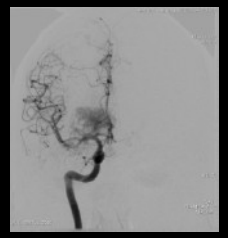
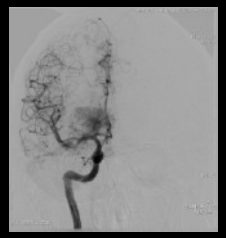
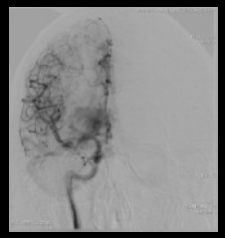
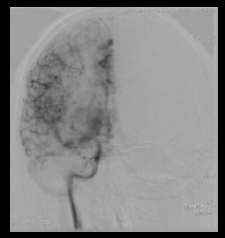
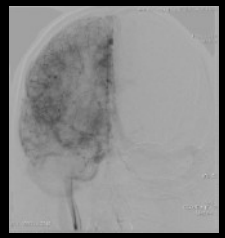
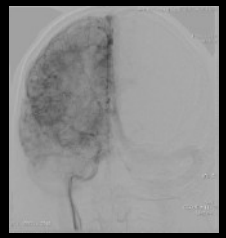
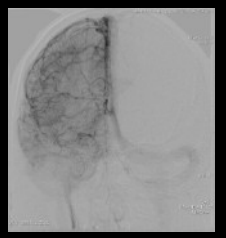
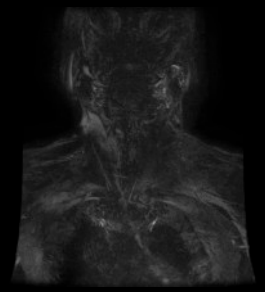









THROMBECTOMIE : 2ème REVOLUTION THERAPEUTIQUE DE L'INFARCTUS CEREBRAL

B. GORY, F. TURJMAN & F. COTTON

Samedi Matin 25 Juin 2016



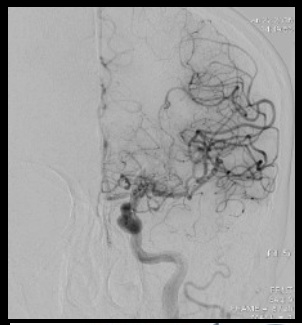
L'IRM est-elle indispensable pour la thrombectomie ?

O. Naggara, W. Ben Hassen,

C.Rodriguez-Régent, G. Boulouis, D.Trystram,

D. Calvet, G. Turc, J-L. Mas,

C. Oppenheim, J-F. Meder

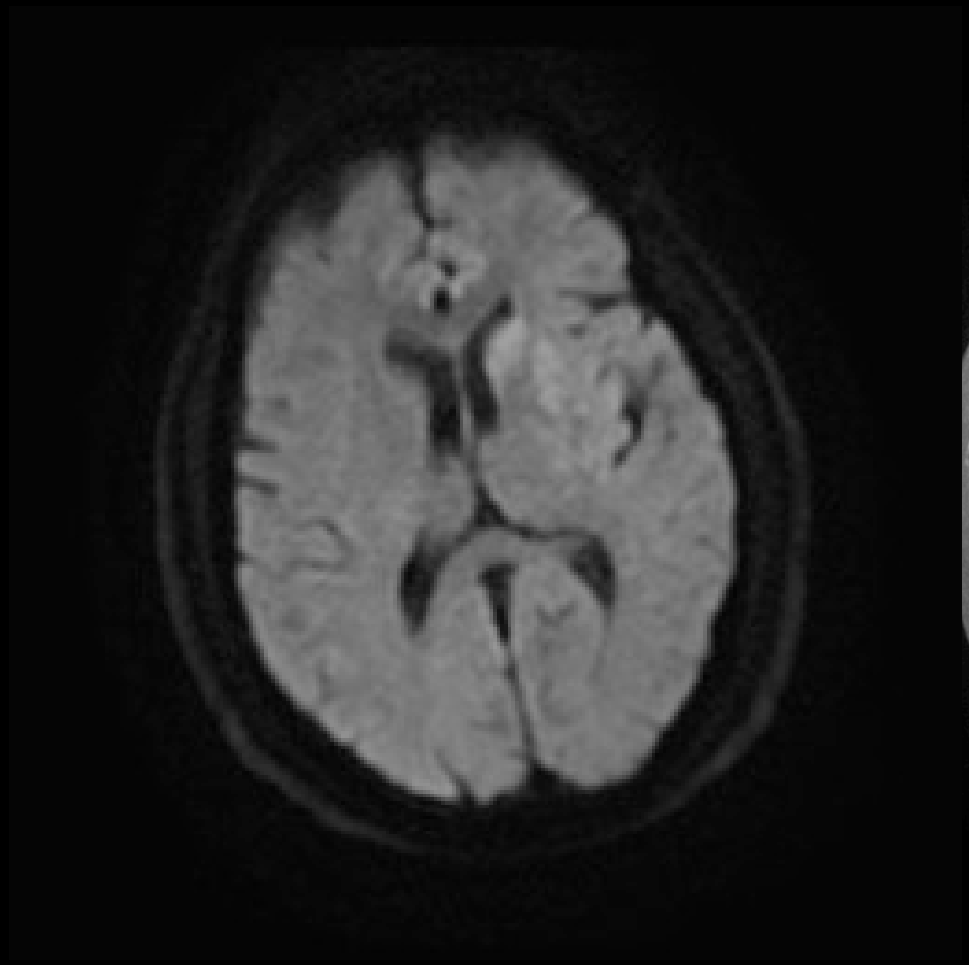


FACULTÉ DE MÉDECINE PARIS DESCARTES

Necker ENFANTS MALADES HÔPITAL UNIVERSITAIRE

Centre hospitalier Sainte-Anne

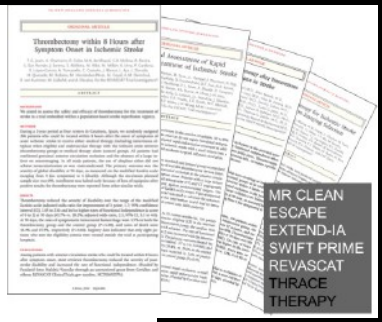
Patiente âgée de 58 ans, déficit neurologique brutal depuis 1h30. mutisme, déficit hémi-corporel droit. NIHSS = 15



Centre hospitalier Sainte-Anne


The NEW ENGLAND JOURNAL of MEDICINE
ESTABLISHED IN 1812 JANUARY 1, 2015 VOL. 372 NO. 1
A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke
O.A. Berkhemer, P.S.S. Fransen, D. Beumer, L.A. van den Berg, H.F. Lingsma, A.J. Yoo, W.J. Schonewille, J.A. Vos, P.J. Nederkoorn, M.J.H. Wermer, M.A.A. van Walderveen, J. Staals, J. Hofmeijer, J.A. van Oostayen, G.J. Lycklama à Nijeholt, J. Boiten, P.A. Brouwer, B.J. Emmer, S.F. de Bruijn, L.C. van Dijk, L.J. Kappelle, R.H. Lo, E.J. van Dijk, J. de Vries, P.L.M. de Kort, W.J.J. van Rooij, J.S.P. van den Berg, B.A.A.M. van Hasselt, L.A.M. Aerden, R.J. Dallinga, M.C. Visser, J.C.J. Bot, P.C. Vroomen, O. Eshghi, T.H.C.M.L. Schreuder, R.J.J. Heijboer, K. Keizer, A.V. Tielbeek, H.M. den Hertog, D.G. Gerrits, R.M. van den Berg-Vos, G.B. Karas, E.W. Steyerberg, H.Z. Flach, H.A. Marquering, M.E.S. Sprengers, S.F.M. Jenniskens, L.F.M. Beenen, R. van den Berg, P.J. Koudstaal, W.H. van Zwam, Y.B.W.E.M. Roos, A. van der Lugt, R.J. van Oostenbrugge, C.B.L.M. Majoie, and D.W.J. Dippel, for the MR CLEAN Investigators*
ABSTRACT
BACKGROUND
METHODS
RESULTS
CONCLUSIONS
JOURNAL of MEDICINE
thin 8 Hours after
n Ischemic Stroke
thrombectomy for the treatment of
-based stroke reperfusion registry.
nia, Spain, we randomly assigned
rs after the onset of symptoms of
therapy (including intravenous al-
with the Solitaire stent retriever
(control group). All patients had
n and the absence of a large in-
use of alteplase either did not
The primary outcome was the
d on the modified Rankin scale
hough the maximum planned
cause of loss of equipoise after
m other similar trials.
r the range of the modified
1 point, 1.7; 95% confidence
tional independence (a score
atio, 2.1; 95% CI, 1.1 to 4.0).
rhage were 1.9% in both the
), and rates of death were
ndicated that only eight pa-
de the trial at participating
be treated within 8 hours
ced the severity of post-
dependence. (Funded by
grant from Covidien and
9.)
d Assessment of Rapid
eatment of Ischemic Stroke
ctomy after Intravenous
one in Stroke
erapy for Ischemic Stroke
on-Imaging Selection
MR CLEAN
ESCAPE
EXTEND-IA
SWIFT PRIME
REVASCAT
THRACE
THERAPY

RCT récents



SWIFT-PRIME: Solitaire 100%
EXTEND-IA: Solitaire 100%
ESCAPE: Stentrievers 86%
REVASCAT: Solitaire 100%
MR CLEAN: Stentrievers 82%
IMS III: IA TPA 48% + MERCI 28%
MR RESCUE: MERCI 58%

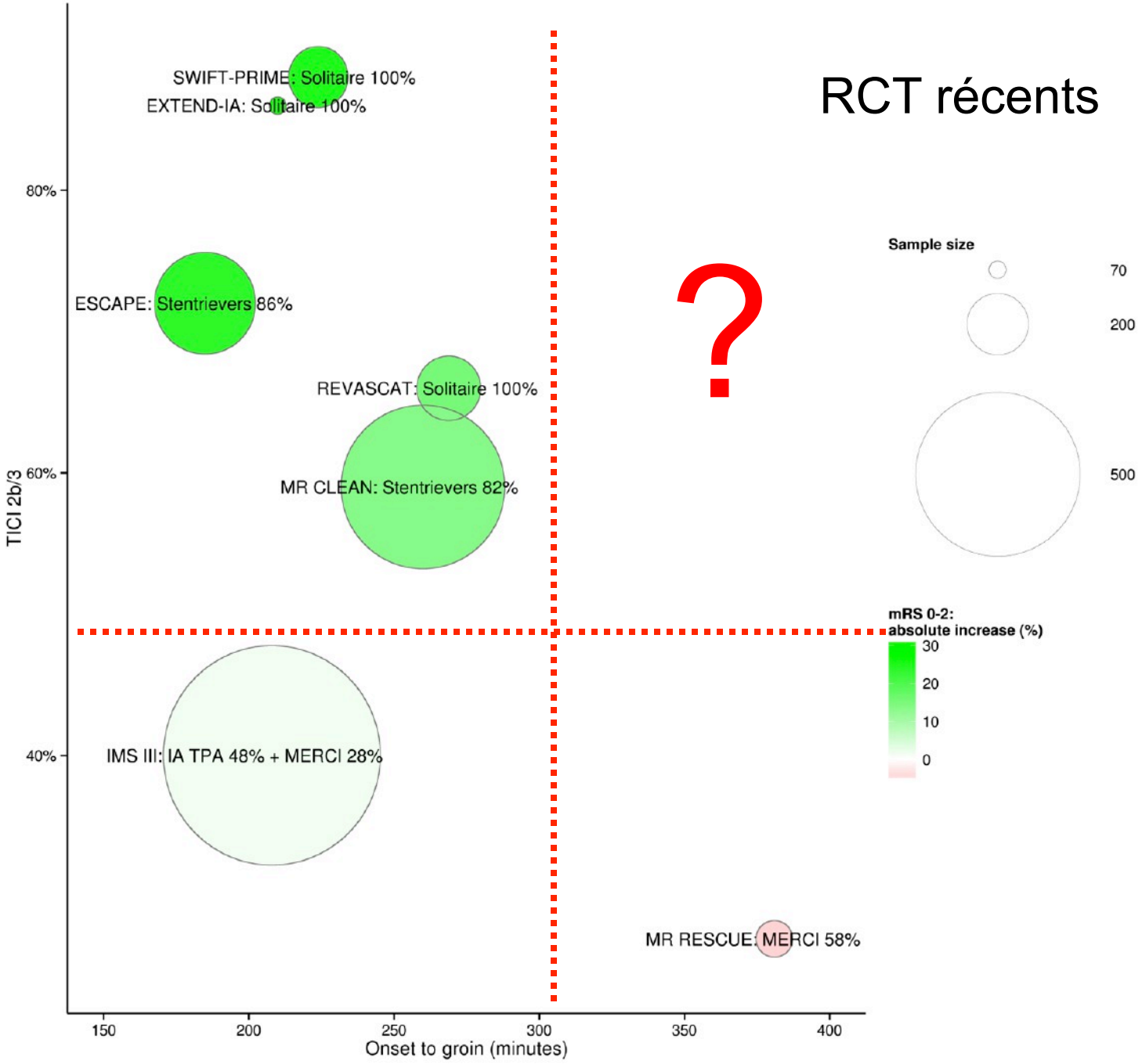
80%
60%
40%
TICI 2b/3

150
200
250
300
350
400
Onset to groin (minutes)

Sample size
70
200
500

mRS 0-2: absolute increase (%)
30
20
10
0

RCT récents


SWIFT-PRIME: Solitaire 100%
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MR CLEAN: Stentrievers 82%
IMS III: IA TPA 48% + MERCI 28%
MR RESCUE: MERCI 58%
?
Sample size
70
200
500
mRS 0-2:
absolute increase (%)
30
20
10
0
TICI 2b/3
80%
60%
40%
150
200
250
300
350
400
Onset to groin (minutes)

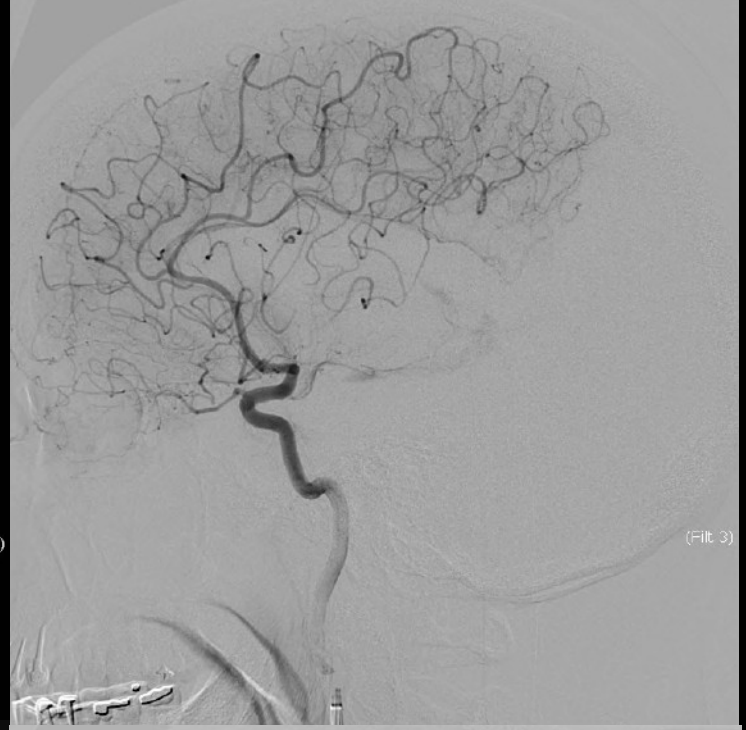
tional independence (modified Rankin scale

18.4% and 15.5%, respectively (P=0.60). Registry data indicated that only ei
tients who met the eligibility criteria were treated outside the trial at partic
hospitals.

