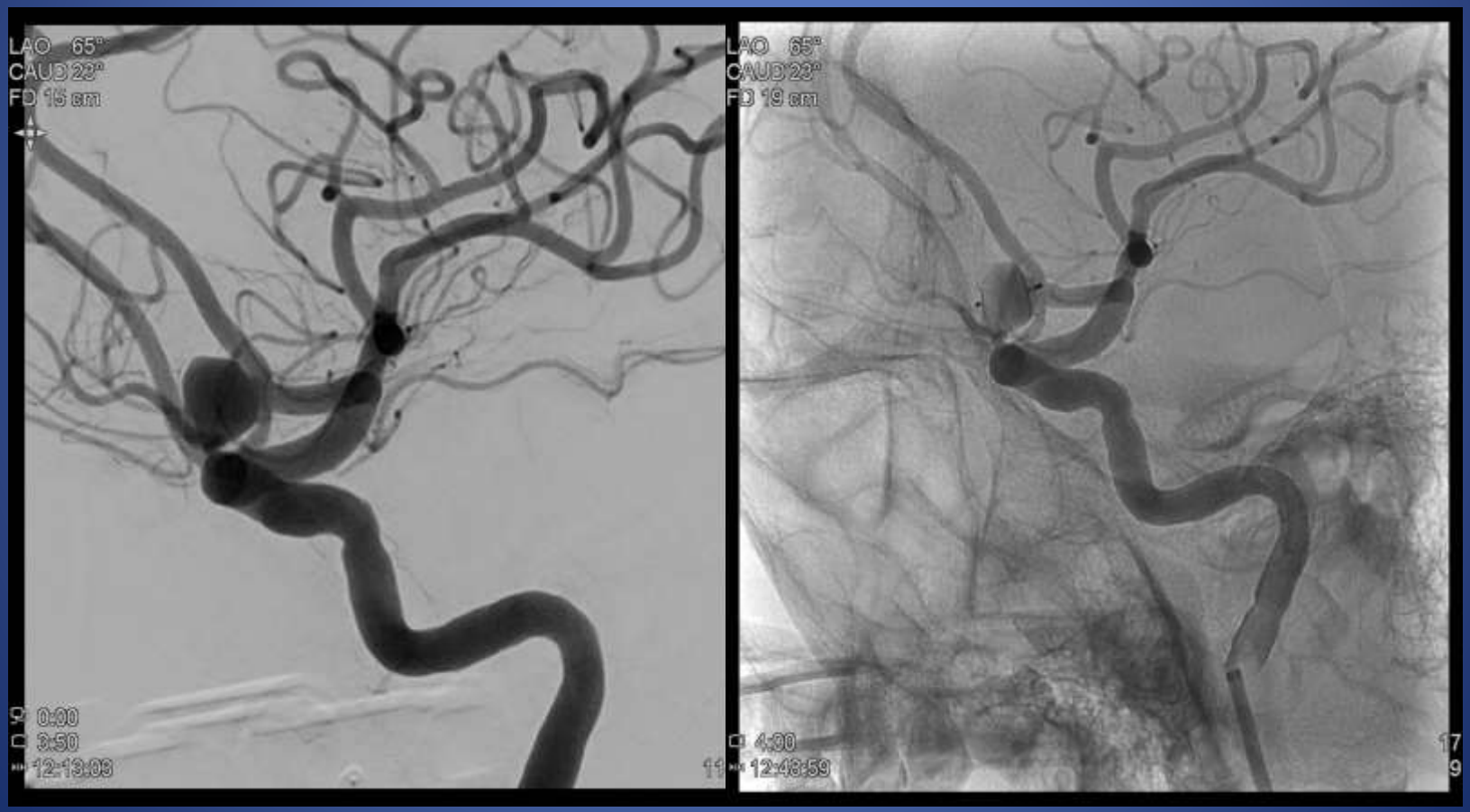
-ACOM

No need for dual anti-platelet therapy
(ruptured and non ruptured aneurysms)

Vascular malformations

aneurysms

The flow disruptors(FD')



Vascular malformations

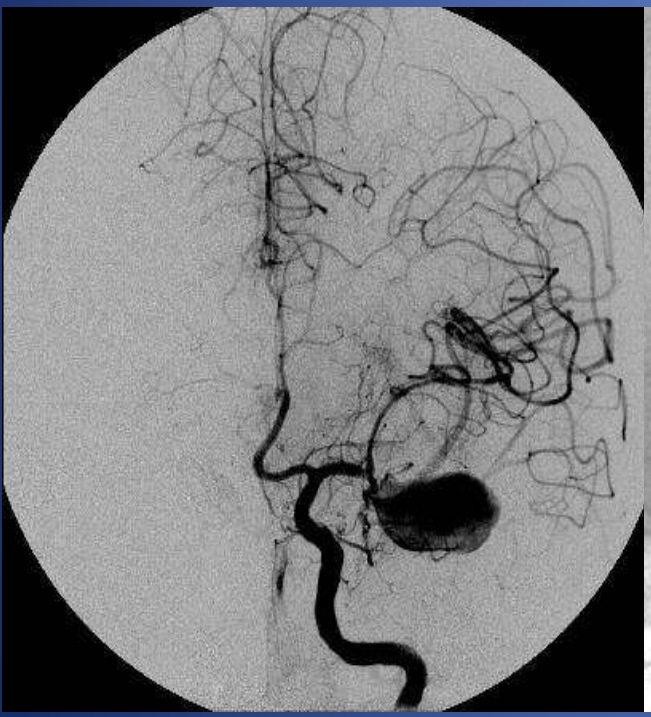
aneurysms

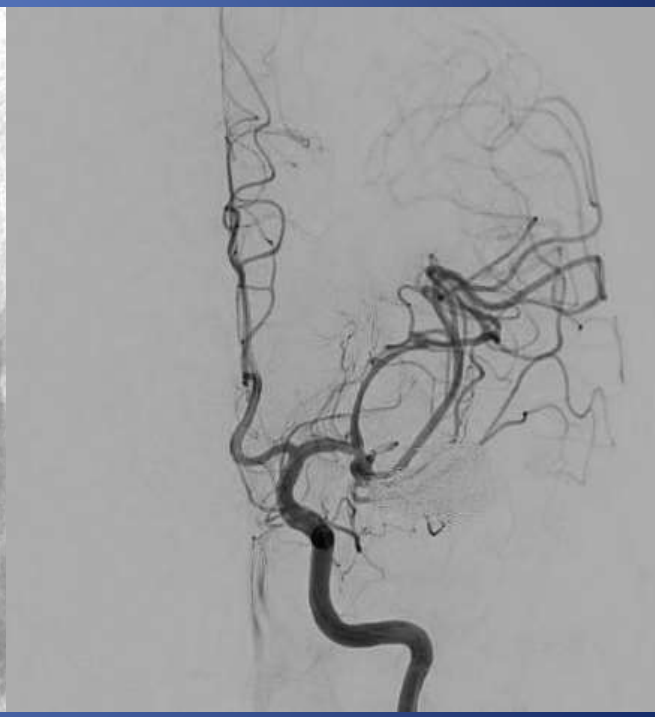
The flow disruptors(FD')

Vascular malformations

aneurysms

The flow disruptors(FD')





Vascular malformations

aneurysms

The flow disruptors(FD')

The flow disruptors: WEBCAST and FROB

Prospective 12 month GCP data for WEB in challenging wide neck bifurcation aneurysms demonstrates:

High Technical success: 96.5%

Impressive Safety

- 2.7% Morbidity at 30 Days; 0% Morbidity at 12 Months
- 0% Procedure-Related Mortality

Significant and Stable Aneurysm Occlusion at 12 Months

- 82% Adequate Occlusion
- 98% Occlusion Stability (Post-Procedure to 12 Months)
- 3.6% Retreatment Rate

Pierot L *et al*. Clinical and Anatomical Follow-up in Patients With Aneurysms Treated With WEB Device: One-year Follow-up Report in the Cumulated Population of 2 Prospective, Multicenter Series (WEBCAST, French Observatory). Neurosurgery Jan 2016, 78:133-141.

INR in ischemic stroke

EPIDEMIOLOGY IN BELGIUM

- 19.000 stroke/year
- 52 patients/day
- 9000 patients will die in the year following the stroke
- 6000 patient remain invalide
- 3^{e} cause of death after heart infarct and cancer
- First cause of invalidity among survivals

INR in ischemic stroke

PROVEN POSITIVE OUTCOME TRIALS IN ACUTE STROKE MANAGEMENT

1. Aspirine

Aspirin 160mg/d started in 48h of onset leads to improved outcome at 4 weeks (less recurrent stroke and improved mortality)

CAST: Chinese Acute Stroke Trial, 1997 Lancet. 20,000 randomized

Number needed to treat to prevent one stroke

Product	NNT
Aspirine	42
Clopidogrel (CAPRIE)	125
Ticlopidine (TASS)	40
Asa + ER-Dipyridamole (ESPS-2)	33

INR in ischemic stroke

PROVEN POSITIVE OUTCOME TRIALS IN ACUTE STROKE MANAGEMENT

2. Stroke units (1986-1997)

Stroke Unit Trialists'Collaboration: Randomized trials of organized in-patient care after stroke. BMJ 1997

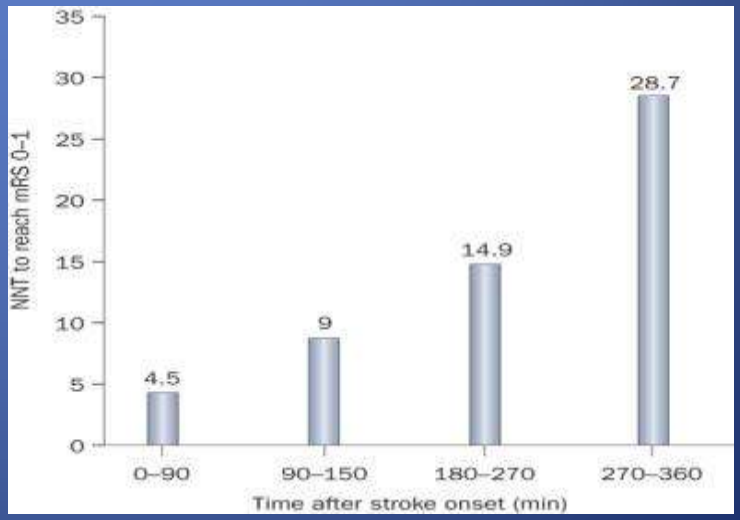
3. IV thrombolyse met rt-PA

(=recombinant tissue plasminogen activator)

IV rt-PA (max.90mg) within the 3 hours (Class I; Level of Evidence A) or 4.5 hours (Class I; Level of Evidence B)

1995: NINDS IV rt-PA 0-3h

2008: ECASS III rt-PA 0-4.5h



INR in ischemic stroke

2015: historical landmark in acute stroke treatment

*To assess the effect of **intra-arterial treatment** on functional outcome after ischemic stroke caused by a proven intracranial arterial occlusion against a background of best medical management with or without IV t-Pa*

N Engl J Med 2015; 372:11-20 A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

INR in ischemic stroke

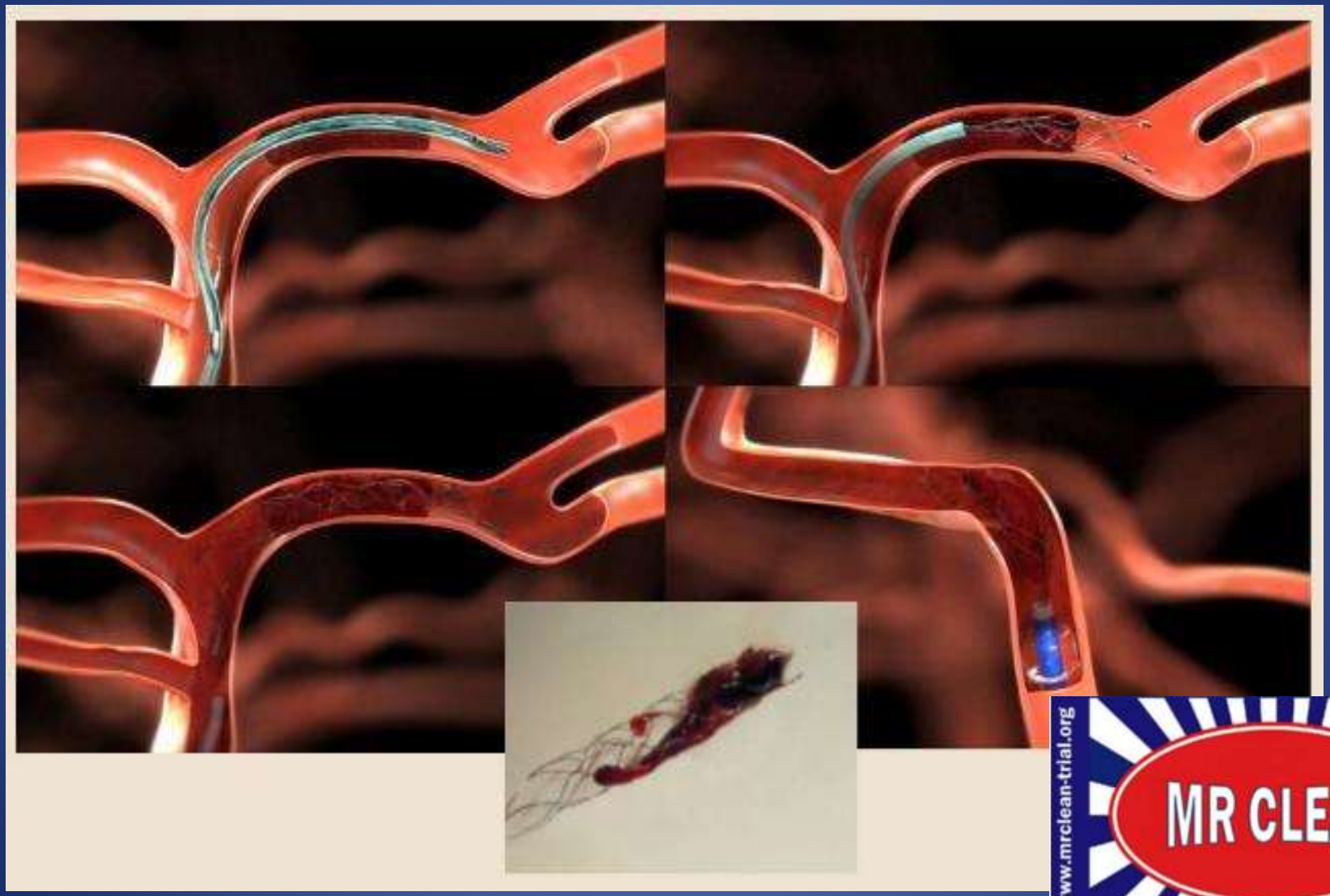
500 pts.

Standard care

Standard care
+
IA treatment

N Engl J Med 2015; 372:11-20 A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

INR in ischemic stroke



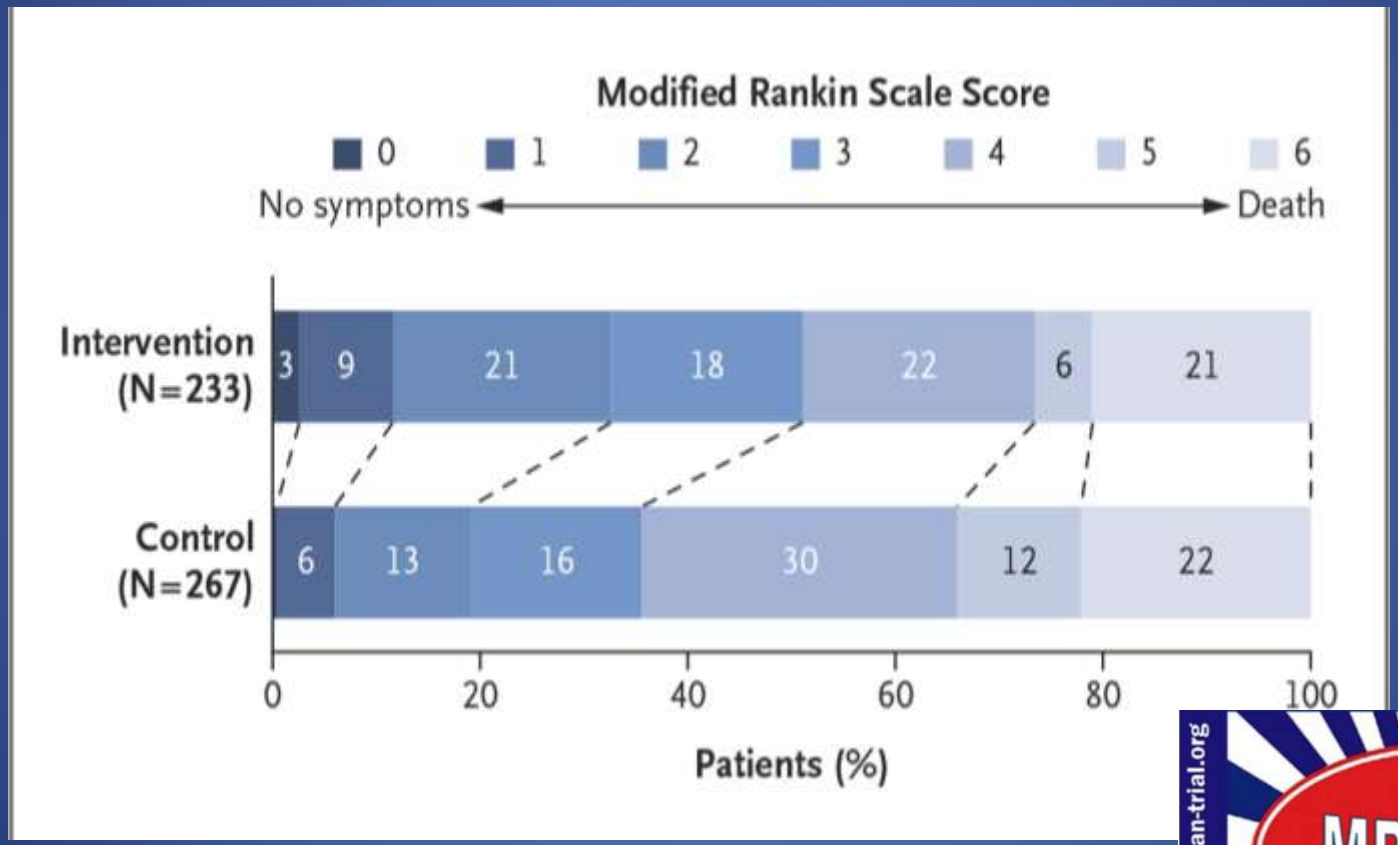
INR in ischemic stroke

- Acute ischemic stroke
- NIHSS ≥ 2
- Intracranial anterior circulation occlusion confirmed by CTA
  - Distal ICA
  - M1 M2
  - A1,A2
- IV treatment within 4.5 hours
- IA treatment within 6 hours

N Engl J Med 2015; 372:11-20 A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

INR in ischemic stroke

Primary outcome

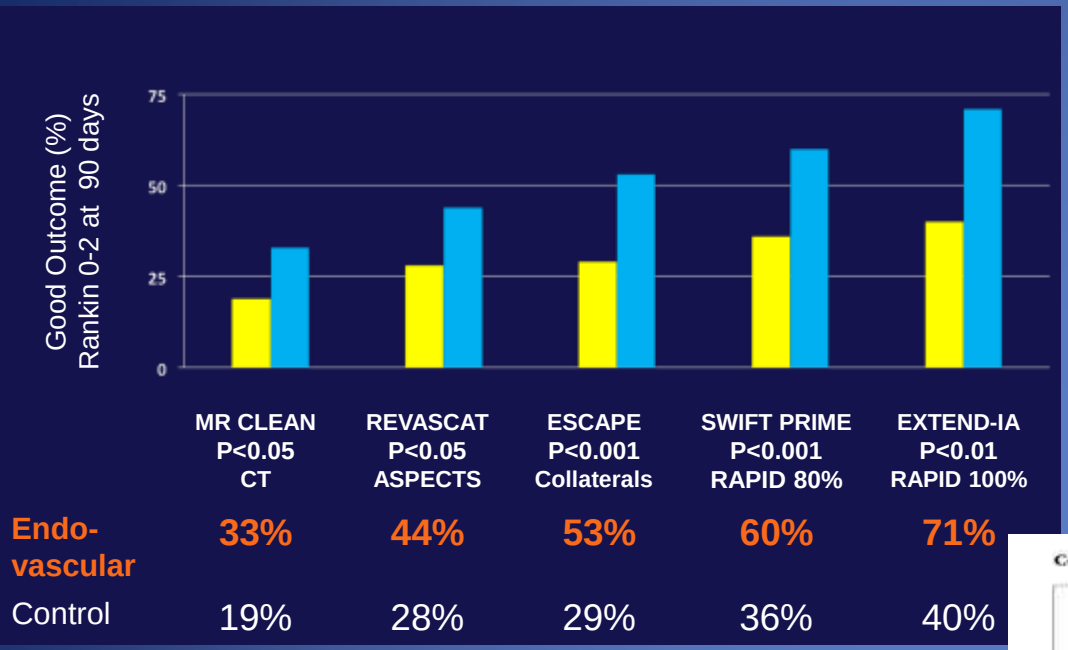


www.mrclean-trial.org

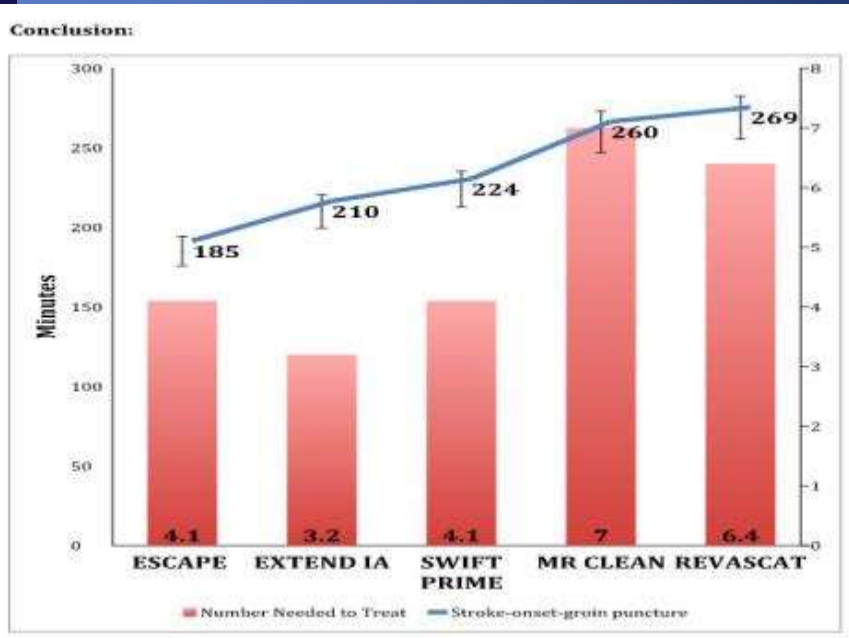
MR CLEAN

A Multicenter Randomized CLinical trial of Endovascular treatment for Acute ischemic stroke in the Netherlands

INR in ischemic stroke



Similar results in other RCT's



INR in ischemic stroke

Sufficient evidence from multiple randomized trials has resulted in significant guideline modifications, with catheter-based endovascular therapy becoming a class IA indication for all patients with acute stroke caused by a major artery occlusion, provided that they present sufficiently quickly to the healthcare system.

- *Karolinska Stroke Update level of evidence for treatment*
- *recommendations, in collaboration with ESMINT and ESNR*
- *AHA/ASA stroke guidelines*

INR in ischemic stroke

(Grade A, Level 1a, KSU Grade A).

- 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.
- Mechanical thrombectomy should be performed as soon as possible after its indication.
- For mechanical thrombectomy, stent retrievers should be considered.
- If intravenous thrombolysis is contraindicated (e.g. Warfarin-treated with therapeutic INR) mechanical thrombectomy is recommended as first-line treatment in large vessel occlusion

INR in ischemic stroke

CT protocol

NCCT HEAD		
Scan coverage/Position	Skull base to vertex parallel to inferior orbitomeateal line / Supine	
FOV (mm)	240 mm	
kV/Effective mAS/collimation	140/450/1 x 5.0	
Reconstruction	Head soft	Head bone
Slice thickness/Interval (mm)	5/5	5/5
Window	Cerebrum	Bone

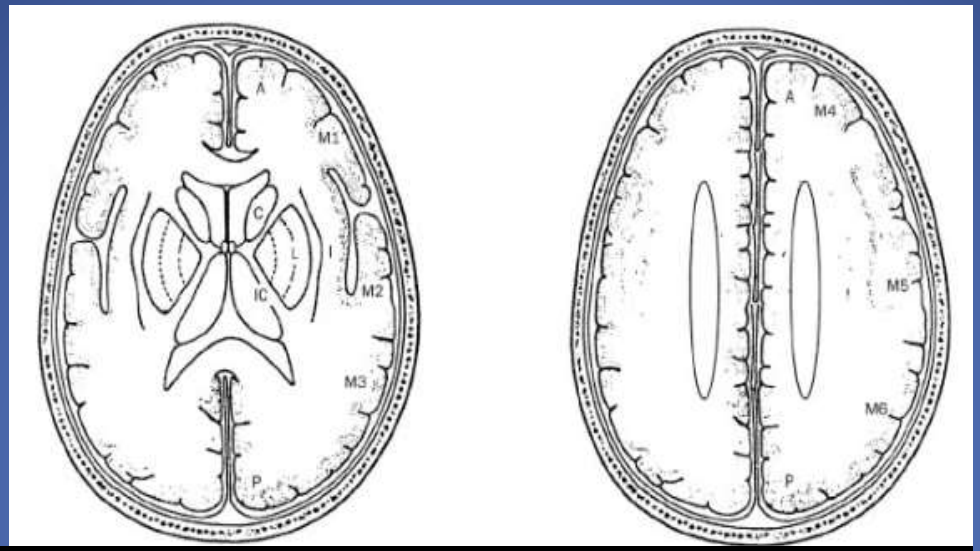
Specifc 'ACUTE STROKE' CT-protocol

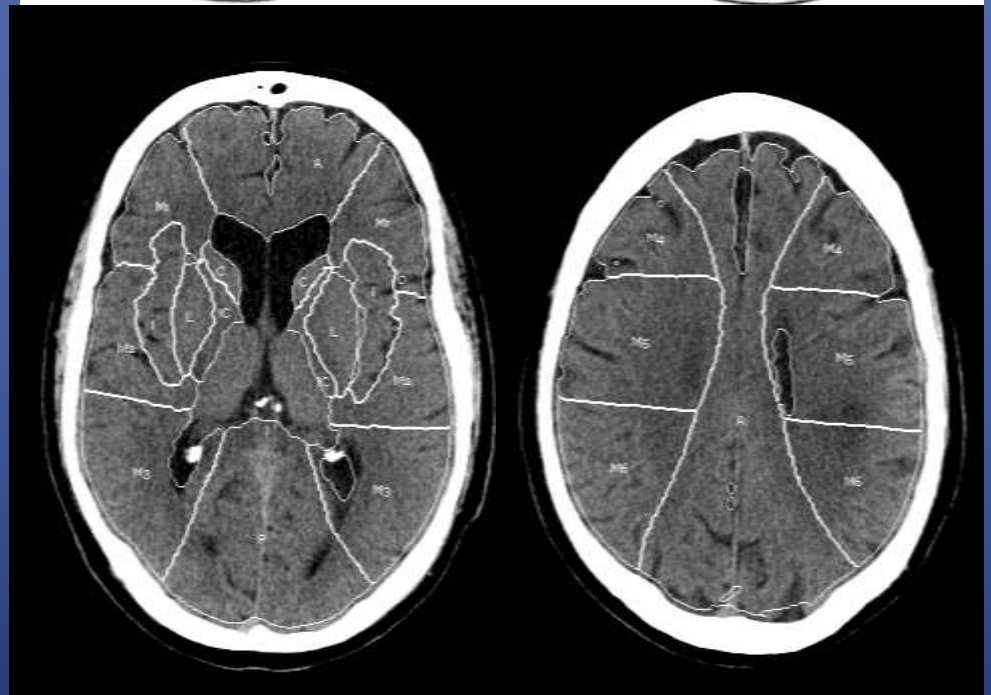
1. Sequential CT
2. 3-phase CT-angiografie