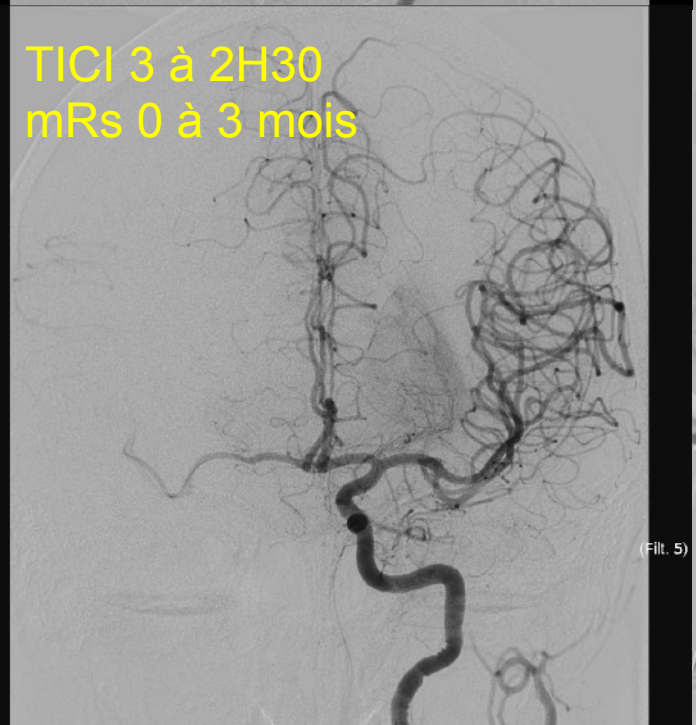
CONCLUSIONS

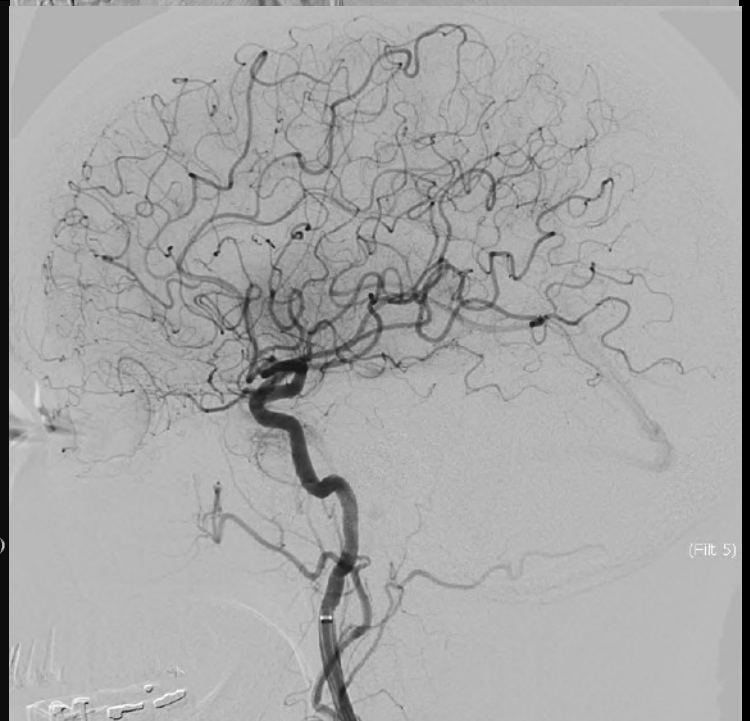
Among patients with anterior circulation stroke who could be treated within 8
after symptom onset, stent retriever thrombectomy reduced the severity o
stroke disability and increased the rate of functional independence. (Fun
Fundació Ictus Malaltia Vascular through an unrestricted grant from Covidi
others; REVASCAT ClinicalTrials.gov number, NCT01692379.)

Traitement IV + IA
Anesthesie locale



TICI 3 à 2H30
mRs 0 à 3 mois





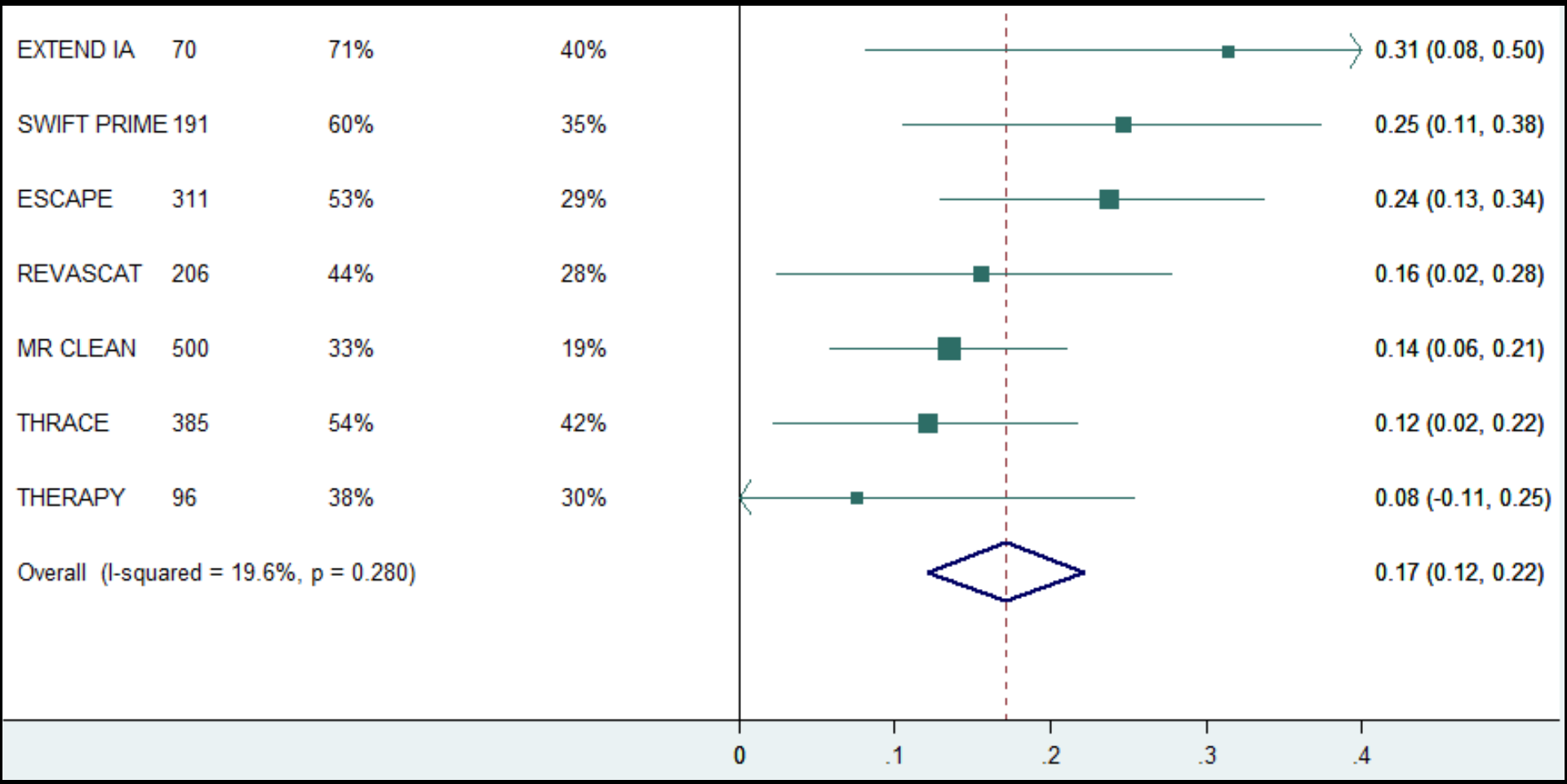
L’IRM a t’elle été indispensable pour cette thrombectomie ?

L’IRM a t’elle été indispensable pour cette thrombectomie ?

NON !

Ni pour poser l’indication
Ni pour aider à sa réalisation

	MR CLEAN	REVASCAT	ESCAPE	SWIFT-PRIME	EXTEND-IA
N	500 (16 centres)	206 (4 centres)	316 (22 centres)	196 (39 centres)	70 (14 centres)
Age	≥18	18-85	≥18	18-80	≥18
Img	TDM (IRM)	TDM (IRM)	TDM	TDM (IRM)	TDM
Occl.	ACI, M1, M2	ACI, M1 (M2) ASPECTS>6/5	ACI, M1, M2 ASPECTS>6 Collat.> 50%	ACI, M1 ASPECTS >5 (Mismatch perf)	ACI, M1, M2 Small core perf Mismatch perf
TTT	IA+BMT vs BMT (6h)	IA+BMT vs BMT (8h)	IA+BMT vs BMT (12h)	IV+IA vs IV	IV+IA vs IV
%TIV	87%/91%	68%/78%	73%/79%	100%/100%	100%/100%
DST/ R	IA : 4h20/5h32 IV : 1h27	IA: 4h29/5h55 IV: 1h15	IA : 2h57/4h01 IV : 1h50	IA : 3h44/≥4h12 IV : 1h53	IA : 3h30/4h08 IV : 2h07
AG	38%	7%	9%	37%	36%
Reprf/ Recan	IA+BMT : 59 % BMT(H24): 33%	IA+BMT:66% BMT:?	IA+BMT: 72% BMT(H24):31%	IV+IA(H27):88% IV (H27): 40%	IV+IA : 86% IV (H24) : 43%
mRs ≤2	IA+BMT=33 % BMT=19% OR aj = 2.2 **NNT = 7**	IA+BMT=44% BMT=28% OR aj = 2.1 **NNT = 6**	IA+BMT=53% BMT=29% OR naj = 2.6 **NNT = 4**	IV+IA=60% IV=35 % OR naj = 2,8 **NNT = 4**	IV+IA=71 % IV=40 % OR aj = 4.2 **NNT = 3**



mRS ≤2: Bénéfice absolu 17%; NNT=5,9 (4,5-8,3)

Chirurgie des sténoses carotides symptomatiques >70%, NNT=6

AHA/ASA Guideline

2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Recommandations en imagerie

Imaging

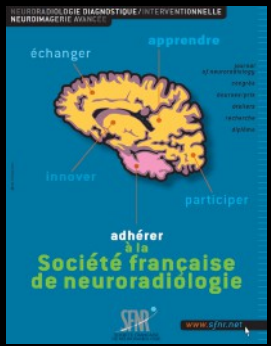
1. **Emergency imaging of the brain is recommended before any specific treatment for acute stroke is initiated *(Class I; Level of Evidence A)*. In most instances, nonenhanced CT will provide the necessary information to make decisions about emergency management.** (Unchanged from the 2013 guideline)
2. **If endovascular therapy is contemplated, a noninvasive intracranial vascular study is strongly recommended during the initial imaging evaluation of the acute stroke patient but should not delay intravenous r-tPA if indicated. For patients who qualify for intravenous r-tPA according to guidelines from professional medical societies, initiating intravenous r-tPA before noninvasive vascular imaging is recommended for patients who have not had noninvasive vascular imaging as part of their initial imaging assessment for stroke. Noninvasive intracranial vascular imaging should then be obtained as quickly as possible *(Class I; Level of Evidence A)*.** (New recommendation)

Stroke Oct 2015

IRM ?

Recommandations thérapeutiques

- La TM est recommandée à la phase aiguë dans le traitement de l'AVC jusqu'à 6 heures après le début des symptômes chez les patients qui présentent une occlusion proximale des artères cérébrales (carotide, cérébrale moyenne, tronc basilaire). (Grade A, Niveau 1a)
- La TM est réalisée en complément de la TIV lorsqu'elle est indiquée (4h30) ou d'emblée en cas de contre-indications à la TIV.
(Grade A, Niveau 1a)

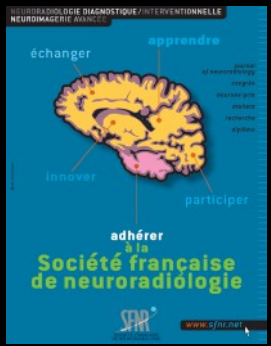


IRM ?

Recommandations thérapeutiques

Recommandations thérapeutiques

- La décision de réaliser une TM ne doit pas retarder la réalisation de la TIV. De même, la réalisation de la TIV ne doit pas retarder la TM (Grade A, Niveau 1a).
- La TM doit être réalisée le plus rapidement possible dès que son indication a été posée. (Grade A, Niveau 1a)
- La TM doit être réalisée avec des stents retrievers approuvés par les autorités de santé. (Grade A, Niveau 1a)

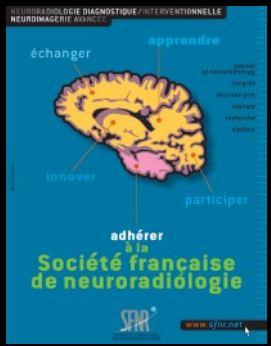


IRM ?

Recommandations sélection des patients

- L'occlusion vasculaire doit être diagnostiquée par une méthode non invasive en première intention avant d'envisager la phase thérapeutique par thrombectomie mécanique. (Grade A, Niveau 1a)

- L'âge élevé (> 80 ans) n'est pas à lui seul une contre-indication à la thrombectomie mécanique. (Grade A, Niveau 1a)



Ça tombe bien
L'IRM n'est pas réalisable dans le cadre de l'AVC hyper aigu

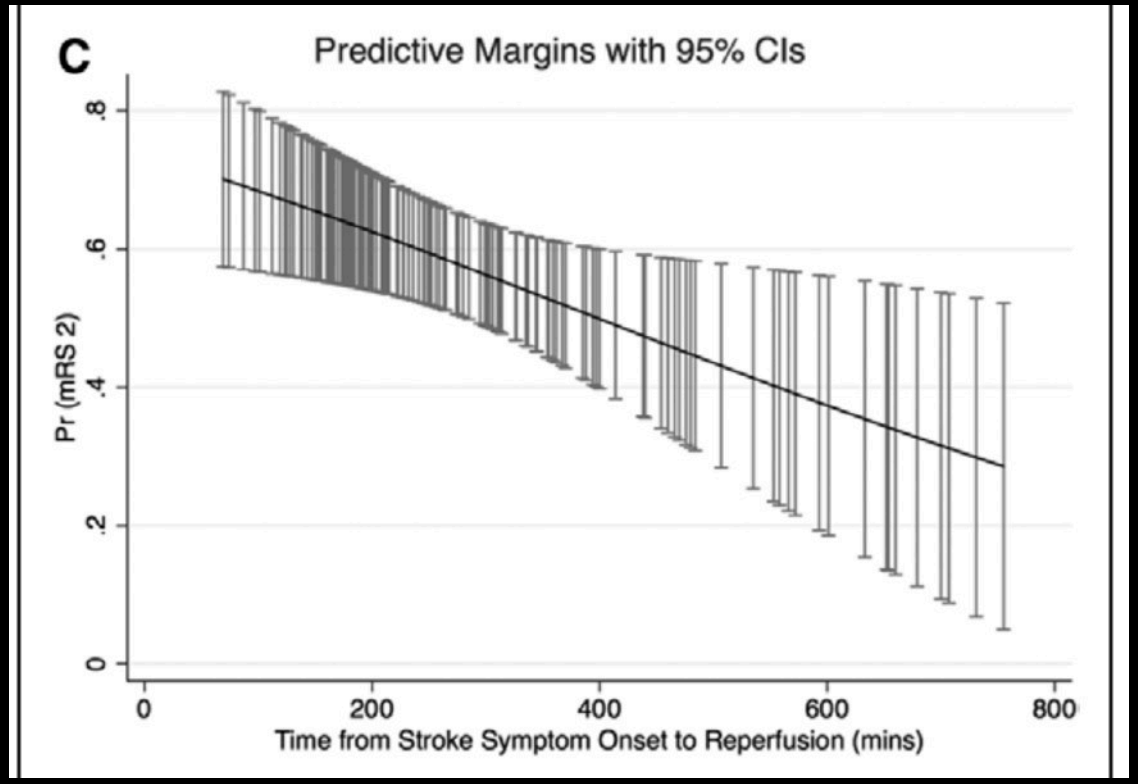
Pas assez rapide
Appareil non disponible, surchargé
Nombreuses contre-indications
Patients agités (négligents +++)

Stroke

Analysis of Workflow and Time to Treatment on Thrombectomy Outcome in the Endovascular Treatment for Small Core and Proximal Occlusion Ischemic Stroke (ESCAPE) Randomized, Controlled Trial

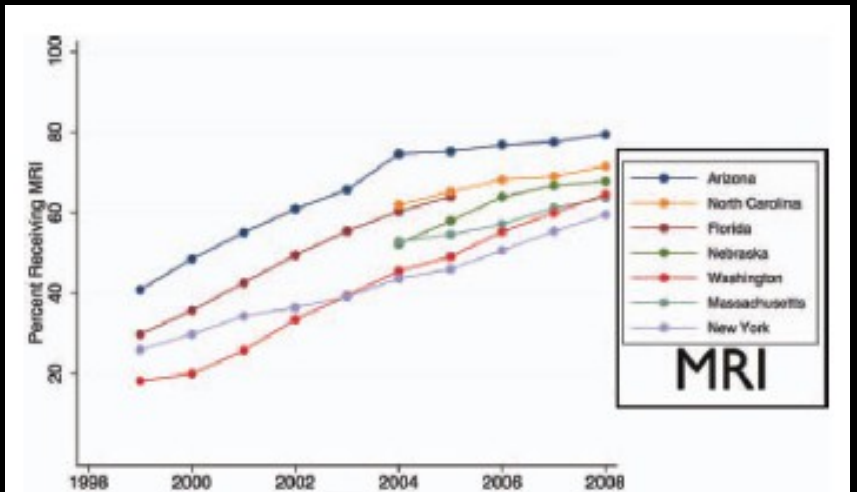
BK Menon et al. Circulation 2016

- 1% / 4 min.



Pourtant …
Etat des lieux aux US

- 624.000 patients
- IRM ↗
  - 1999 : 28% IRM
  - 2008 : 66% IRM
  - Variations géographiques
- Scanner stable
- Pas de substitution

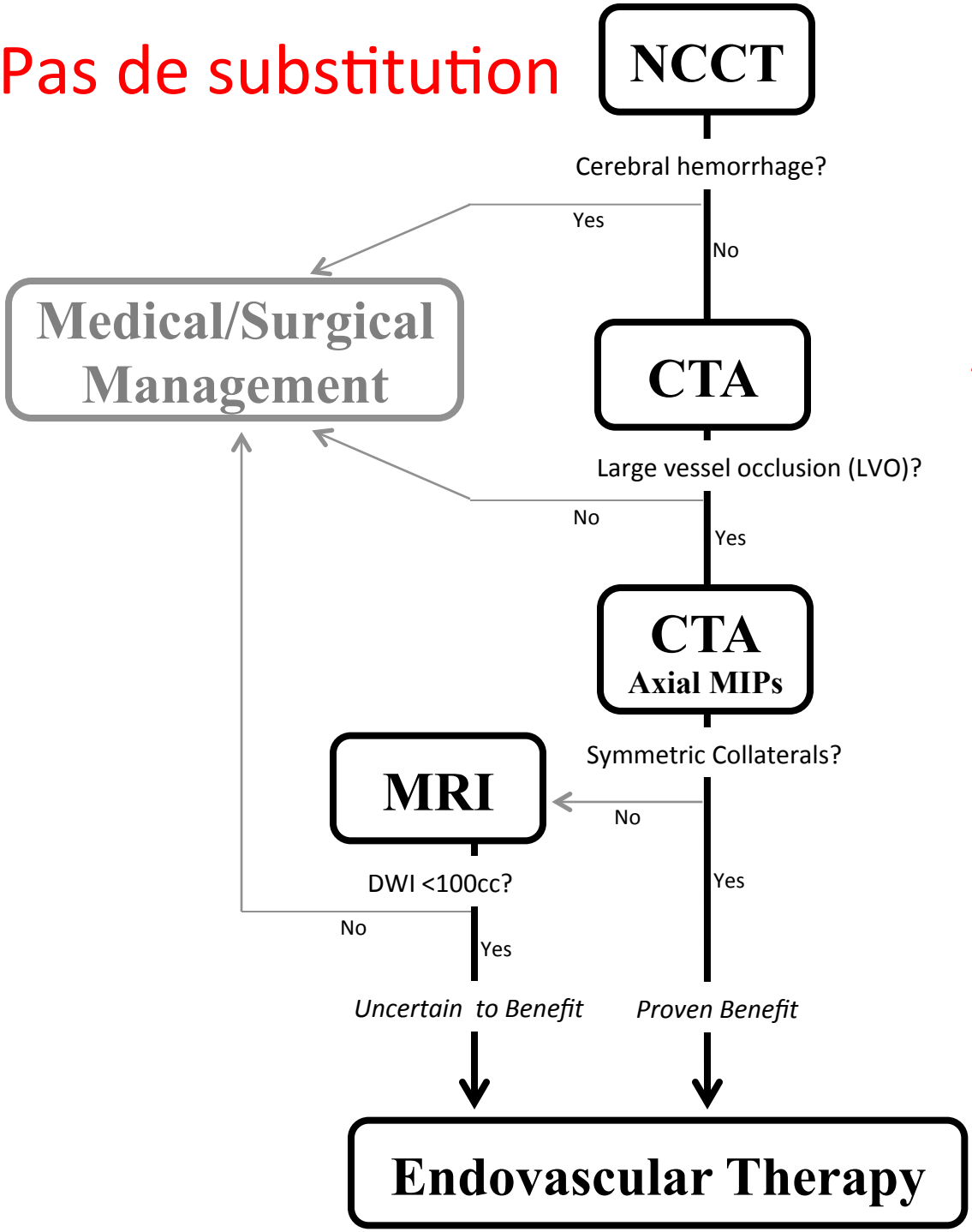


Hospital availability of MRI

Year	% of Hospitals with MRI access	% of Stroke Patients at Hospital with MRI access
1999	74%	89%
2000	77%	91%
2001	80%	93%
2002	83%	94%
2003	82%	94%
2004	83%	94%
2005	86%	95%
2006	83%	94%
2007	84%	94%
2008	87%	96%

Burke et al. Ann Neurol, 2012
Wide variation and rising utilization of stroke magnetic resonance imaging: data from 11 states

Pas de substitution



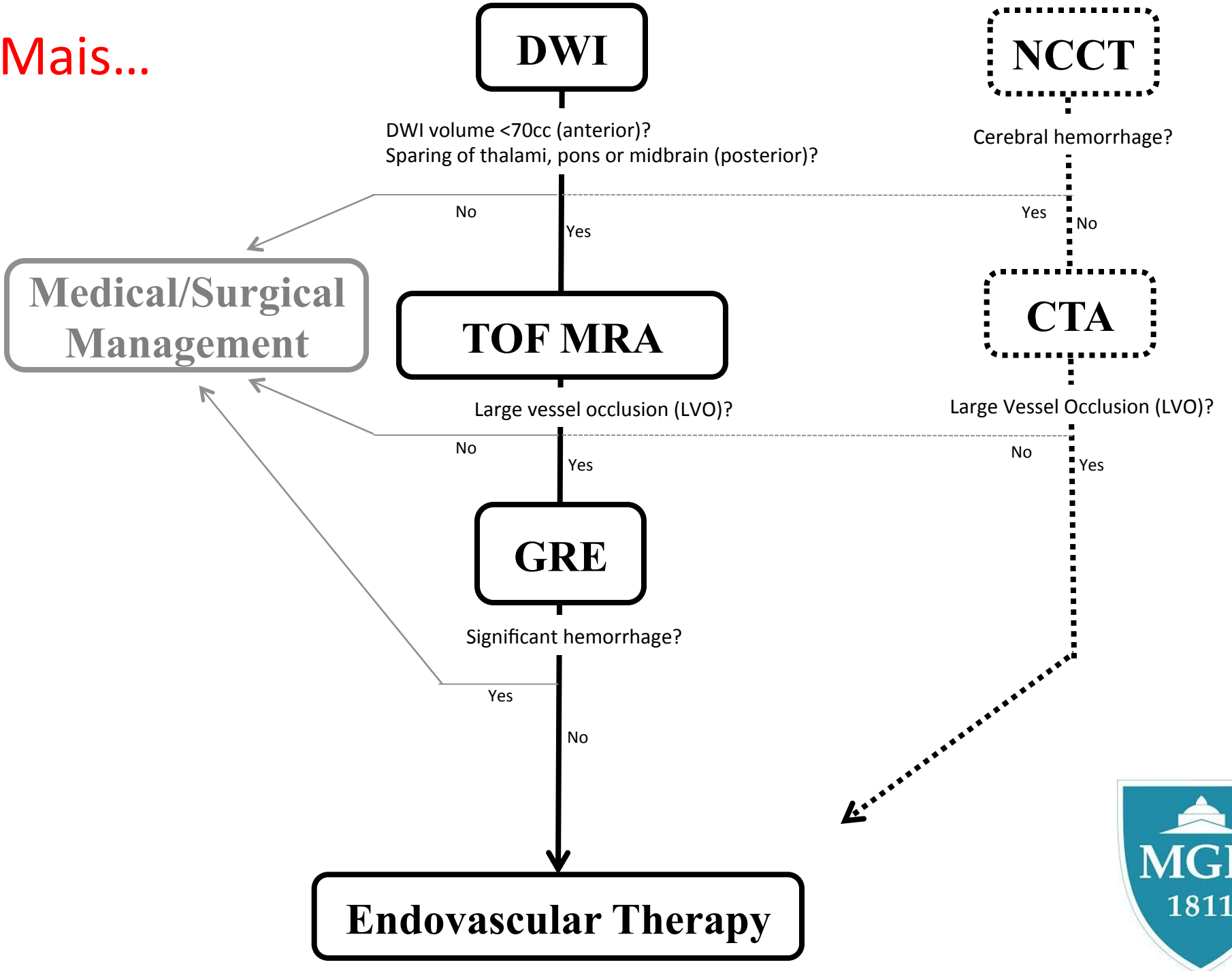
For patients with NIHSS ≥6:

Anterior Circulation

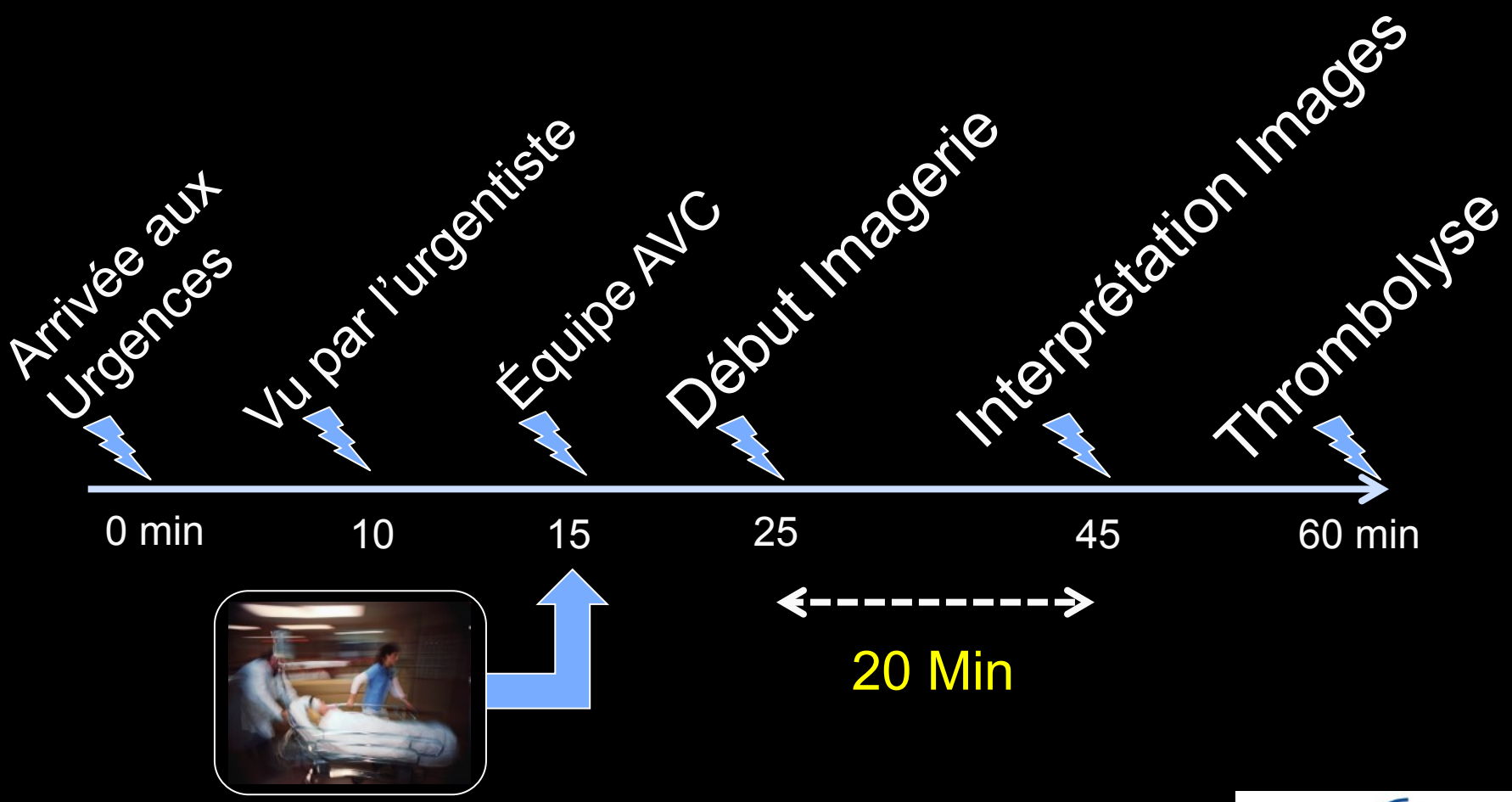
LSW <6hrs

MGH 1811

Mais…


DWI
DWI volume <70cc (anterior)?
Sparing of thalami, pons or midbrain (posterior)?
No
Yes
Medical/Surgical Management
TOF MRA
Large vessel occlusion (LVO)?
No
Yes
GRE
Significant hemorrhage?
Yes
No
Endovascular Therapy
NCCT
Cerebral hemorrhage?
Yes
No
CTA
Large Vessel Occlusion (LVO)?
No
Yes