Specific 'ACUTE STROKE' CT-verslag

1. Blood ?
2. Core of the infarct ? ASPECT score
3. Clot ?
4. Collaterals? Collateral score

INR in ischemic stroke





Aspect score

INR in ischemic stroke

Collaterals score

Figure 1

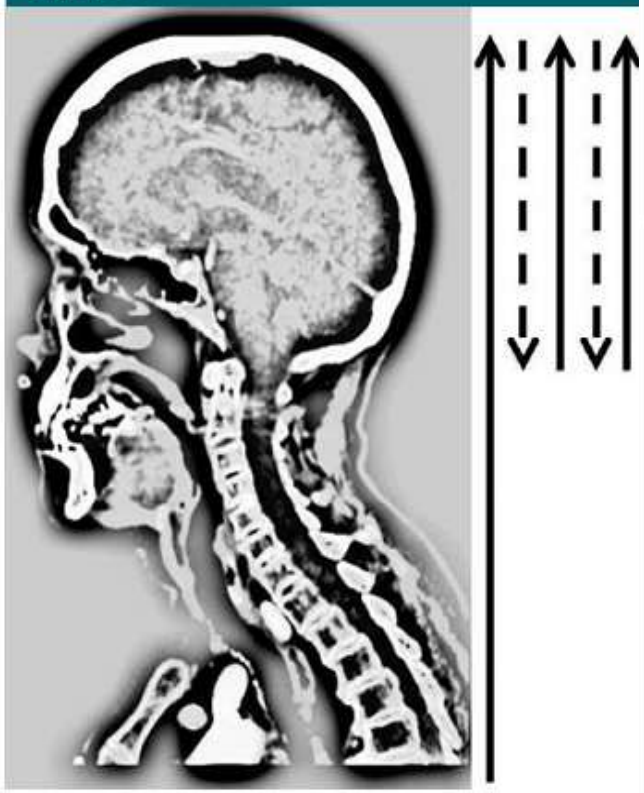


Figure 1: Multiphase CT angiography image, with each phase represented by an arrow. The first phase (long solid arrow) is conventional arch-to-vertex CT angiography. The next two phases (short solid arrows) are sequential skull base–to-vertex acquisitions performed in the midvenous and late venous phases. Dashed arrows indicate movement of the scanner in between image acquisitions.

Figure 2

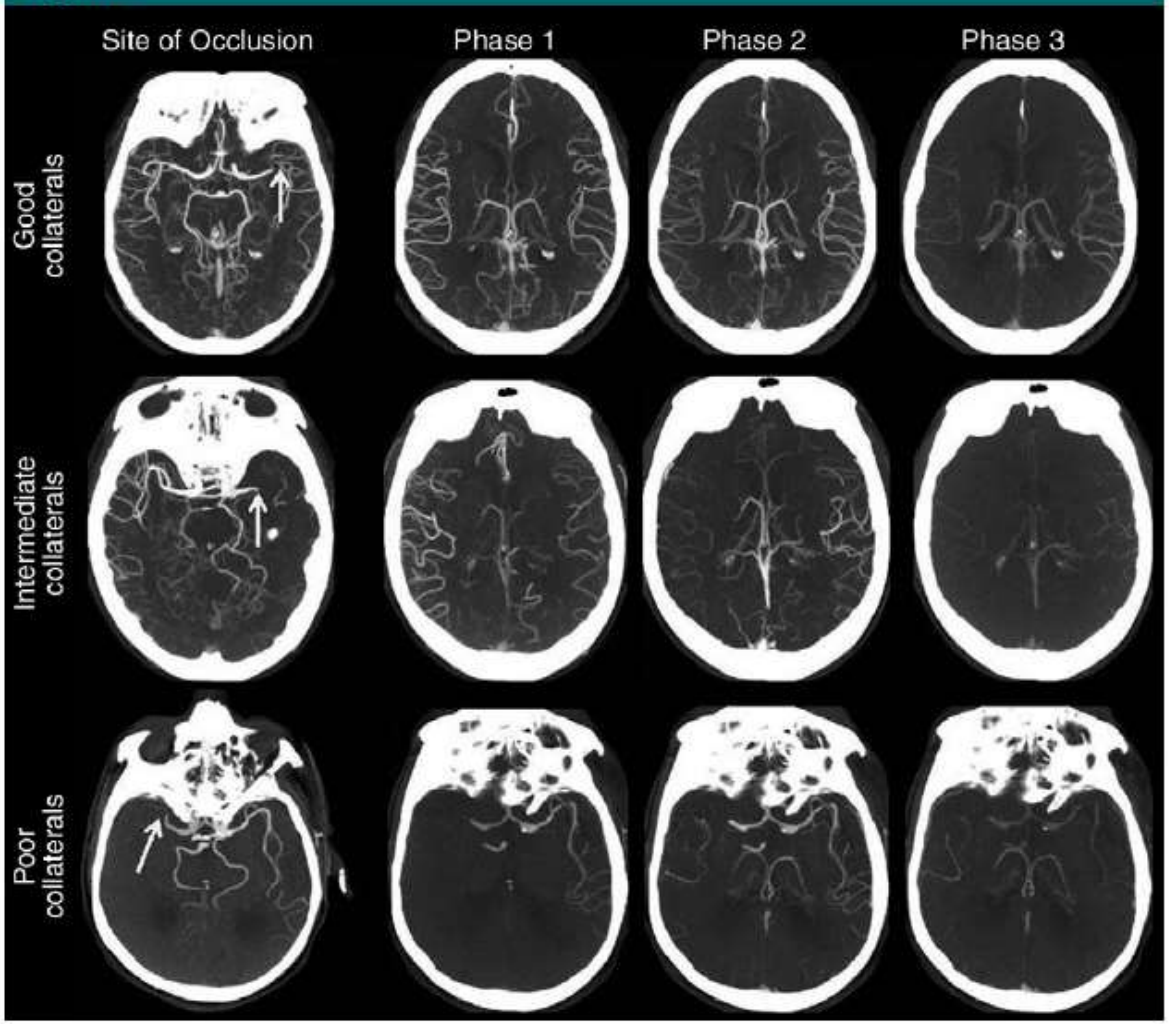


Figure 2: Multiphase CT angiography images. Top row: Images in a patient with a left M1 MCA occlusion (arrow) and good collaterals (backfilling arteries). Middle row: Images in a patient with a left M1 MCA occlusion (arrow) and intermediate collaterals. Bottom row: Images in a patient with a right M1 MCA occlusion (arrow) and poor collaterals (minimal backfilling arteries).

INR in ischemic stroke

Patient selection

Pertinent neurological deficit
- NHISS ≥ 6

Large vessel occlusion
- M1 –M2, BA, ICA, carotid T, tandem

ASPECT score

≥ 4 if younger than 70

≥ 5 if older than 70

COLLATERALS score?

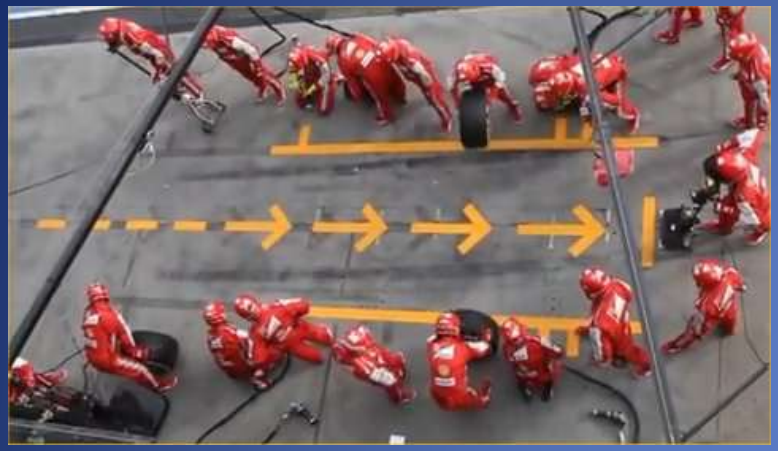
No limitation of age but pre mRS score 0-1

Delay??

Table 1. Proposed NCCT/CTA 3C approach to select patients presenting with symptoms of large anterior circulation stroke for endovascular treatment

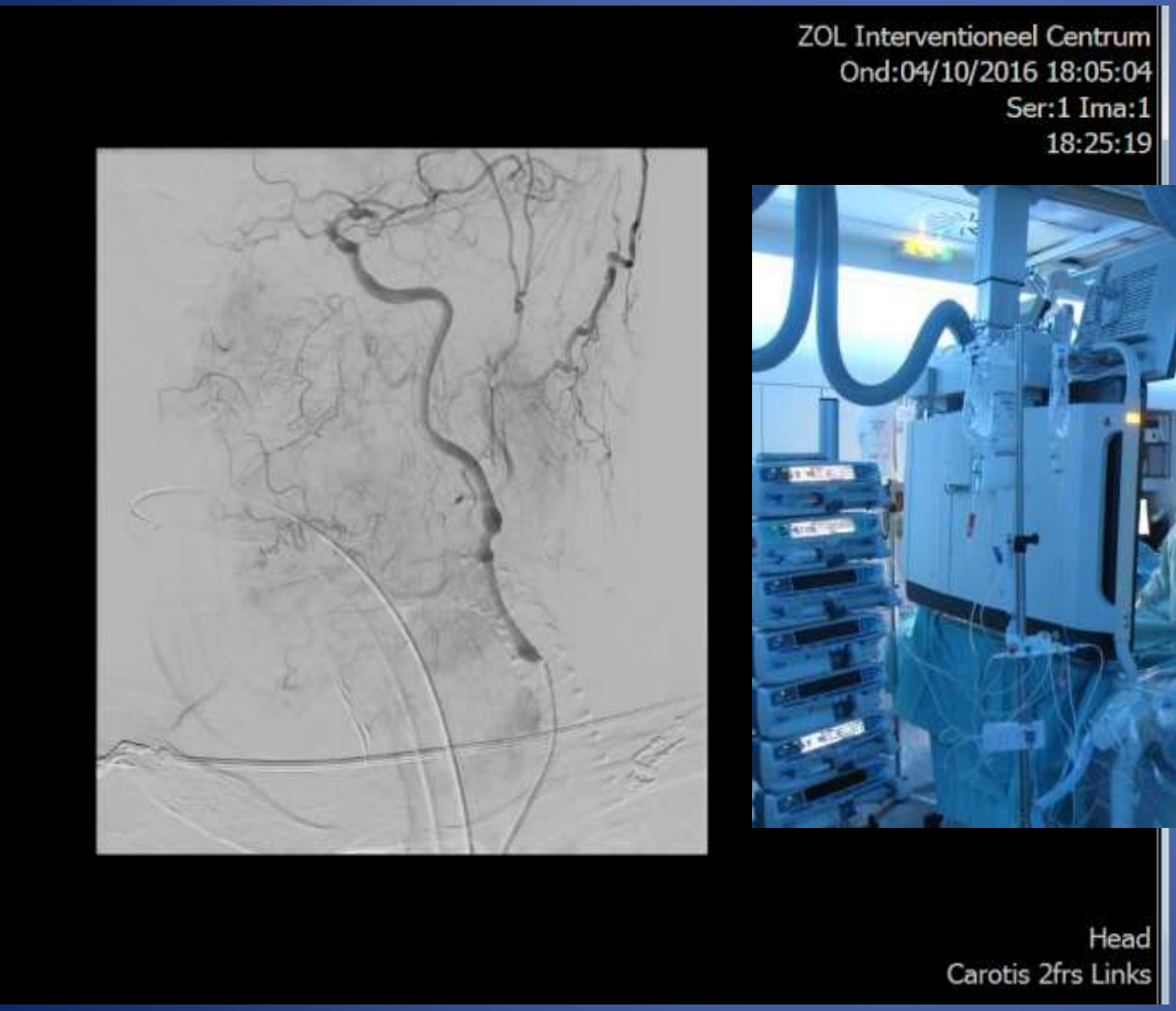
	Ideal candidate	Fair candidate	Poor candidate
Ischemic core volume	ASPECTS 8–10	ASPECTS 5–7	ASPECTS 0–4
Clot (thrombus)	Proximal/large	Distal/small	No visible intracranial occlusion
Collaterals (pial backfilling)	Good	Fair	None/poor