Le respect des délais "recommandés" peut permettre la réalisation d'une IRM



http://www.ninds.nih.gov/news_and_events/proceedings/stroke_proceedings/recs-acute.htm / AHA 2013

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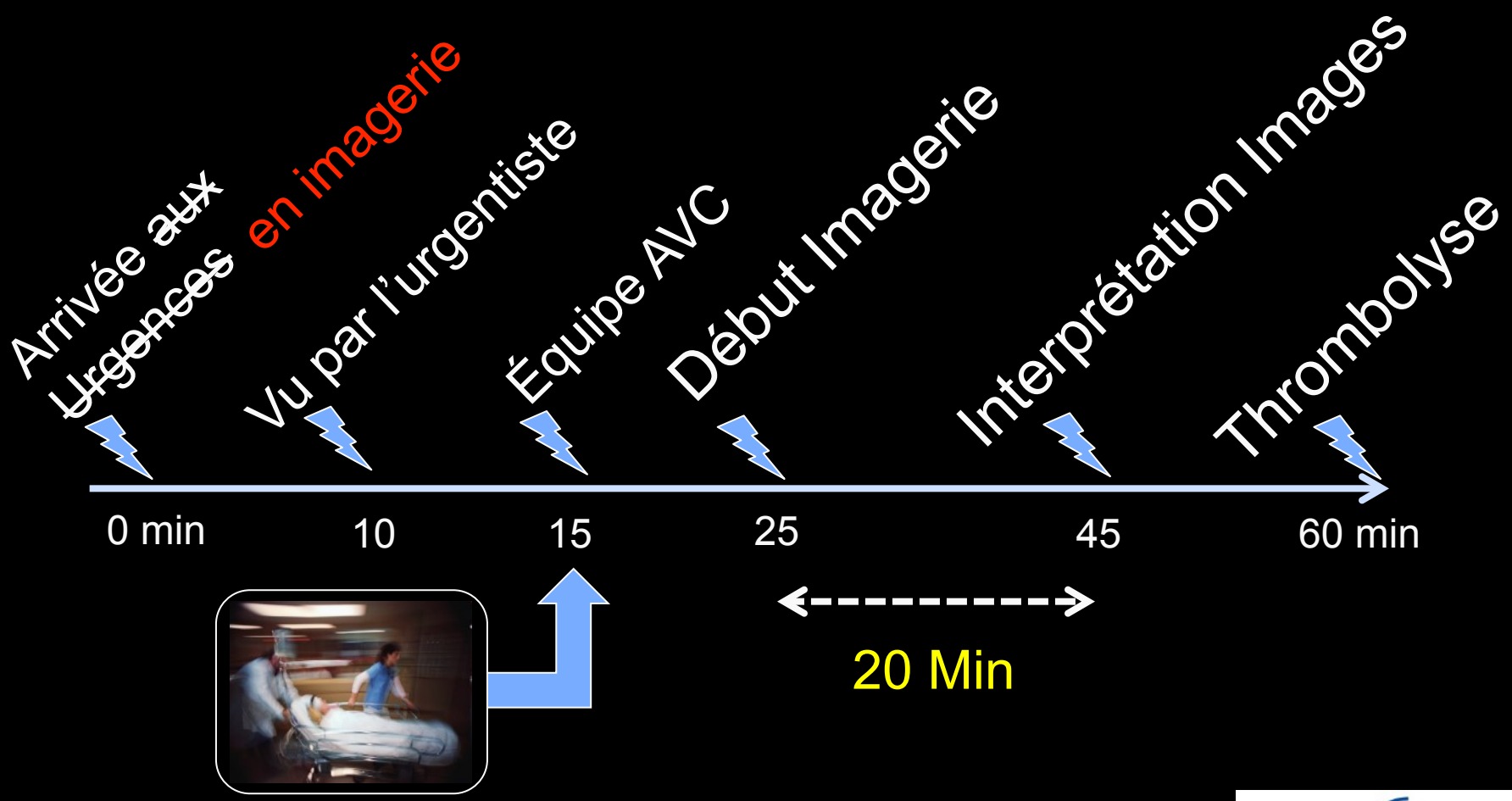
Le respect des délais "recommandés" peut permettre la réalisation d'une IRM



http://www.ninds.nih.gov/news_and_events/proceedings/stroke_proceedings/recs-acute.htm / AHA 2013

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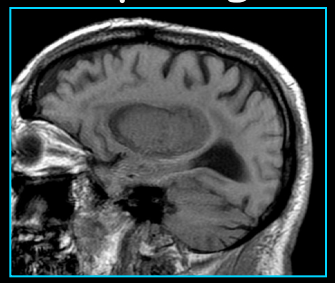
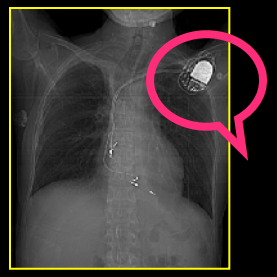
Repérage

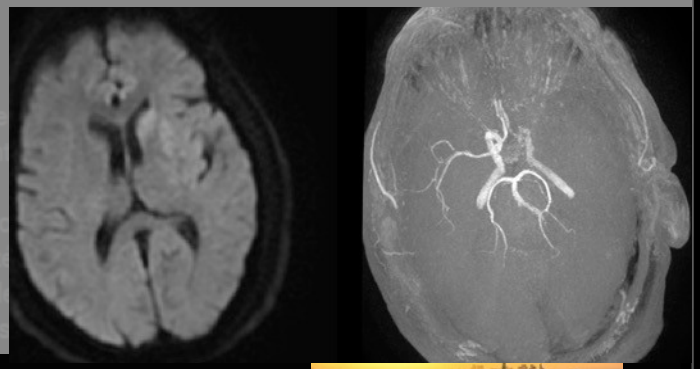


Mais

1. Recherche de CI
2. Calibration et Pré-scanning par séquence



INDICATIONS:
Déficit moteur de l'hémicorps droit. Mutisme. Début déficit ce jour à 7h50. IRM débuté à 9h13. Suspicion d'accident ischémique aigu. Score NIHSS avant l'irm = 15.
Fin de l'irm à 9h26
TECHNIQUE:
Acquisition de coupes sagittales T1, axiales flair, diffusion, angio-IRM trois D tof du polygone de Willis, séquences axiales T2*, séquence de perfusion.
RÉSULTATS:



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En pratique : 90% patients depuis 2003

IRM et AVC : faisabilité ?

Entrée dans l'IRM
→ Début IVT
30 minutes

Table 1. Patients' Characteristics

	Whole Sample, n=267	DWI<70 mL, n=213	DWI≥70 mL, n=54	*P* Value
$DWI_{baseline}$ volume, mL	21.6 [9.6–60.1]	15.8 [7.5–55.5]	118.3 [94.8–178.4]	<0.0001
Age, y	71 [59–75]	71 [58–82]	70 [60–79]	0.74
Medical history				
Hypertension, n (%)*	150 (57)	123 (58)	27 (50)	0.29
Diabetes mellitus, n (%)*	36 (14)	29 (14)	7 (13)	1
Hyperlipemia, n (%)*	98 (37)	79 (37)	19 (35)	0.88
Smoking, n (%)†	107 (40)	88 (42)	19 (35)	0.44
TIA, n (%)*	16 (6)	14 (7)	2 (4)	0.54
Stroke, n (%)*	19 (7)	15 (7)	4 (7)	1
Atrial fibrillation, n (%)†	71 (27)	57 (27)	14 (26)	1
Clinical measure				
Blood glucose, mmol/L†	6.4 [5.4–7.5]	6.3 [5.4–7.3]	6.7 [5.8–8.2]	0.08
Diastolic blood pressure, mm Hg†	80 [70–92]	80 [70–92]	81 [70–92]	0.86
Systolic blood pressure, mm Hg†	150 [132–169]	150 [130–166]	149 [133–169]	0.98
Baseline NIHSS	15 [9–20]	13 [8–18]	19 [15–22]	<0.0001
24-h NIHSS	11 [4–18]	8 [3–17]	16 [11–22]	<0.0001
Etiology				
Large-artery atherosclerosis, n (%)†	41 (15)	34 (16)	7 (13)	0.68
Small-vessel occlusion, n (%)†	0	0	0	
Cardioembolism, n (%)†	138 (53)	113 (54)	25 (47)	0.36
Other determined, n (%)†	14 (5)	12 (6)	2 (4)	0.74
Undetermined, n (%)†	67 (26)	50 (24)	17 (32)	0.29
Time to MRI, min	116 [86–151]	113 [85–148]	130 [90–173]	0.05
Time to IVT, min	152 [120–185]	150 [120–180]	168 [134–202]	0.02

Tisserand et al.
Stroke. 2016;47:1005- 1011

IRM et AVC : faisabilité ?

- Protocole encore plus rapide (8 min → 6 min)
  - Acquisition EPI

Six-Minute Magnetic Resonance Imaging Protocol for Evaluation of Acute Ischemic Stroke

Pushing the Boundaries

Kambiz Nael, MD; Rihan Khan, MD; Gagandeep Choudhary, MD; Arash Meshksar, MD; Pablo Villablanca, MD; Jennifer Tay, MD; Kendra Drake, MD; Bruce M. Coull, MD; Chelsea S. Kidwell, MD

Background and Purpose—If magnetic resonance imaging (MRI) is to compete with computed tomography for evaluation of patients with acute ischemic stroke, there is a need for further improvements in acquisition speed.

Methods—Inclusion criteria for this prospective, single institutional study were symptoms of acute ischemic stroke within 24 hours onset, National Institutes of Health Stroke Scale ≥3, and absence of MRI contraindications. A combination of echo-planar imaging (EPI) and a parallel acquisition technique were used on a 3T magnetic resonance (MR) scanner to accelerate the acquisition time. Image analysis was performed independently by 2 neuroradiologists.

Results—A total of 62 patients met inclusion criteria. A repeat MRI scan was performed in 22 patients resulting in a total of 84 MRIs available for analysis. Diagnostic image quality was achieved in 100% of diffusion-weighted imaging, 100% EPI-fluid attenuation inversion recovery imaging, 98% EPI-gradient recalled echo, 90% neck MR angiography and 96% of brain MR angiography, and 94% of dynamic susceptibility contrast perfusion scans with interobserver agreements (k) ranging from 0.64 to 0.84. Fifty-nine patients (95%) had acute infarction. There was good interobserver agreement for EPI-fluid attenuation inversion recovery imaging findings (k=0.78; 95% confidence interval, 0.66–0.87) and for detection of mismatch classification using dynamic susceptibility contrast-Tmax (k=0.92; 95% confidence interval, 0.87–0.94). Thirteen acute intracranial hemorrhages were detected on EPI-gradient recalled echo by both observers. A total of 68 and 72 segmental arterial stenoses were detected on contrast-enhanced MR angiography of the neck and brain with k=0.93, 95% confidence interval, 0.84 to 0.96 and 0.87, 95% confidence interval, 0.80 to 0.90, respectively.

Conclusions—A 6-minute multimodal MR protocol with good diagnostic quality is feasible for the evaluation of patients with acute ischemic stroke and can result in significant reduction in scan time rivaling that of the multimodal computed tomographic protocol. (***Stroke*. 2014;45:1985-1991.)**

Key Words: magnetic resonance angiography ■ magnetic resonance imaging ■ perfusion imaging ■ stroke

IRM et AVC : faisabilité ?

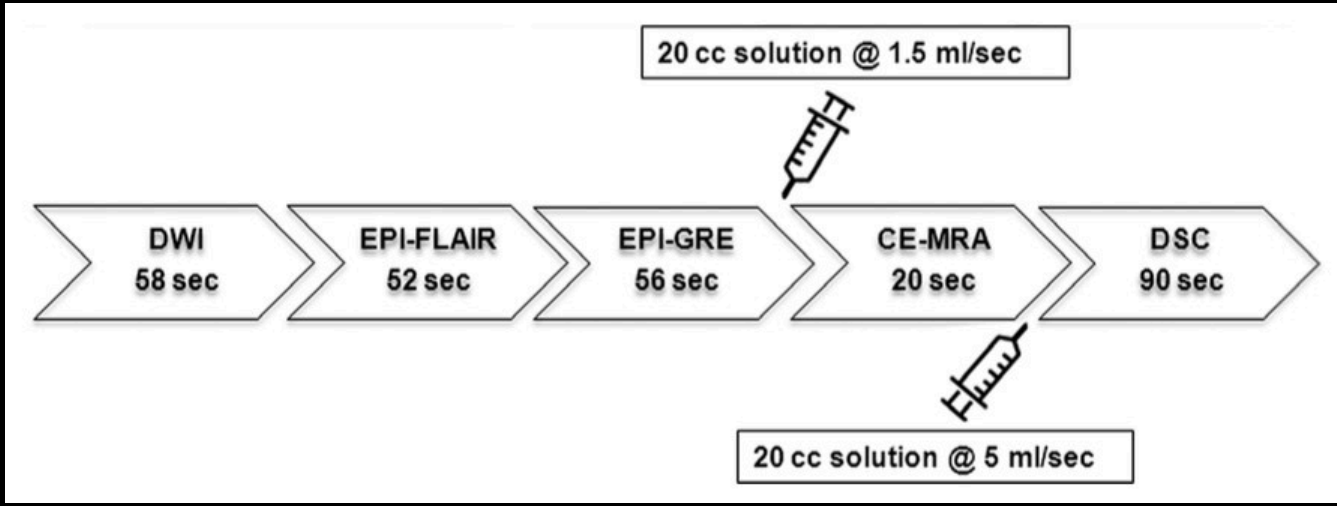


Table 1. MR Imaging Protocol and Sequence Parameters

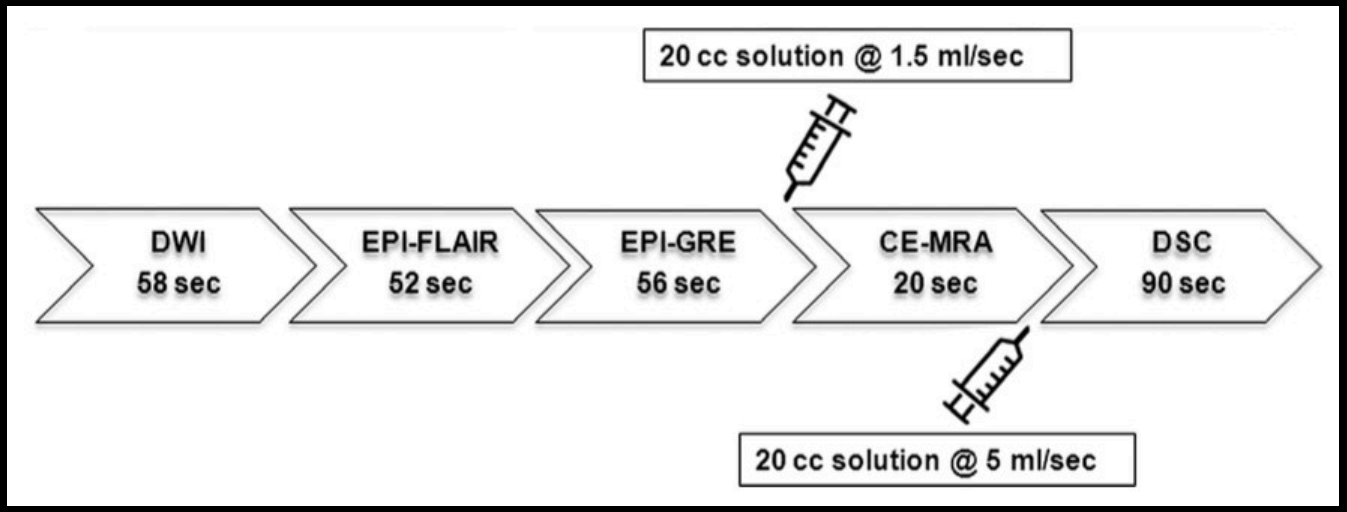
	DWI	EPI-FLAIR	EPI-GRE	CE-MRA	DSC
TR/TE, ms	4600/65	10000/82	1860/48	3.3/1.2	1450/22
FA, °	90	90	90	25	90
Matrix, mm	160	128	192	448	128
FOV, mm	220	220	220	340	220
Slices (n×thickness), mm	30×4	30×4	40×3	120×0.8	30×4
GRAPPA	3	3	3	4	3
Acquisition time, s	58	52	56	22	90

CE-MRA indicates contrast-enhanced magnetic resonance angiography; DSC, dynamic susceptibility contrast perfusion; DWI, diffusion-weighted imaging; EPI, echo-planar imaging; FA, flip angle; FLAIR, fluid attenuation inversion recovery imaging; FOV, field-of-view; GRAPPA, generalized autocalibrating partially parallel acquisition; GRE, gradient recalled echo; MR, magnetic resonance; TE, echo-time; Tmax, time-to-maximum; and TR, repetition time.

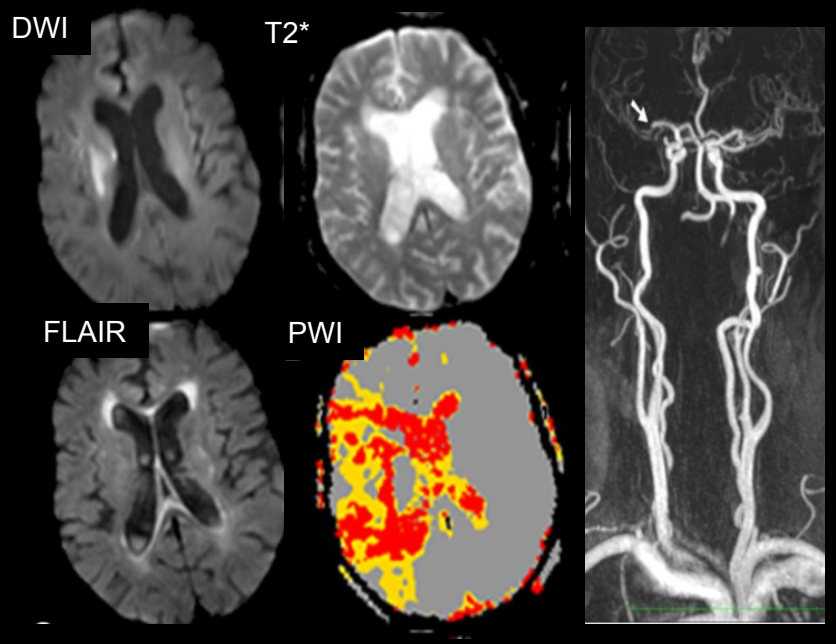
Nael et al. Stroke. 2014

3.0T (Siemens Skyra)

IRM et AVC : faisabilité ?



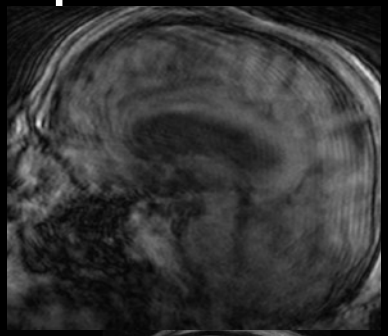
Patiente de 90 ans
NIHSS = 8
Onset to MRI= 70’

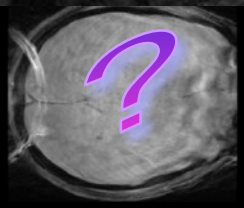


Nael et al. Stroke. 2014

IRM et AVC : faisabilité ?

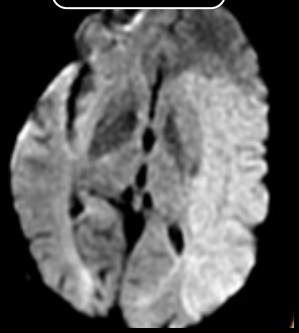
Acquisition EPI



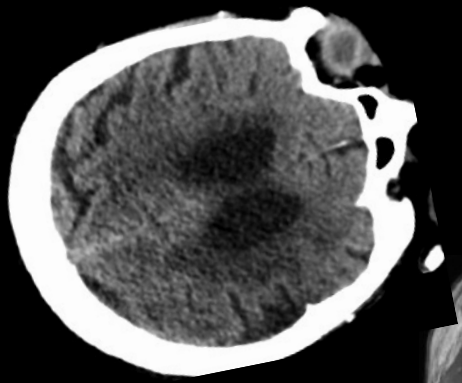


FLAIR

15 sec

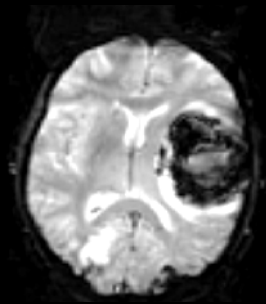


EPI-FLAIR

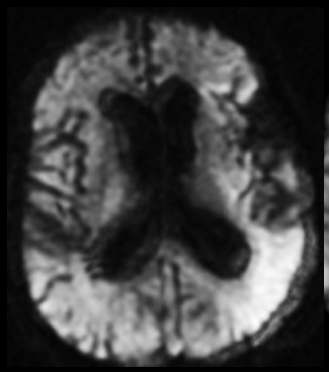


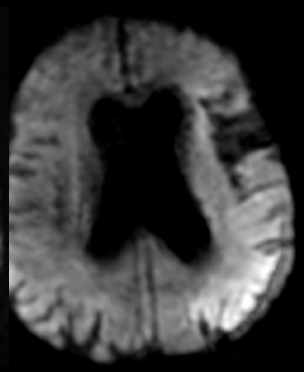
Patient agité < 5 min

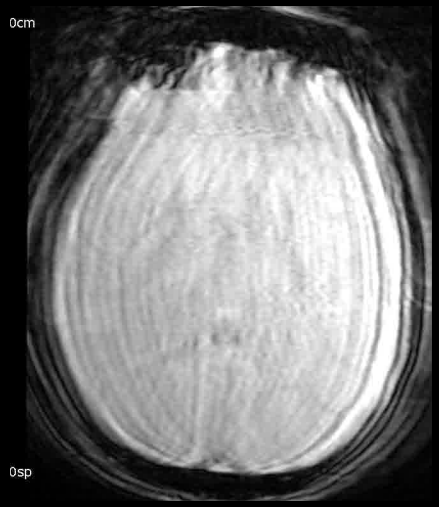
ARM



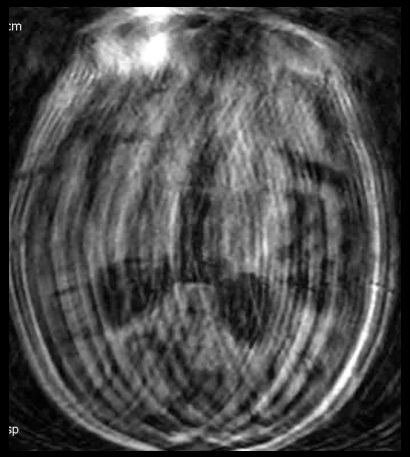
T2*< 10 sec





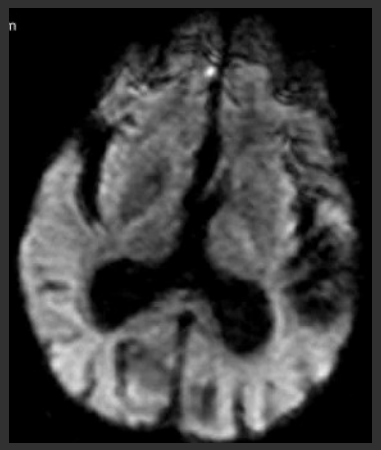


T2* classique

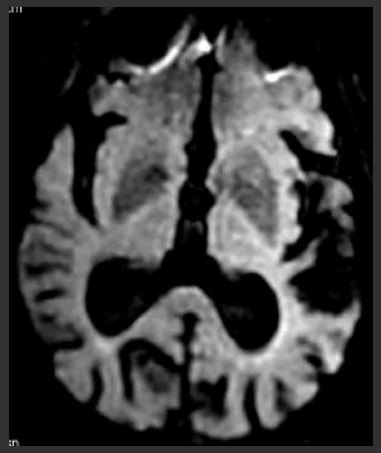


FLAIR

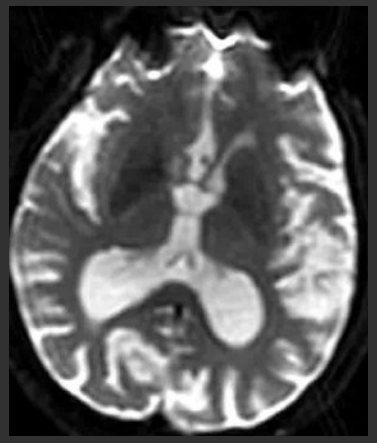
Attention : DWI et FLAIR se ressemblent !!!!



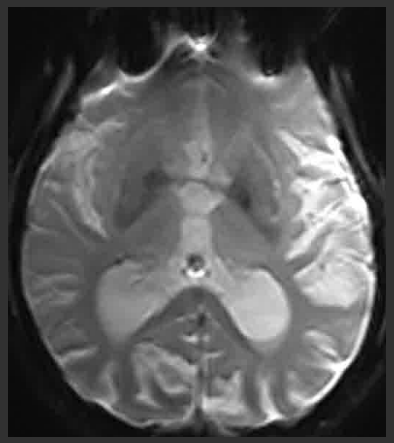
Diffusion



FLAIR



b0



T2*

ECHO PLANAR

IRM et AVC : faisabilité ?

- Protocole rapide → Ne pas retarder le traitement
  - « door to needle time »
    - IRM vs TDM = 87 / 68 minutes (médiane)[1]
    - Outcome équivalent
    - 25% DTNT <60'

MRI Screening Before Standard Tissue Plasminogen Activator Therapy Is Feasible and Safe

Dong-Wha Kang, MD, PhD; Julio A. Chalela, MD; William Dunn, MD; Steven Warach, MD, PhD; NIH-Suburban Stroke Center Investigators

Background and Purpose—MRI screening for thrombolytic therapy may improve patient selection. Alternatively, it may excessively delay treatment and thereby lead to worse outcomes. We hypothesized that times to treatment and outcomes in a stroke center with immediate MRI access and interpretation would not differ from those of the typical clinical practice.

Methods—We compared the results of 120 consecutive patients treated with intravenous tissue plasminogen activator (tPA) within 3 hours of onset at our center with those of the 2 largest multicenter registries of tPA use.[5,6] In addition to standard criteria, MRI specific eligibility criteria were applied in 97 patients. MRI was not performed in 23 patients because of contraindications to MRI or late patient arrival (>2.5 hours). Outcomes were the modified Rankin Scale (mRS) obtained at 3 months.

Results—Times to treatment (median door-to-needle time 81.5 minutes; median onset-to-needle time 135 minutes) and outcomes (mRS 0 to 1, 40.8%; mRS 0 to 2, 47.5%) were not inferior to those of the typical clinical practice. Door-to-needle time was shorter in computed tomography (CT) screening (67.5±22.5 minutes; n=23) than in MRI screening (86.8±21.5 minutes; n=97; $P<0.001$). However, outcomes were not different between MRI screening (mRS 0 to 1, 42.3%; mRS 0 to 2, 49.5%) and CT screening (mRS 0 to 1, 34.8%; mRS 0 to 2, 39.1%). Neither times to treatment nor MRI screening was predictive of outcomes.