INR in ischemic stroke

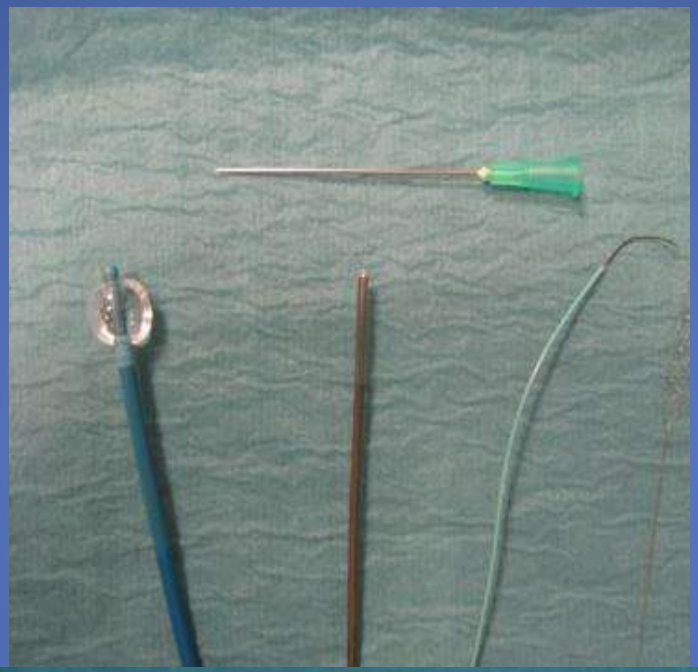


INR in ischemic stroke

INR in ischemic stroke



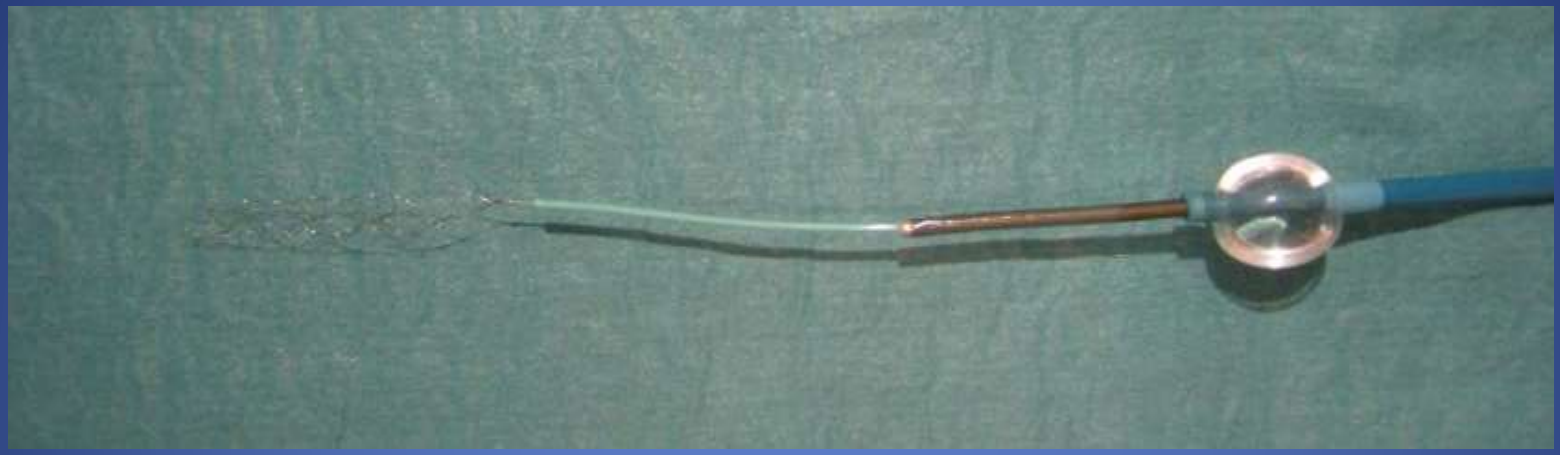
INR in ischemic stroke



New tools

INR in ischemic stroke

New tools



INR in ischemic stroke

Angiografic reperfusion score

0	no reperfusion
1	antegrade reperfusion but limited distal branch filling
2a	antegrade reperfusion of less than half of the previously ischemic territory
2b	antegrade reperfusion of more than half of the previously ischemic territory
3	complete antegrade reperfusion of previously ischemic territory

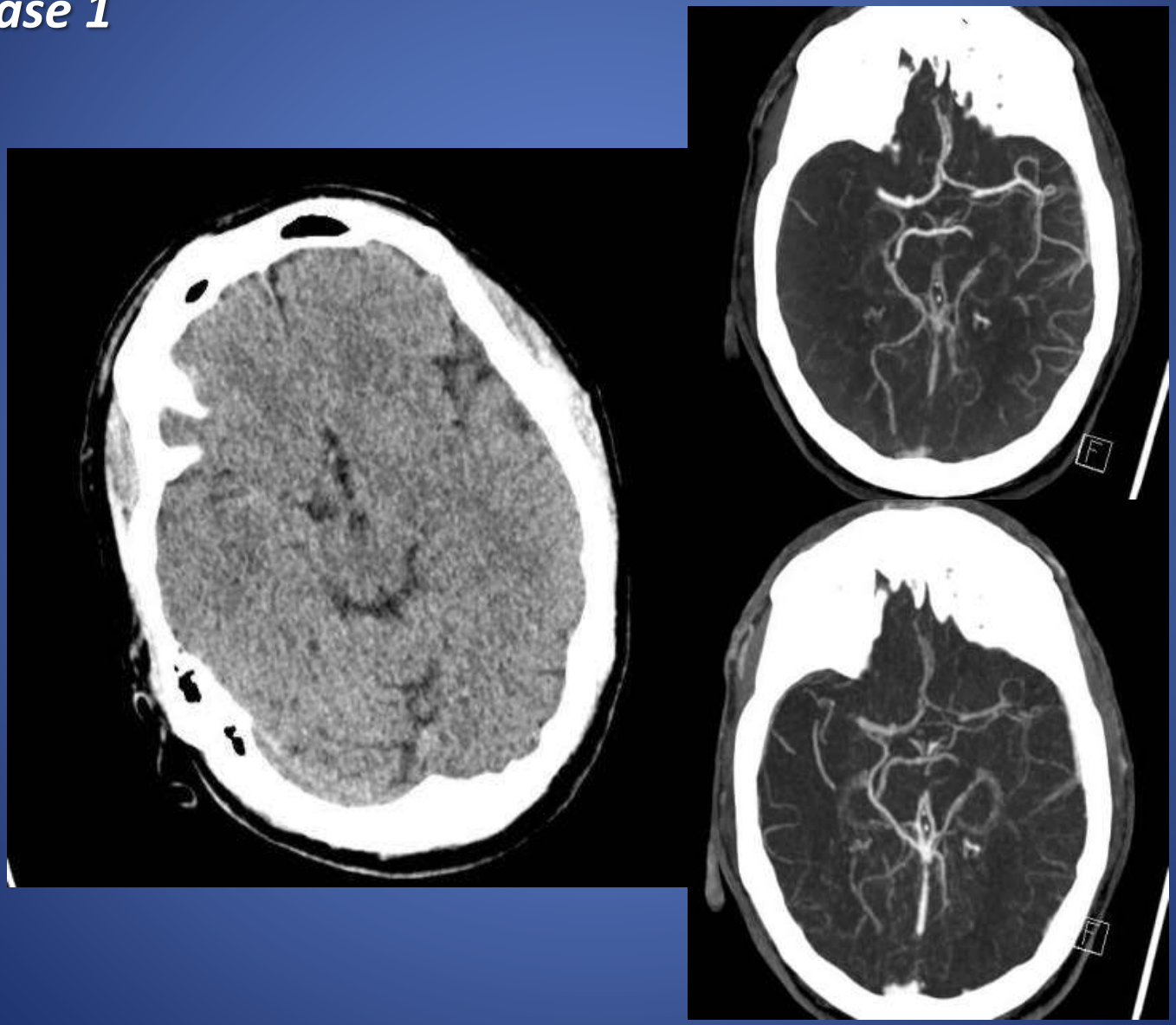
Clinical outcome score

MODIFIED RANKING SCORE

SCORE	DESCRIPTION
0	No symptoms at all
1	No significant disability despite symptoms; able to carry out all usual duties and activities
2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
3	Moderate disability; requiring some help, but able to walk without assistance
4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
6	Dead