Conclusion—These data demonstrate that MRI screening before tPA therapy is feasible and not associated with unacceptable times to treatment or outcomes. (***Stroke*. 2005;36:1939-1943.**)

[1] Kang DW et al. Stroke 2005

DTNT < 60 min et IRM : faisabilité ?

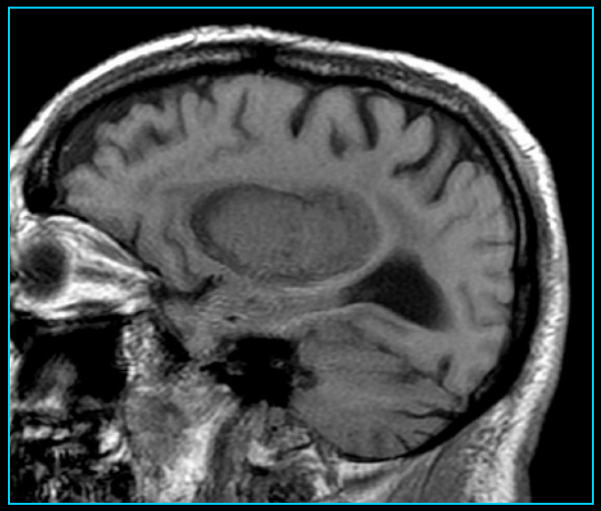
Table 2 Changes in SMART metrics with the QI process

Characteristic	1st half of 2012	2nd half of 2012	1st half of 2013	2nd half of 2013	*p* Value
No. of patients treated with IV tPA (% of patients evaluated)	23 (9)	27 (12.2)	46 (16.0)	39 (12.8)	0.11
Patients with DTN time ≤60 min, %	13.0	11.1	28.2	61.5	0.00001[a]
Door-to-stroke team paging time, min[b]	6 (3-18)	12 (7-21.5)	6 (5-11)	3 (0-8.5)	0.001[a]
Door-to-MRI start time, min[b]	49 (39-61.5)	52 (40.5-60)	44 (31.2-57)	24 (16.5-37)	<0.0001[a]
MRI-to-needle time, min[b]	40 (29.5-52.5)	31 (23.5-39)	33.5 (21.7-40.7)	30.5 (25-38)	0.13
Door-to-needle time, min[b]	93 (77-103)	82 (71-92.5)	71 (58-92)	55 (46.5-76.5)	<0.0001[a]
Last seen normal-to-needle time, min[b]	166 (150-195.5)	160 (114-219)	141.5 (109.7-191.7)	140 (96-201)	0.18

Abbreviations: DTN = door-to-needle; QI = quality improvement; SMART = Screening with MRI for Accurate and Rapid Stroke Treatment; tPA = tissue plasminogen activator.
[a] Statistically significant.
[b] Reported as median (interquartile ratio 25–75).

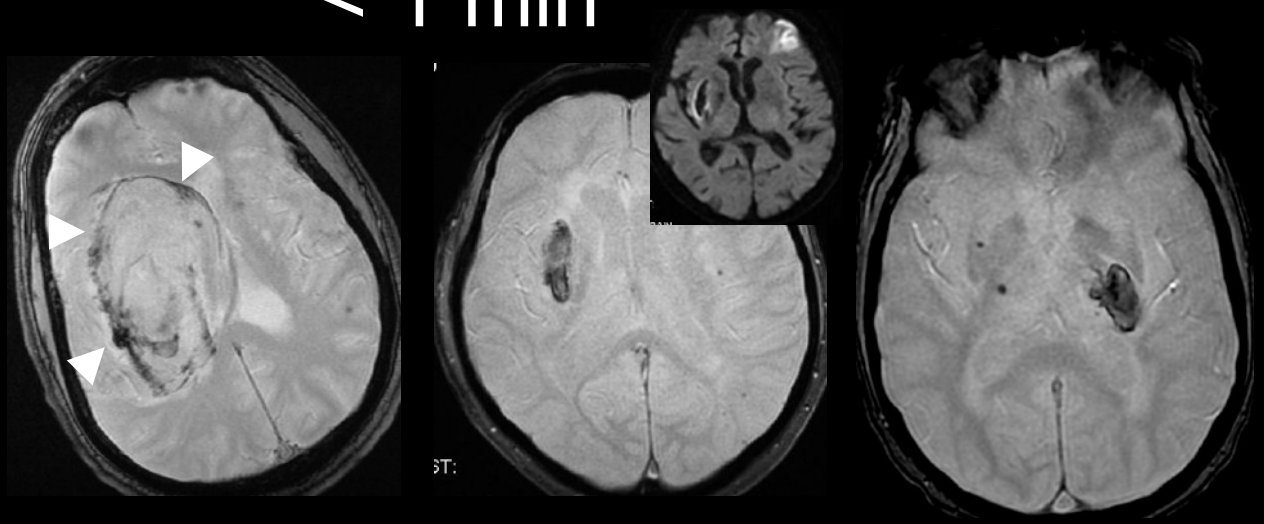
Shah et al. Neurology 2015 SMART study

IRM en 1ère intention: pourquoi tant d'efforts ?

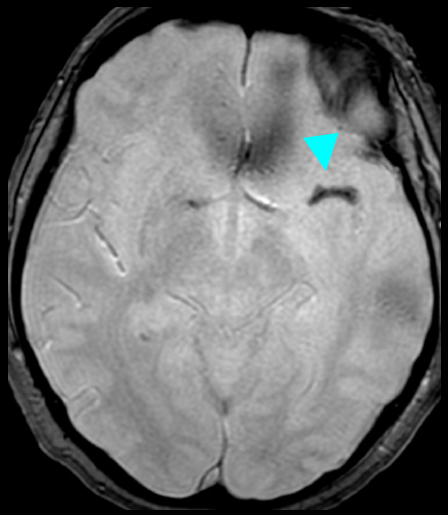


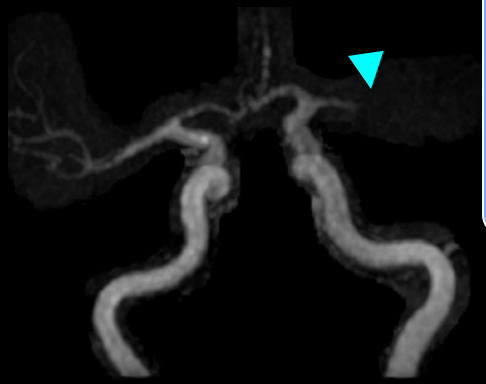
Éliminer une hémorragie

< 1 min

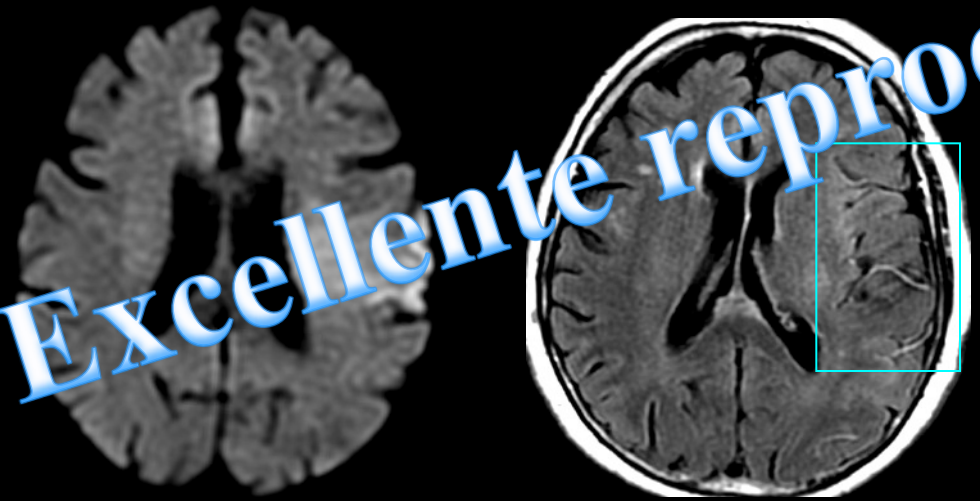


Kidwell et al. JAMA. 2004 Fiebach et al. Stroke 2004
Silvera et al. AJNR 2005 Oppenheim et al. Cerebrovasc Dis. 2005;
Brazelli et al. BMJ, 2009 . Copenhaver Neurology 2009





Confirmer l'ischemie

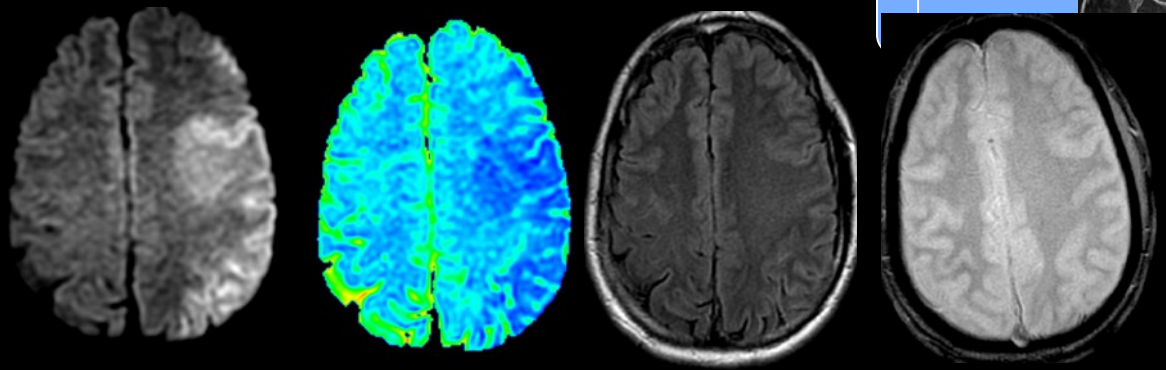


Excellente reproducibilité !

1. Brazelli et al. BMJ 2009
2. Schellinger et al. Neurology 2010

Stroke mimics

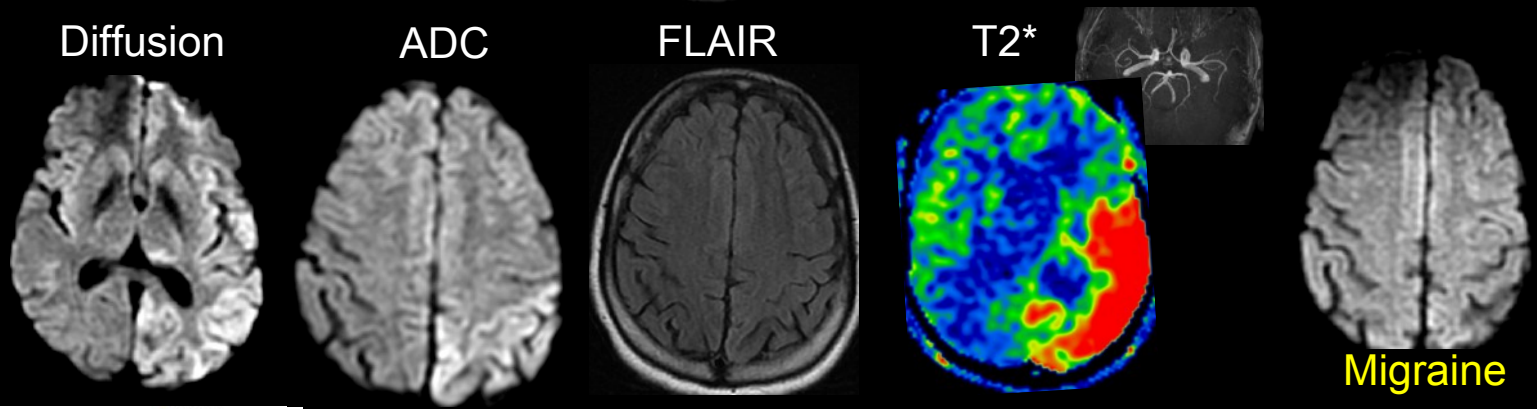
Cas 1



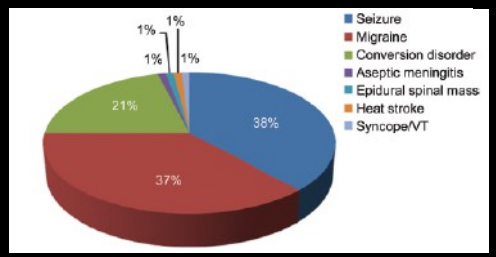
Ischemie

Diffusion ADC FLAIR T2*

Cas 2



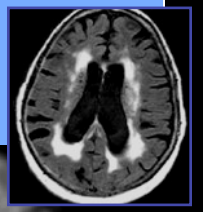
Migraine

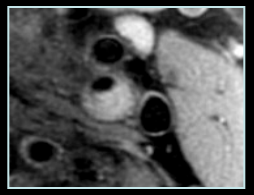


- 512 patients traités sur scanner
- 14% stroke mimics !

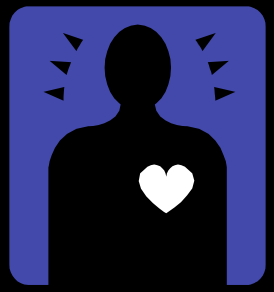
Chernyshev, et al. Neurology 2010

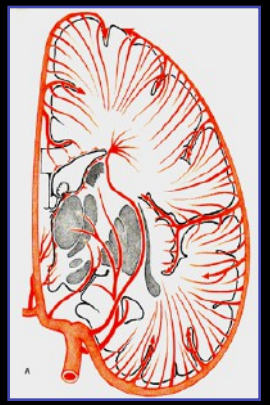
Étiologie





Intra plaque
hemorrhagie





Braemswig et al.
Stroke 2013

IRM en 1ère intention: pourquoi tant d'efforts ?

- 80-85% patients [1-5], Sainte Anne 90%
- Diminue la mortalité et augmente les patients mRs ≤1 [6, 7]
- Meilleure sélection
- Rapport coût-efficacité positif [7]

Lancet Neurol 2006; 5: 661–67

	CT-based (n=209)	MRI-based (all) (n=173)	p
sICH	19 (9%)	5 (3%)	0·01†
Favourable outcome at 90 days	79 (38%)	63 (36%)	0·78†
Independence at 90 days	100 (48%)	91 (53%)	0·35†
Death at 90 days	44 (21%)	21 (12%)	0·021†

*Kruskal-Wallis test; † Pearsons χ^2 test. Results can be more than 100% due to rounding

Table 3: Comparison of main safety and outcome events between CT-based and MRI-based treated patients

[1] Kang 2005; [2] Albers 2000; [3] Hill 2005 [4] Hand 2005; [5] Singer 2005; [6] Korhmann 2006; [7] Earnshaw 2009

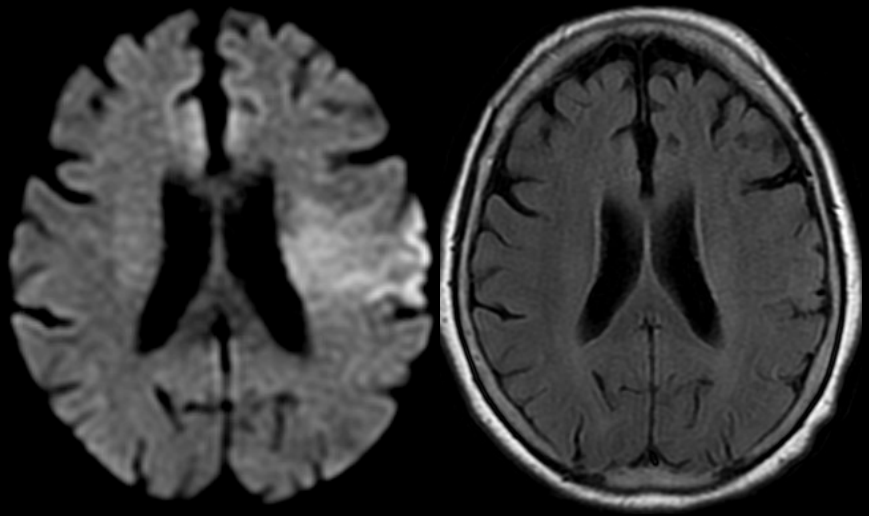
Pourquoi tant d'efforts ?

10% de patients AVC ont un traitement de recanalisation

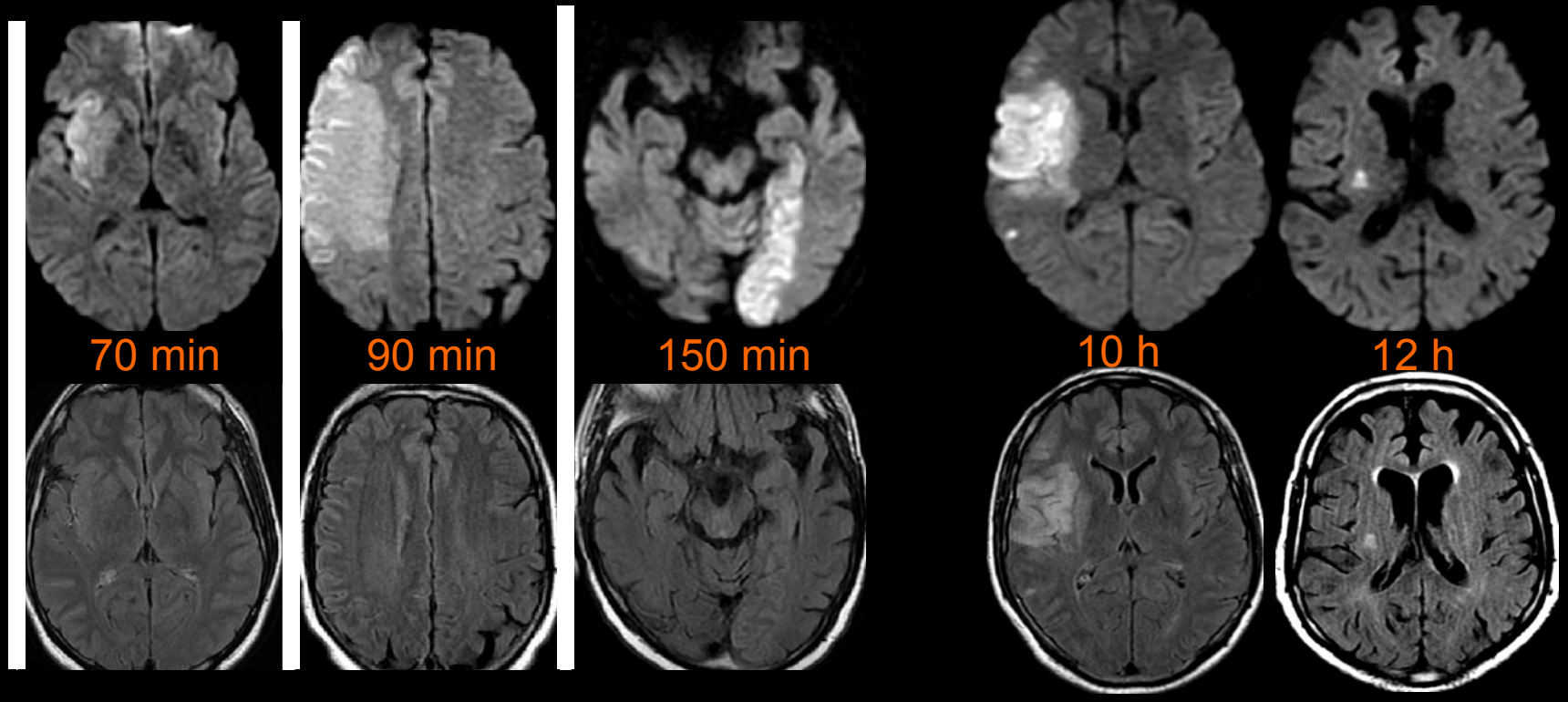
L'IRM en 1ère intention peut permettre d'augmenter ce %

L'IRM permet de dater

- 16-28% des AVC d'horaire inconnus
- Des patients bénéficient de la recanalisation
- Mismatch FLAIR-Diffusion
- RCT en cours [9, 10]



1. Fink, Stroke 2002 2. Serena, CVD 2003 3. Todo CVD 2006 ; 4. Barreto Stroke 2009; 5. Mackey et al. 6. Neurology 2011. Huisa et al. J Stroke Cereb Vasc Dis 2013; 7. Kim Stroke 2014; 8. Petkova et al. Radiology 2010. 8.Thomalla et al. Int J Stroke 2013. 9. MR witness. – 10. Wake up Stroke



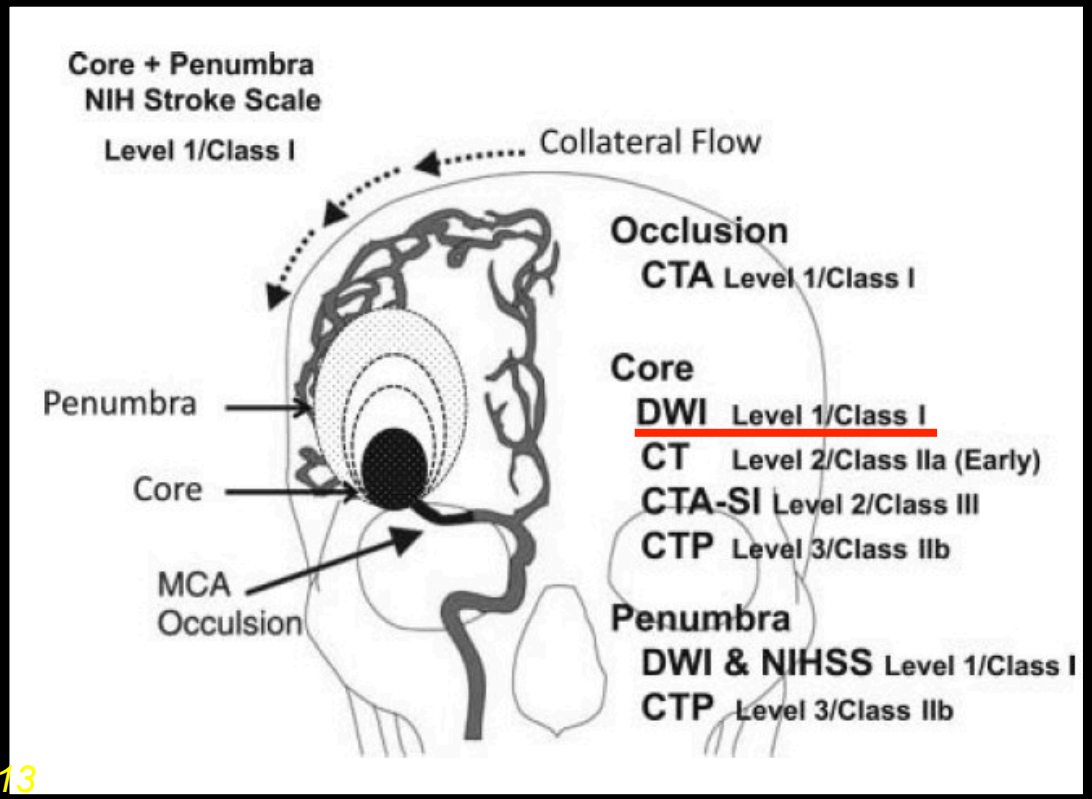
L'IRM est indispensable

1. Petkova et al. Radiology 2011.

2. Thomalla et al. Lancet Neurol 2011.

IRM en 1ère intention, c'est

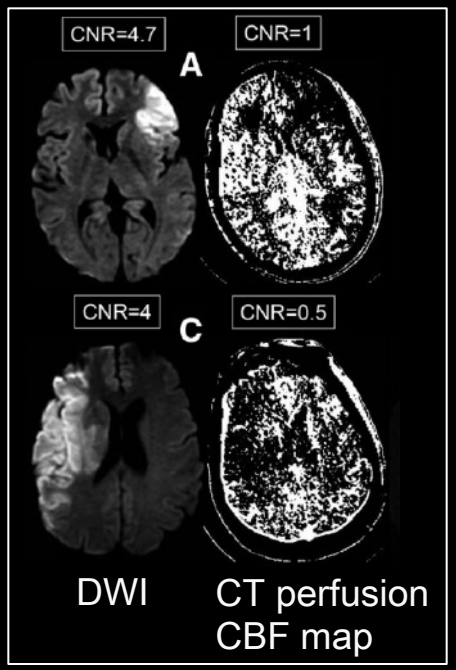
- Définir simplement le volume de l'infarctus
- Définir la pénombre ischémique - la collatéralité
- Visualiser le thrombus



Gonzalez RG et al. J NeuroIntervent Surg 2013

Volume de l'infarctus

- Information directe en DWI
- Indirecte en CT Perfusion
  - Sous estimée en CBV
  - Meilleur en CBF
- Faible rapport S/B et C/B sur les cartes de CT Perfusion*
- DWI volume > 70 mL correspond à un volume en CT-CBF de 10.7 … à 124.1 mL

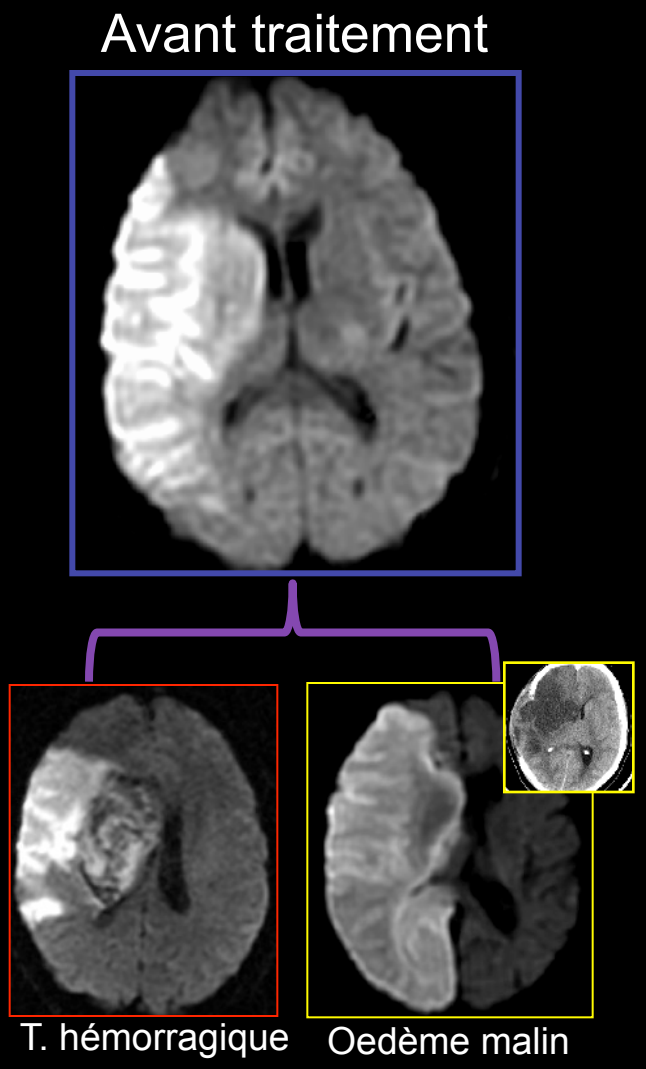


* "Depends on collateral circulation, contrast amount, cardiac output, quality and intensity of the x-ray beam, CTP reconstruction algorithm"

Schaefer P et al. Stroke 2015

Volume de l'infarctus cérébral avant traitement : intérêt ?