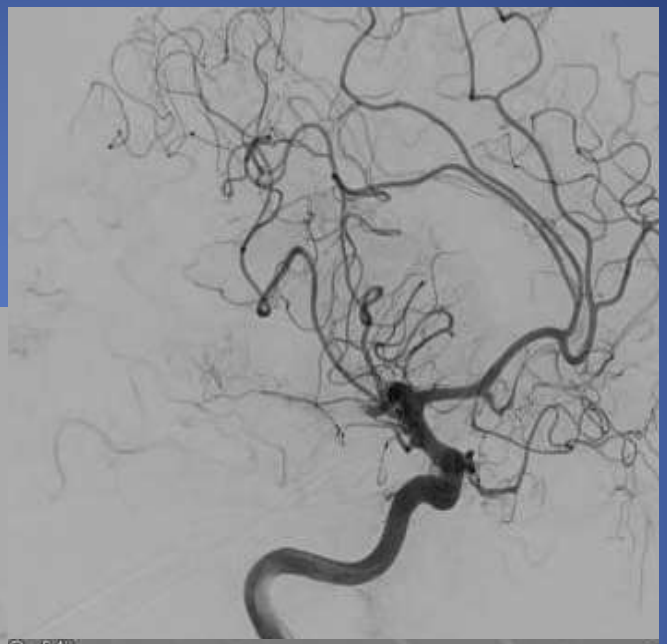
INR in ischemic stroke

Case 1



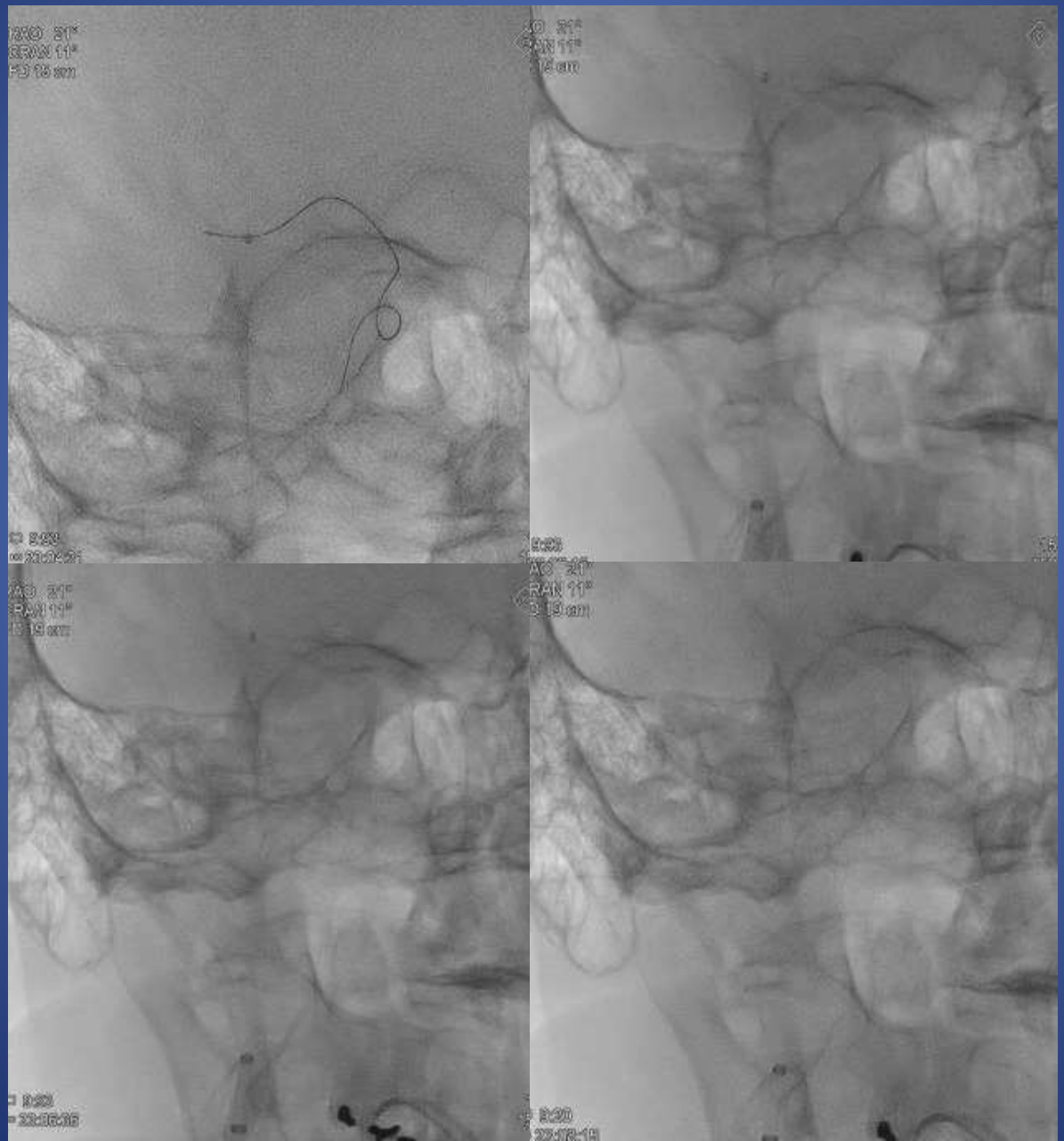
INR in ischemic stroke

Case 1



INR in ischemic stroke

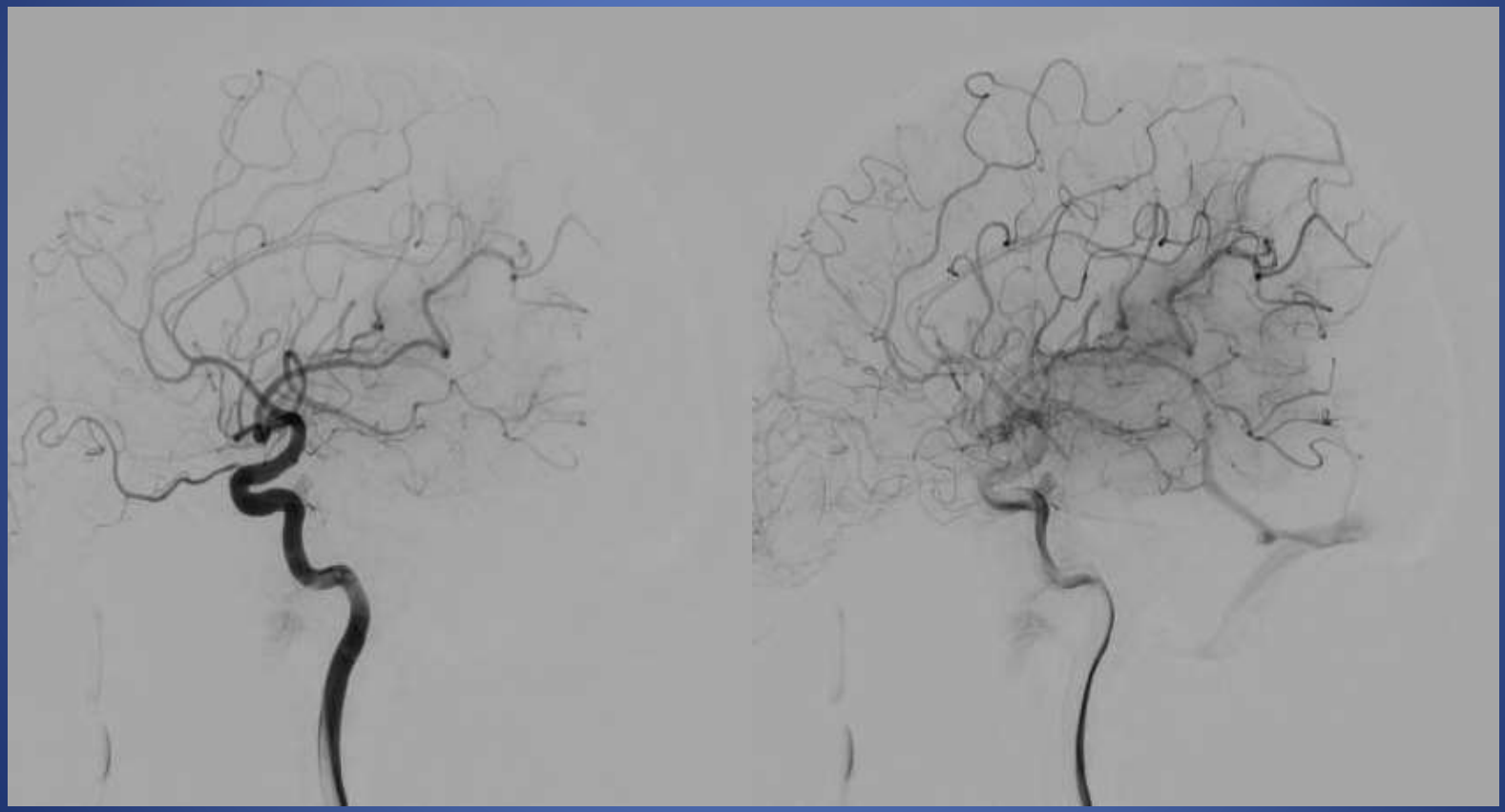
Case 1



aspiration

INR in ischemic stroke

Case 1

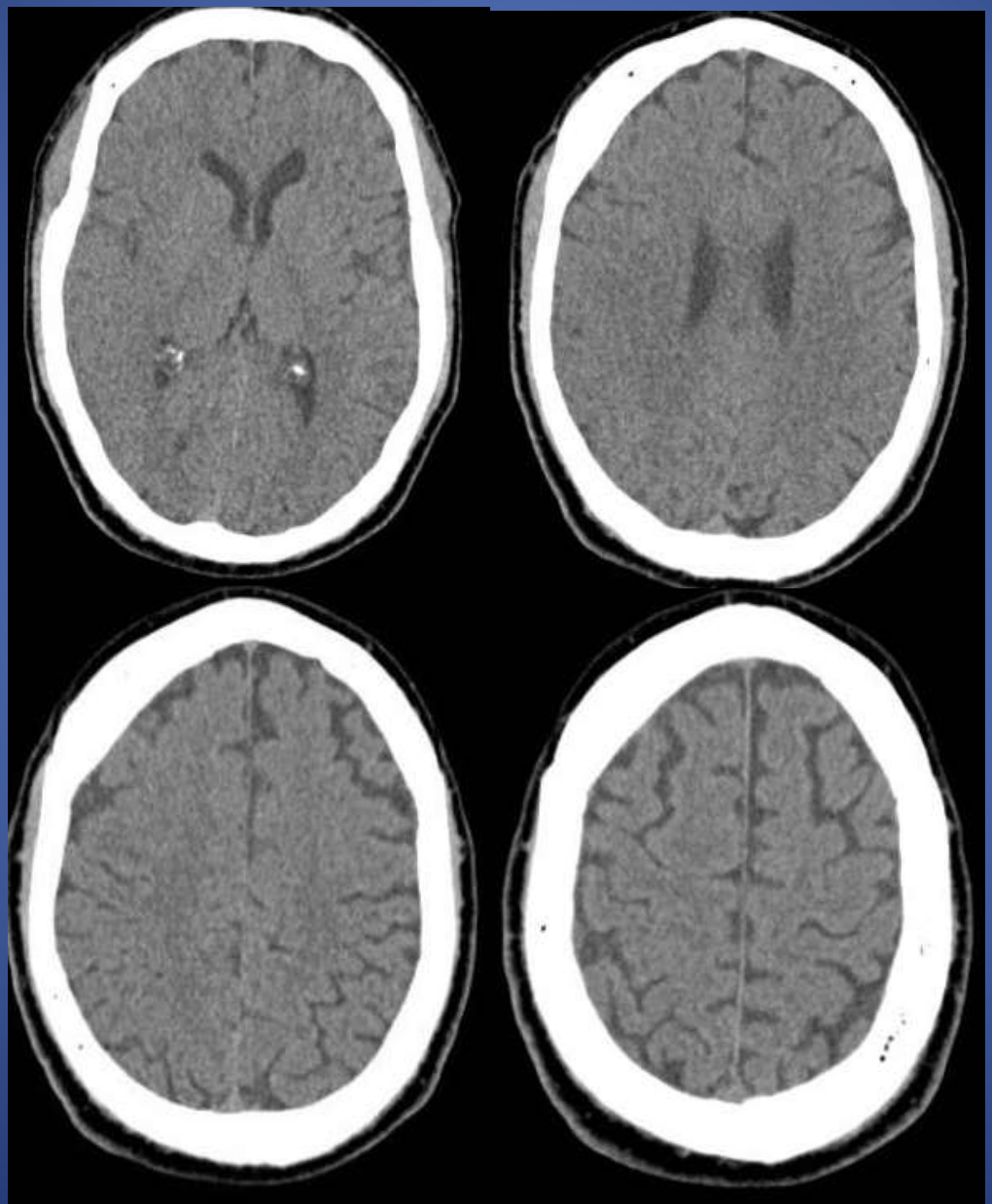


INR in ischemic stroke

Case 1

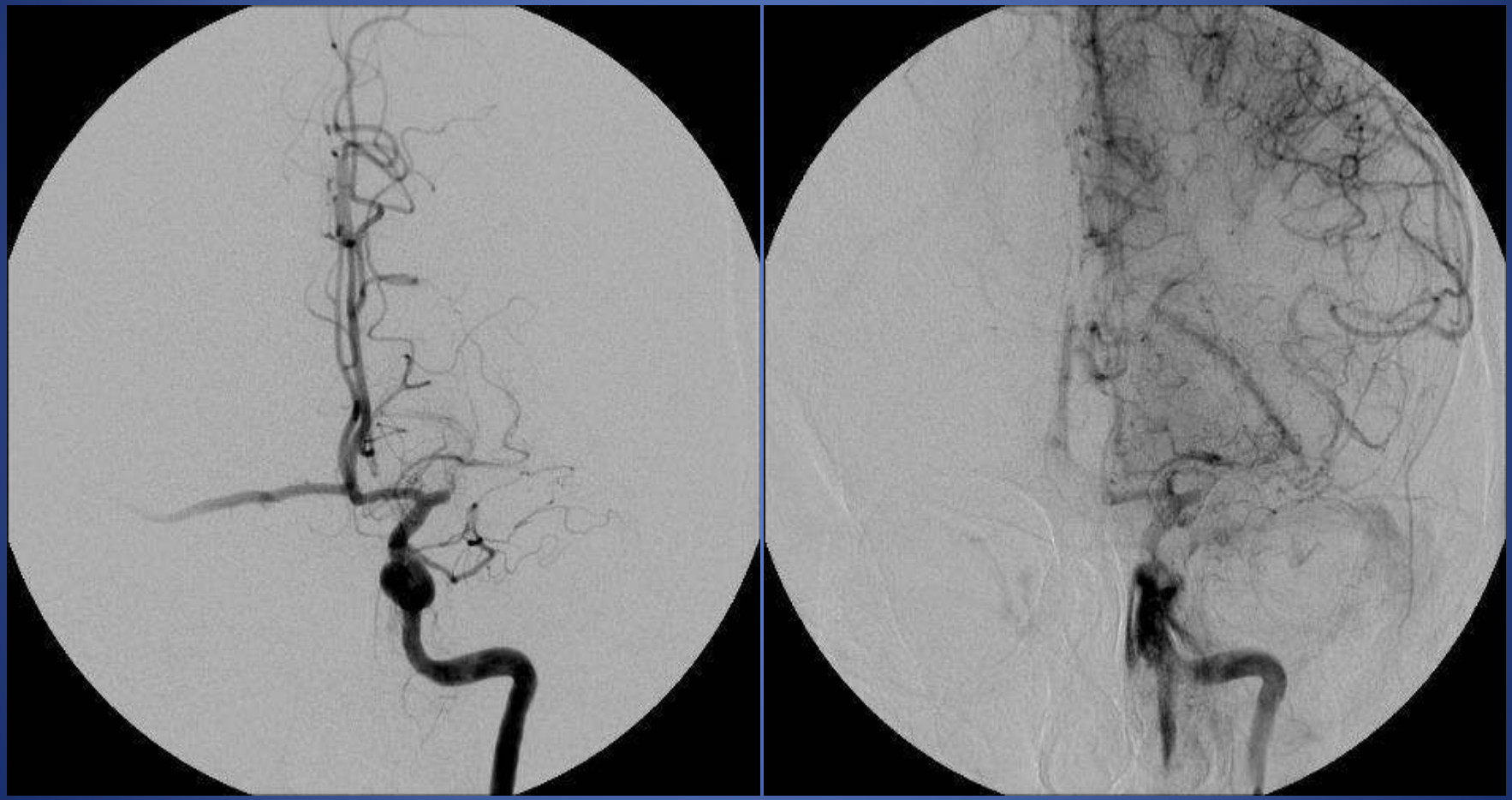
INR in ischemic stroke

Case 1



INR in ischemic stroke

Case 2



INR in ischemic stroke

Case 2

Stent retriever

INR in ischemic stroke

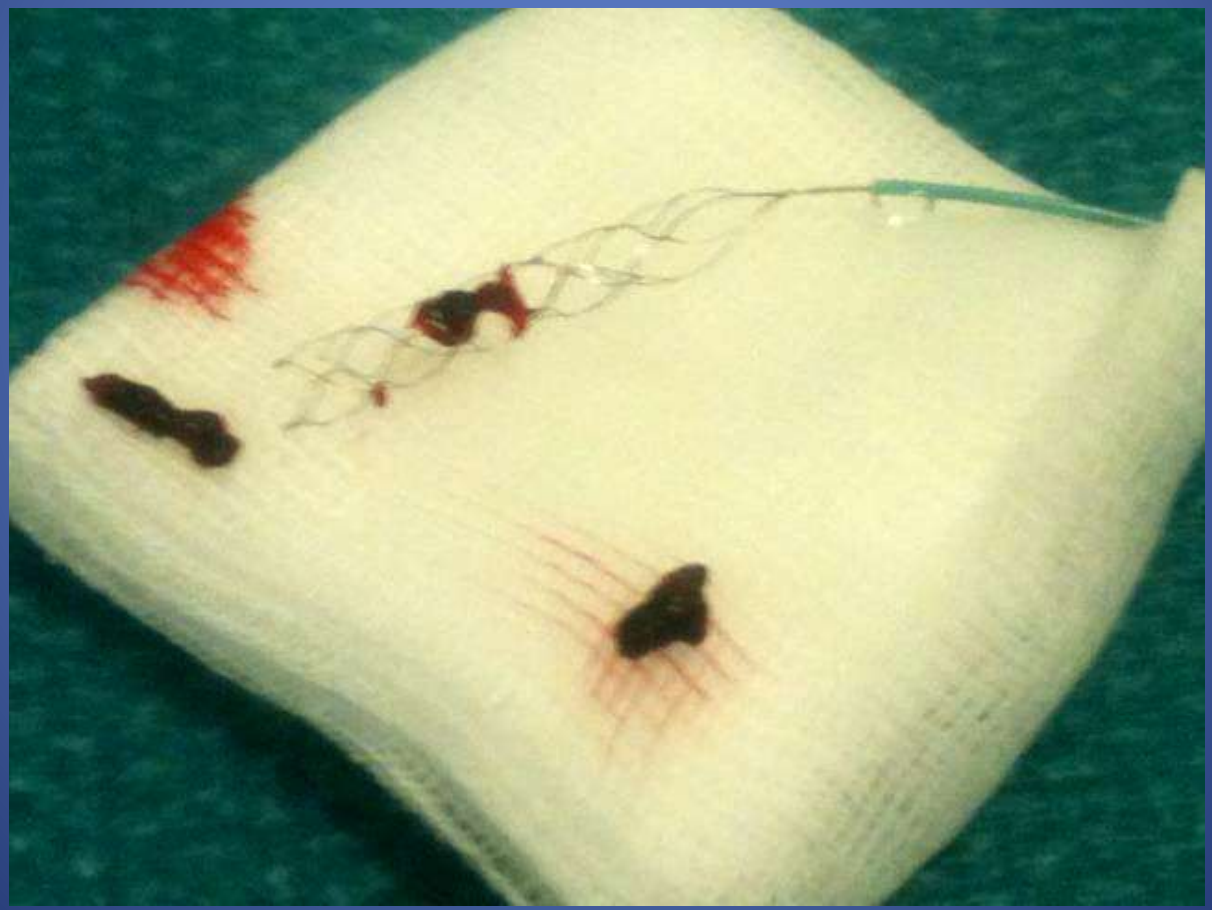
Case 2

Stent retriever

INR in ischemic stroke

Case 2

Stent retriever



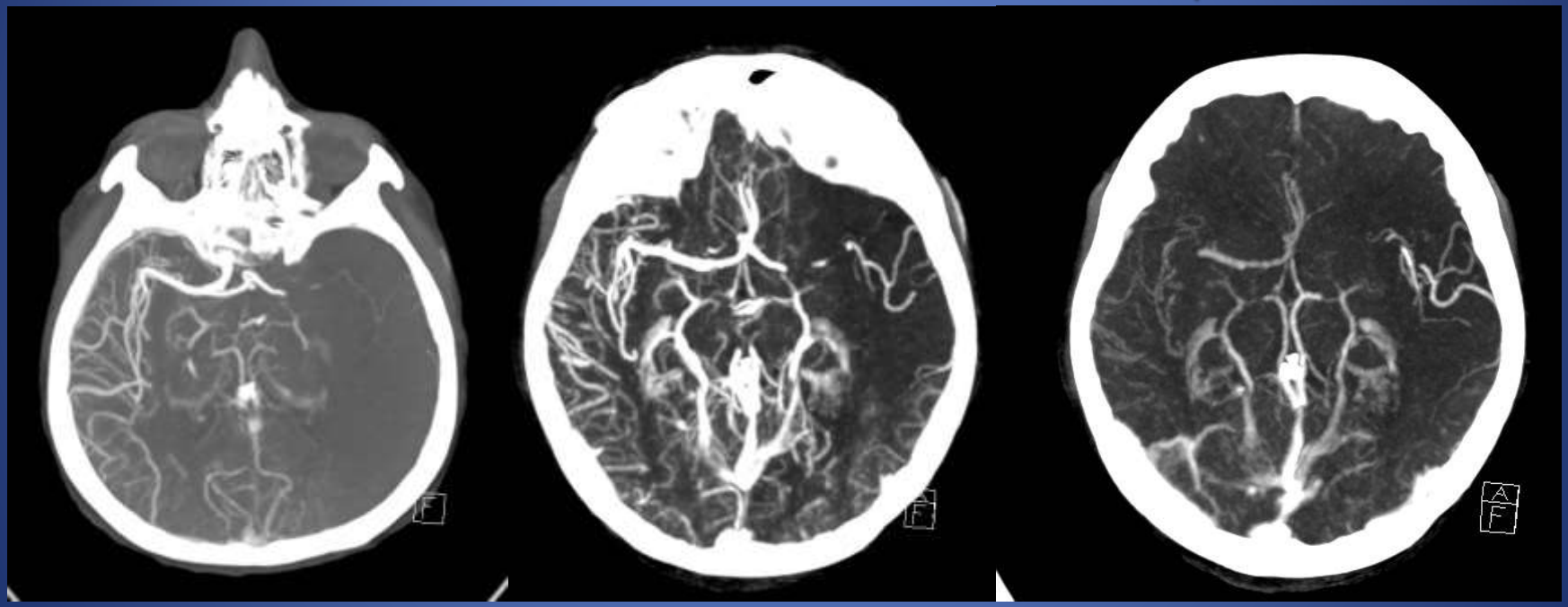
INR in ischemic stroke

Case 2

INR in ischemic stroke

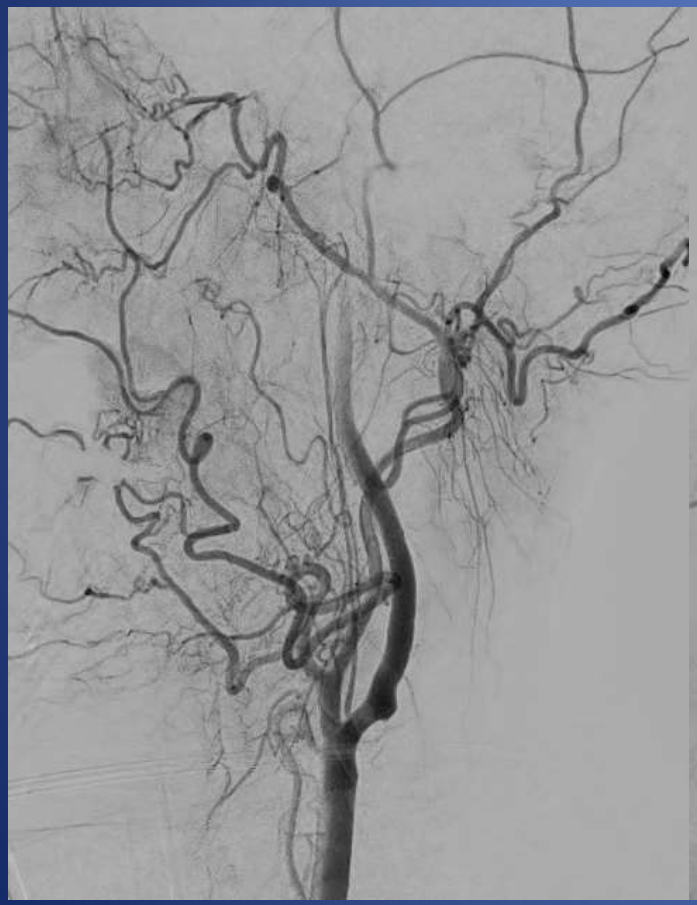
Case 3

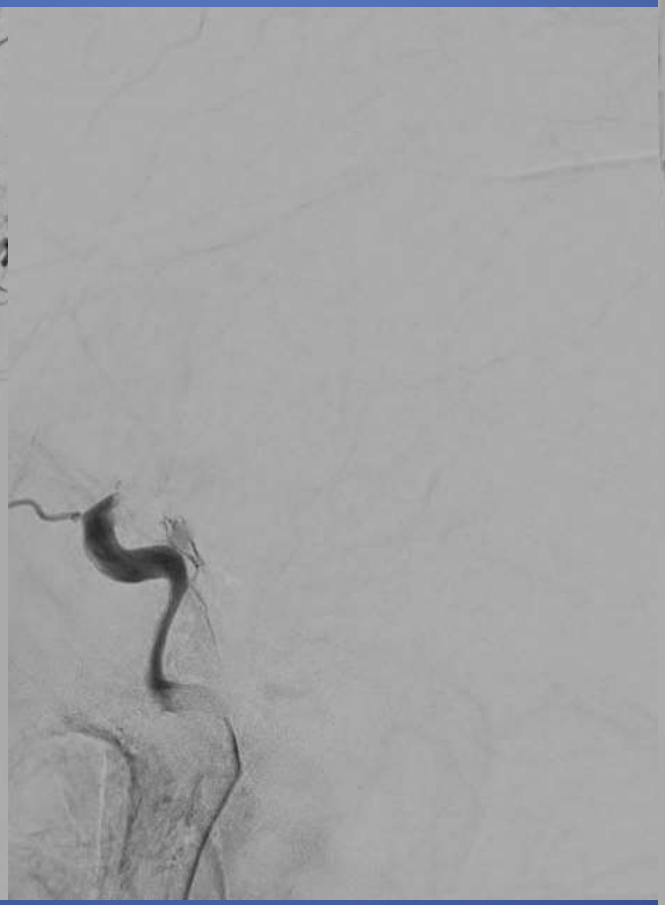
phase1 phase2 phase3

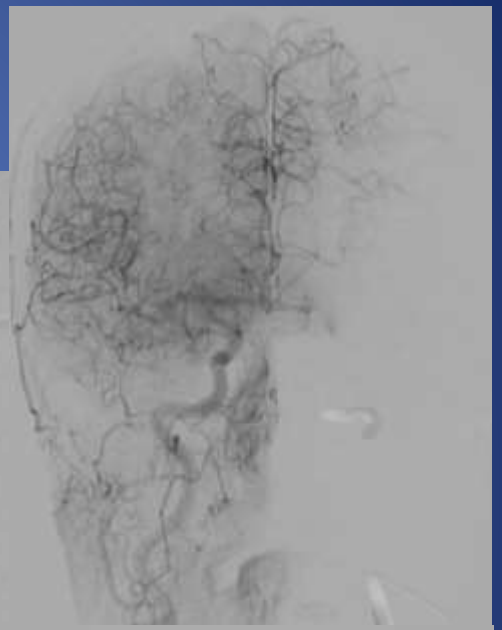


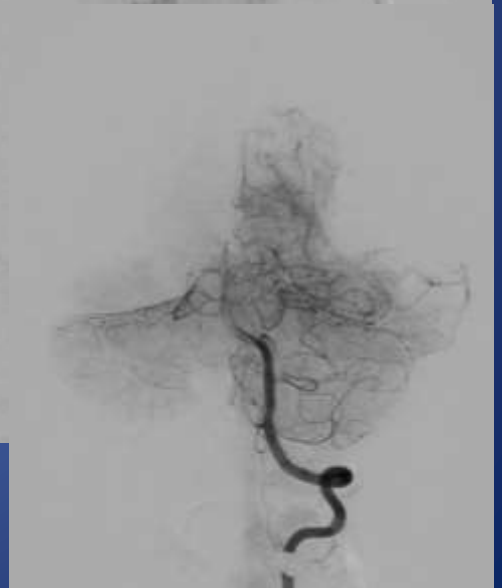
INR in ischemic stroke

Case 3







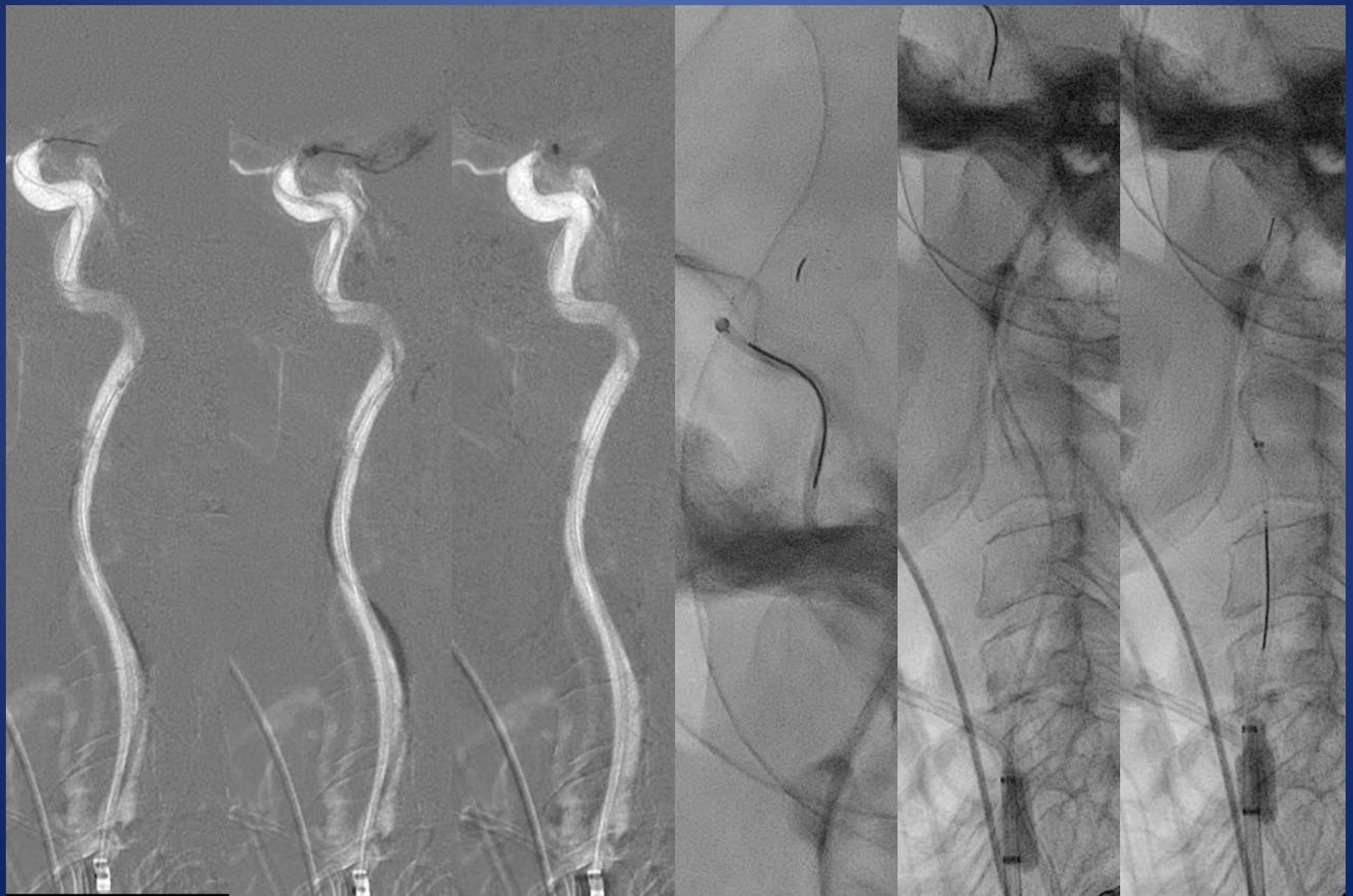


INR in ischemic stroke

Case 3

aspiration

stent retriever

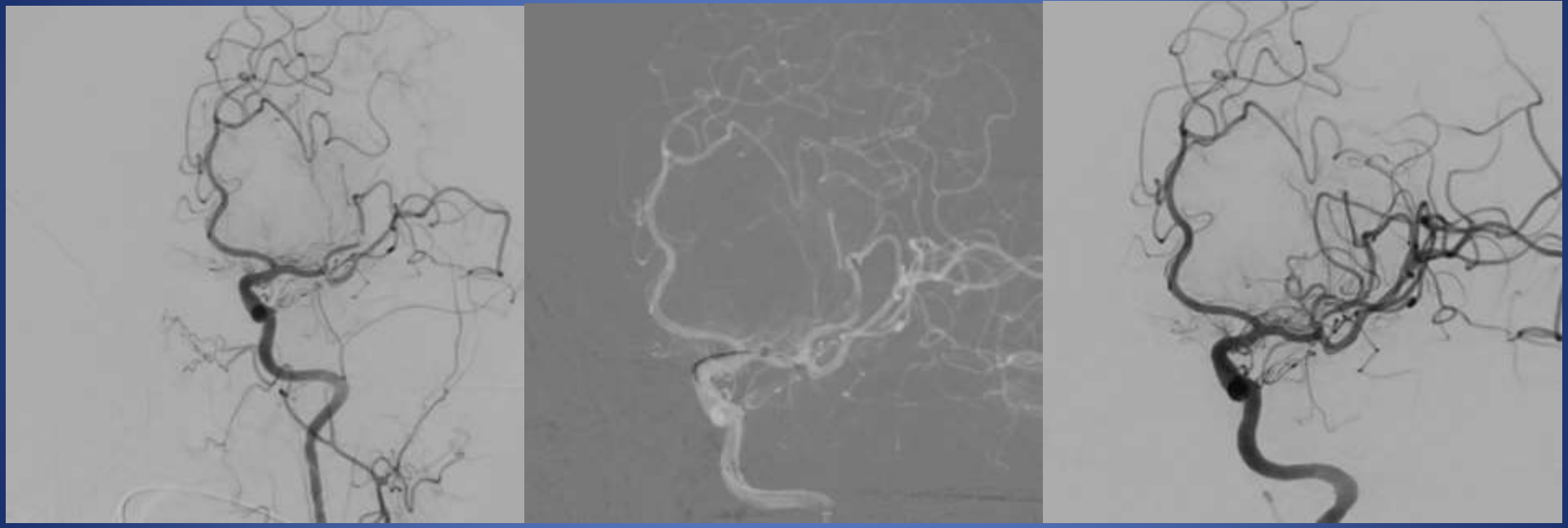


Case 3

INR in ischemic stroke

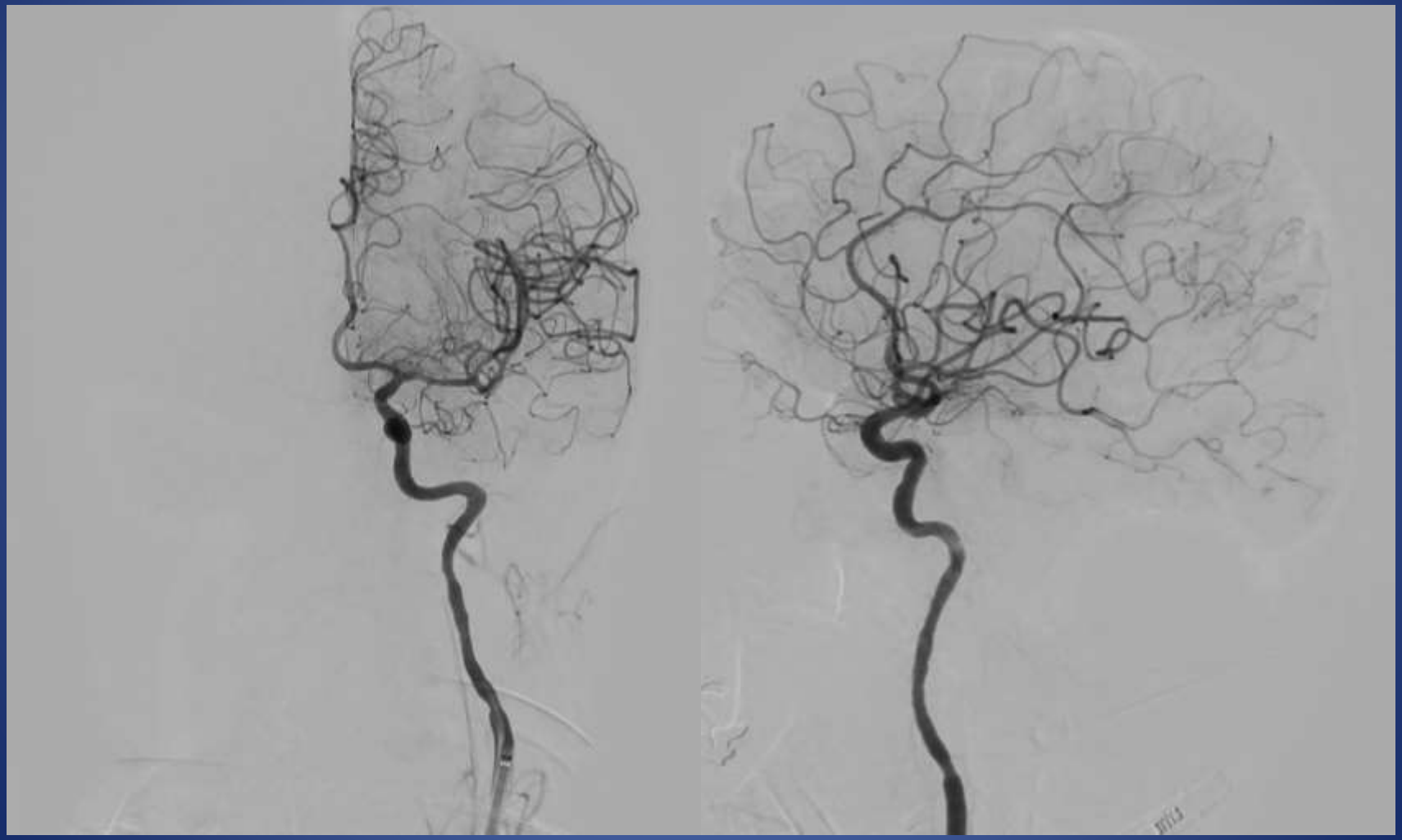
INR in ischemic stroke

Case 3



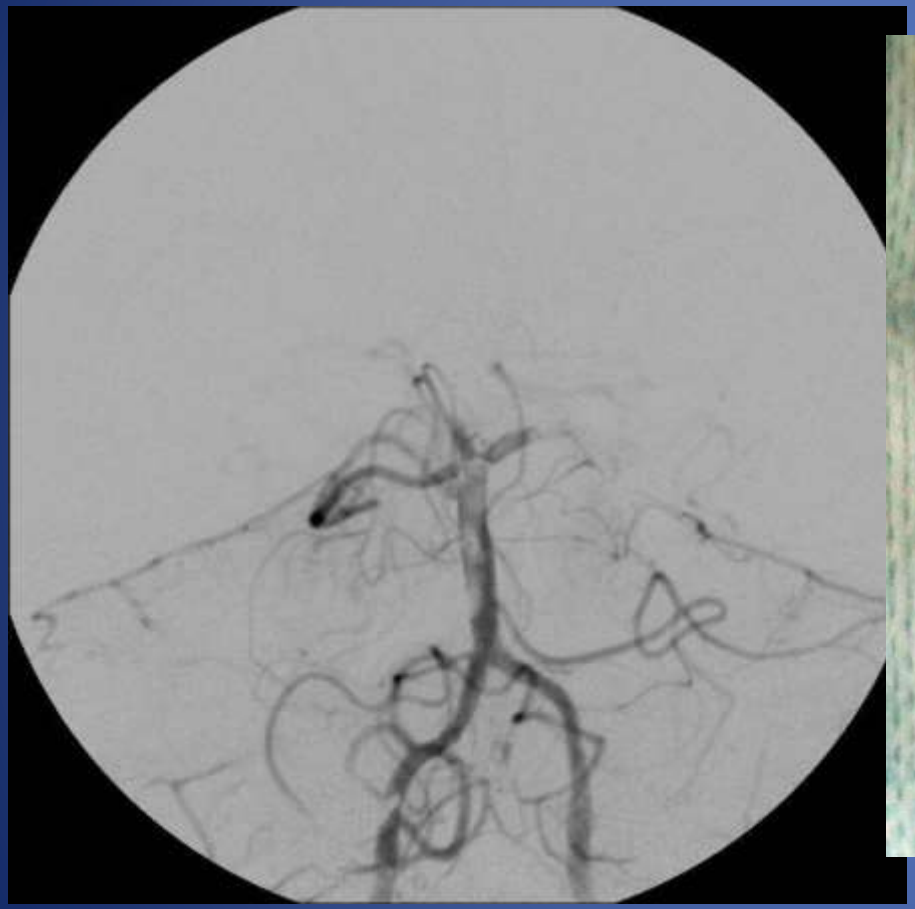
INR in ischemic stroke

Case 3



INR in ischemic stroke

Case 4



INR in ischemic stroke

Patient selection --------→ DELAY??

- Time is brain
- Collateral is brain

Fast progressor* vs *Slow progressor

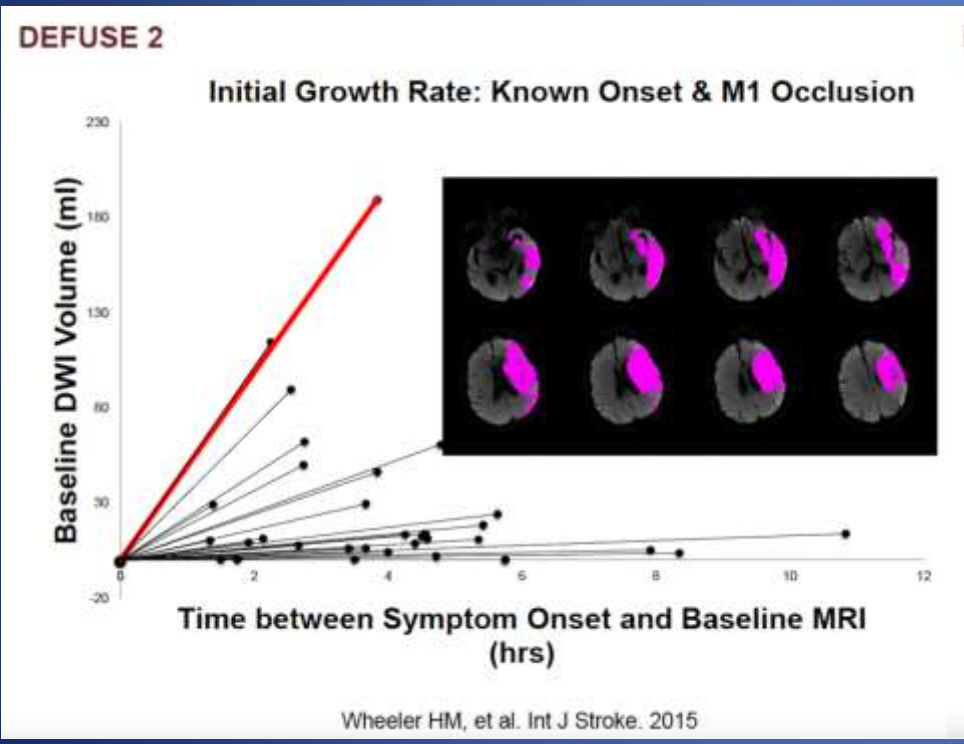
_ "advanced brain imaging"

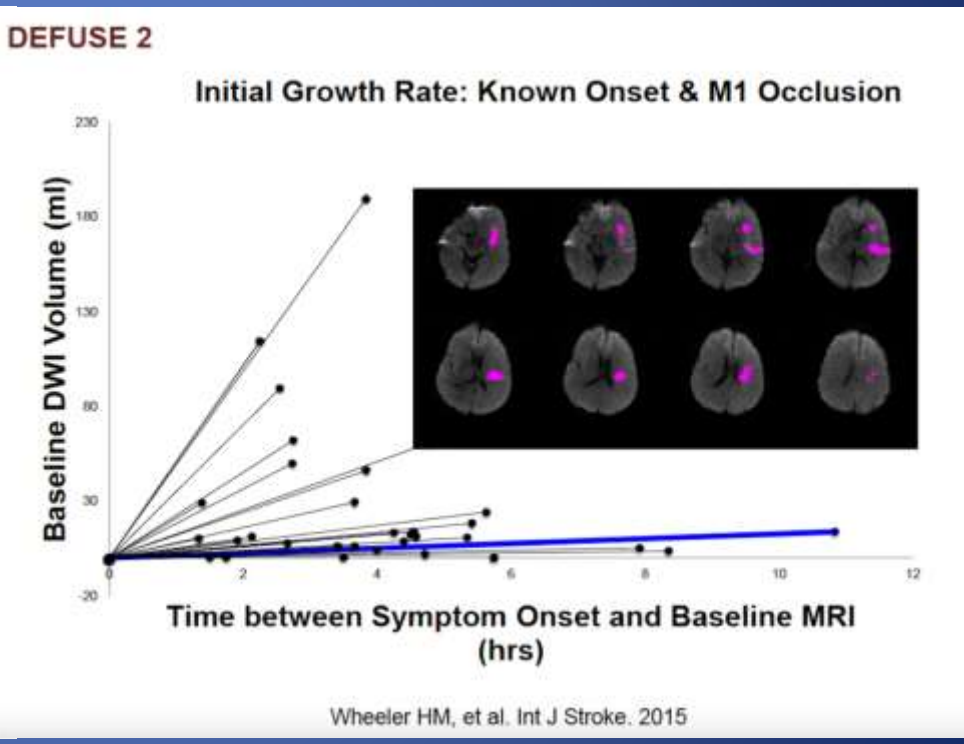
_ extension of therapeutic window ?

_ evolving deficit?

INR in ischemic stroke

Fast progressor vs *Slow progressor*

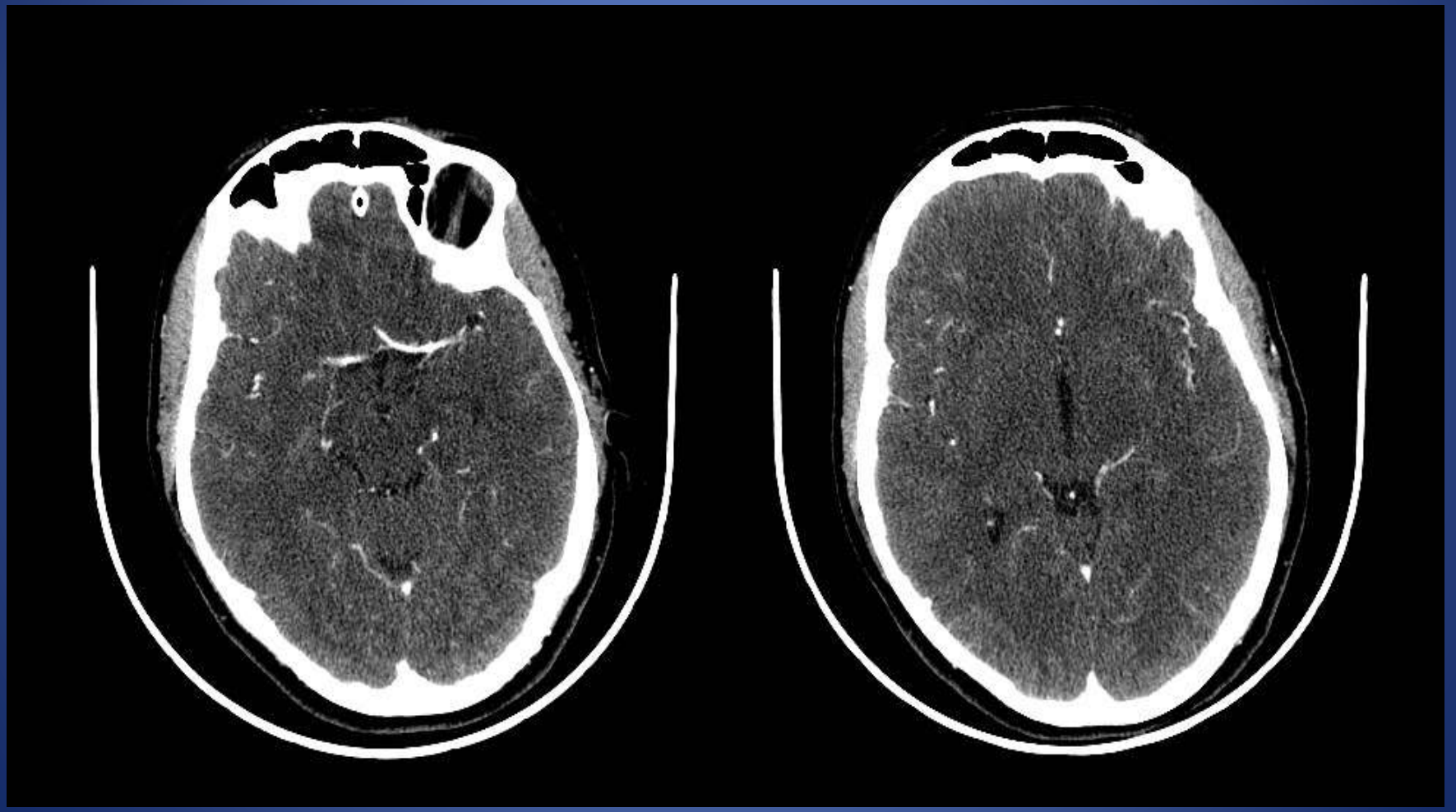




INR in ischemic stroke

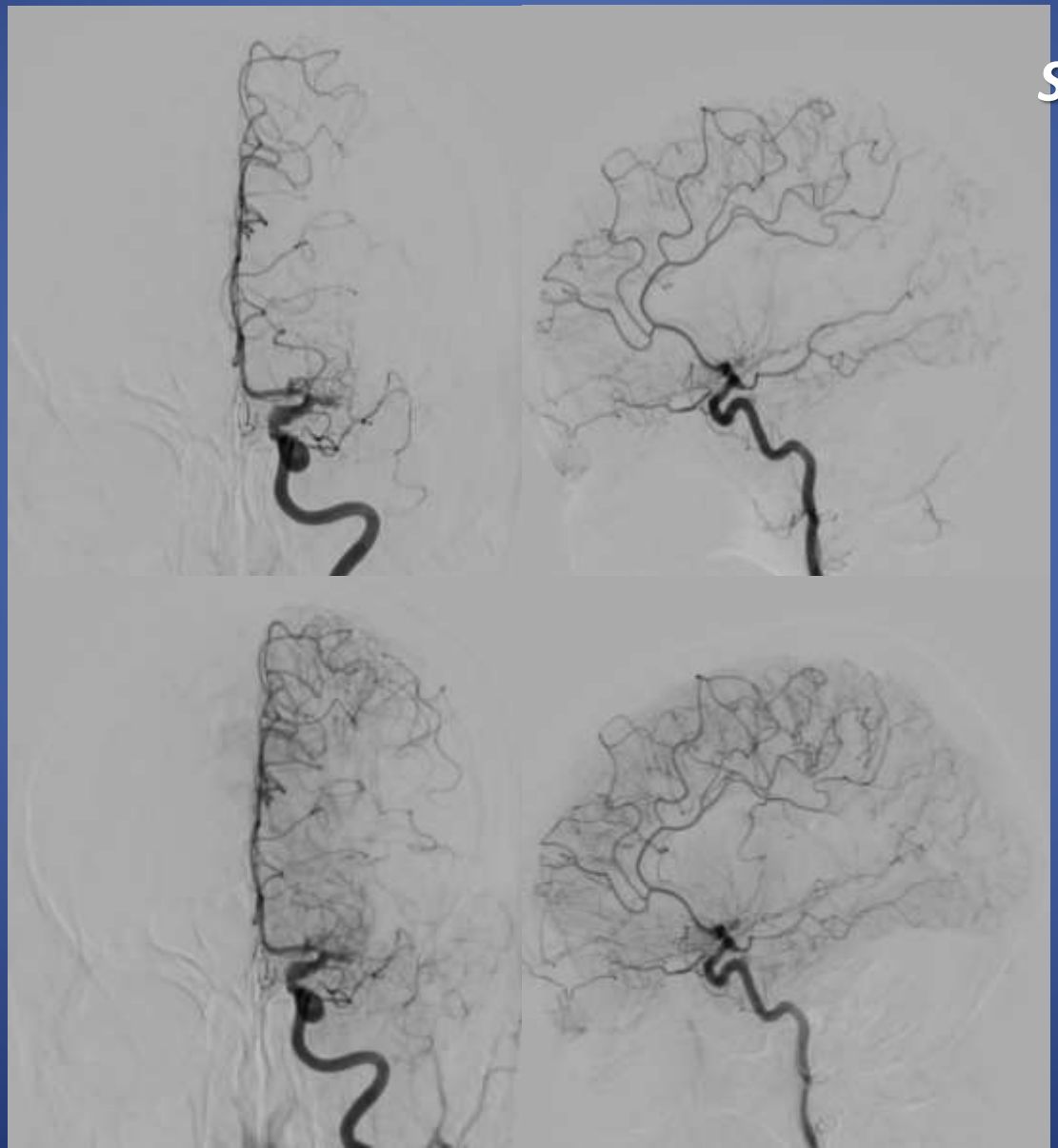
Case 5

Slow progressor



INR in ischemic stroke

Case 5

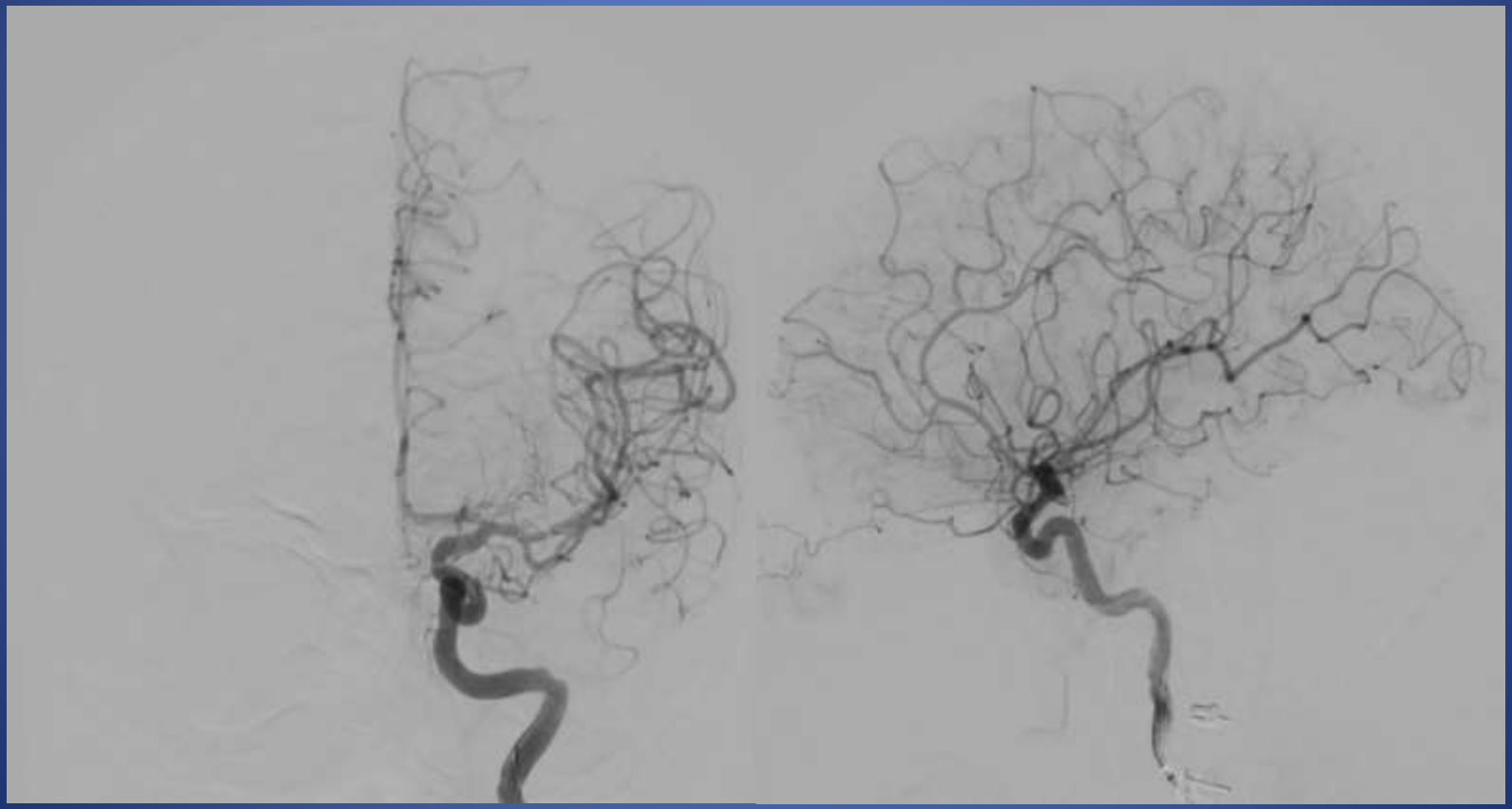


Slow progressor

INR in ischemic stroke

Case 5

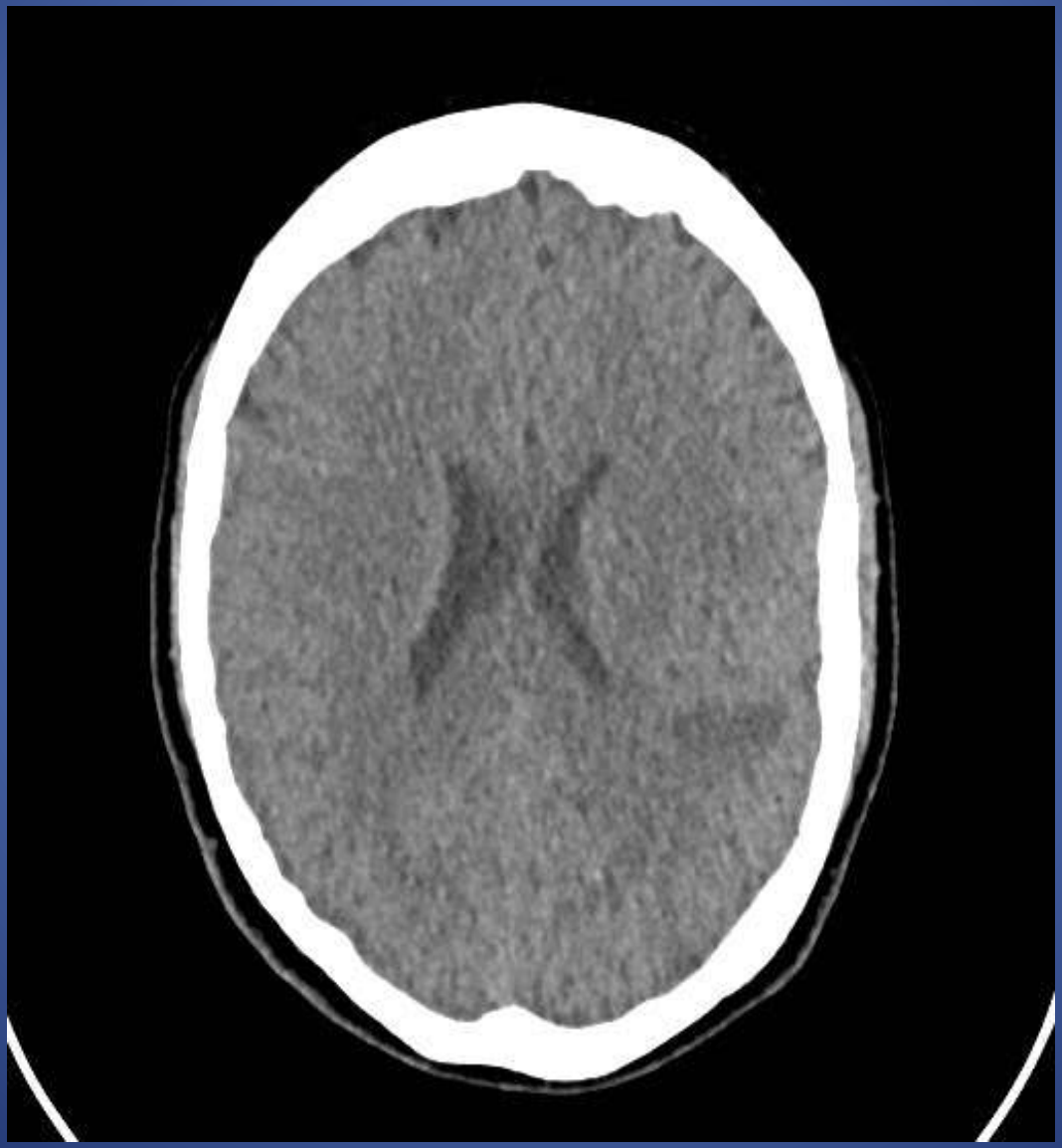
Slow progressor



INR in ischemic stroke

Case 5

Slow progressor



thanks/merci