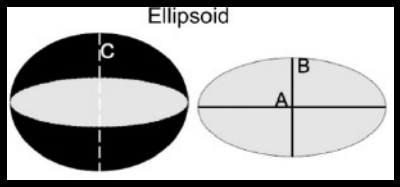
- Prédictif de la réponse au traitement
  - "Target" mismatch (< 70 mL)
  - Complications précoces
    - Transformation hémorragique >100 mL
    - Oedème "malin" : > 145 mL
  - Pronostic à 3 mois



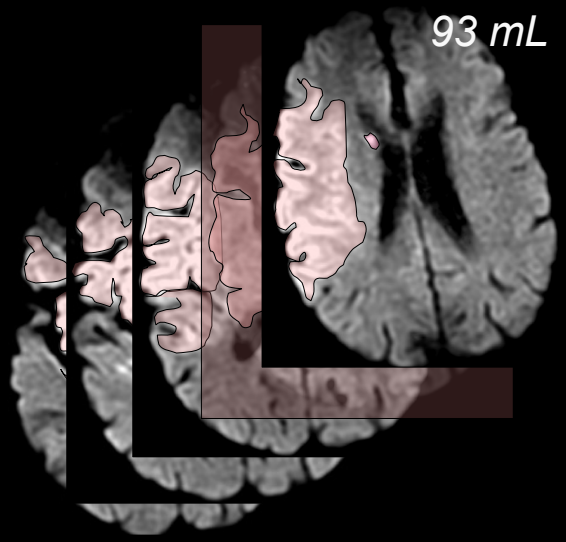
1. Parsons et al. J Cereb Blood Flow Metab. 2010; 2. Mlynash et al. Stroke 2011; 3. Davis et al. Lancet Neurol 2008; 4. Lansberg et al. Lancet Neurol 2012; 5. Oppenheim et al. Stroke 2000
2. Olivot et al. Stroke 2009. Takasawa et al. Stroke 2008;
3. Christensen et al. Stroke 2010; Lansberg et al. Lancet Neurol 2012

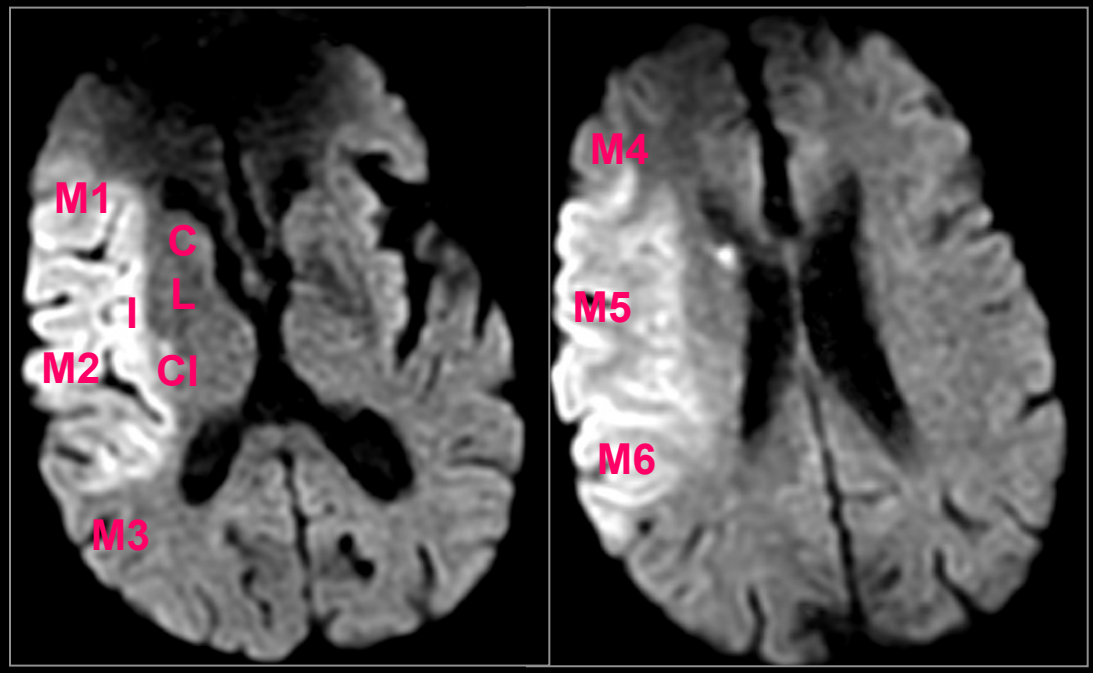
Volume de l'infarctus cérébral

*Exclusion criteria**
DWI > 1/3 ACM
$Volume_{DWI}$ ABC/2 > 100 mL
ASPECTS < 7, < 6 en IRM (ou CT)



Sims et al. Neurology. 2009





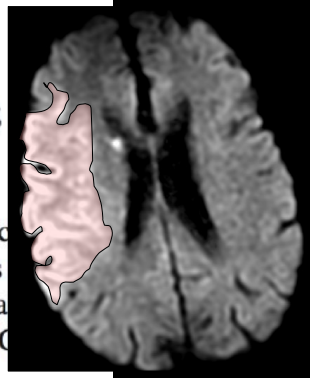
DWI-ASPECTS=4

* https://clinicaltrials.gov/

Peut on évaluer simplement en routine clinique le Volume de l'infarctus cérébral ?

Can DWI-ASPECTS Substitute for Lesion Volume in Acute Stroke?

Constance de Margerie-Mellon, MD*; Guillaume Turc, MD*; Marie Tisserand, MD; Olivier Naggara, PhD; David Calvet, PhD; Laurence Legrand, MD; Jean-François Meder, PhD; Jean-Louis Mas, MD; Jean-Claude Baron, ScD; Catherine Oppenheim, PhD



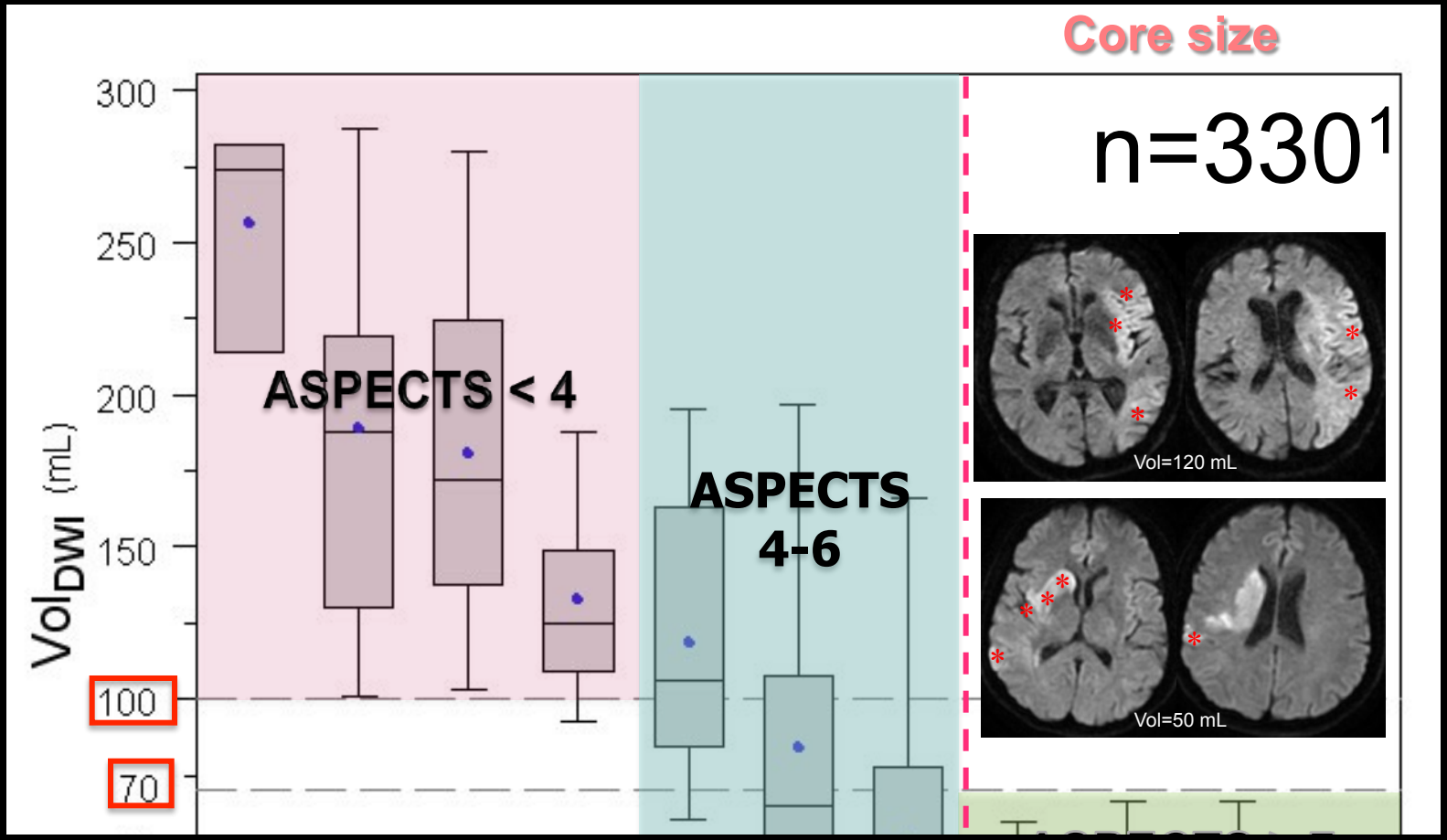
Background and Purpose—The extent of diffusion lesion on pretreatment imaging is a risk factor for poor outc and hemorrhagic transformation after thrombolysis, and volumes of 70 to 100 mL have been advocated as offs. However, estimating diffusion-weighted imaging (DWI) lesion volume (Vol_{DWI}) in the acute setting ma cumbersome. We aimed to determine whether the DWI-Alberta Stroke Program Early CT Score (DWI-ASPE can substitute for Vol_{DWI}.

Methods—DWI-ASPECTS and Vol_{DWI} were measured retrospectively on pretreatment MRI (median onset-to-MRI delay=122 minutes) in 330 consecutively treated patients with middle cerebral artery stroke.

Results—DWI-ASPECTS and Vol_{DWI} were strongly correlated (ρ=–0.82), but each DWI-ASPECTS point corresponded to a wide range of Vol_{DWI}. All patients with DWI-ASPECTS ≥7 (n=207) had Vol_{DWI} <70 mL, whereas 32 of the 34 patients with DWI-ASPECTS <4 had Vol_{DWI} >100 mL. However, intermediate DWI-ASPECTS (4–6; n=89) corresponded to highly variable Vol_{DWI} (median, 66 mL; interquartile range, 40–98).

Conclusions—Although each DWI-ASPECTS point corresponds to a wide range of volumes, DWI-ASPECTS <4 or ≥7 may be used as reliable surrogates of Vol_{DWI} >100 or <70 mL, respectively. (***Stroke*****. 2013;44:3565-3567.)**

Key Words: ASPECTS ■ diffusion-weighted imaging ■ stroke ■ thrombolytic therapy

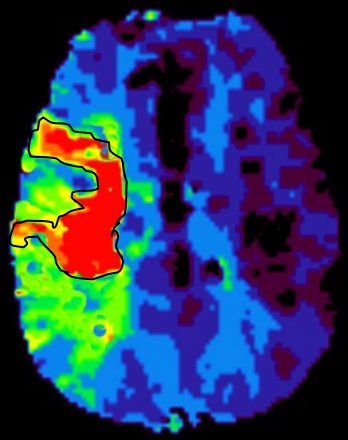


DWI-ASPECTS < 4 = vol>100 mL
DWI-ASPECTS ≥ 7 = vol<70 mLx

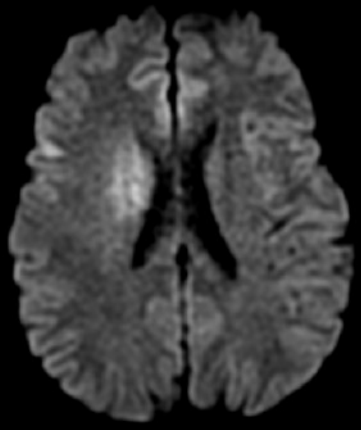
1. De Margerie et al. Stroke. 2013
2. Schröder et al. Stroke 2014

DWI-ASPECTS

Élargir la fenêtre thérapeutique > 6H



PWI Tmax > 6s



DWI

TARGET MISMATCH (DEFUSE 2)

$$\frac{Vol_{PWI}\ (\ Tmax > 6s\ )}{Vol_{DWI}} \geq 1.8$$

and

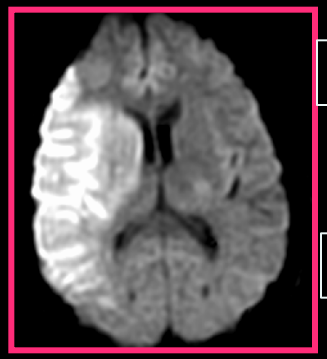
$$Vol_{DWI} < 70\ mL$$

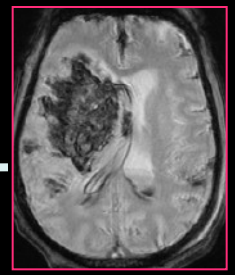
and

$$PWI\ (Tmax > 10s) < 100\ mL$$

Olivot et al. Stroke 2009. Takasawa et al. Stroke 2008;
Christensen et al. Stroke 2010; Lansberg et al. Lancet Neurol 2012

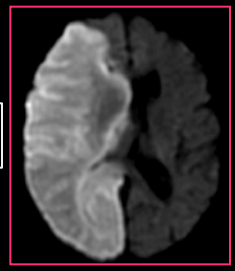
Exclusion of Large core





>70 mL

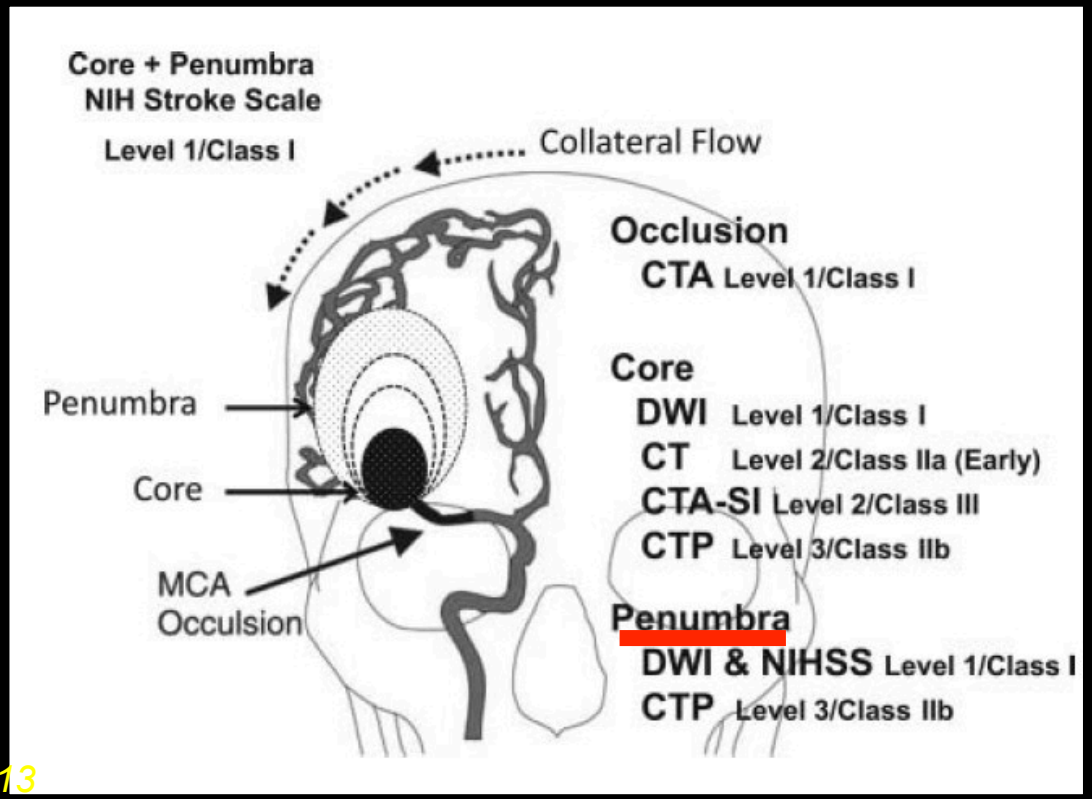
>145 mL



Parsons et al. J Cereb Blood Flow Metab. 2010. Mlynash et al. Stroke 2011. Davis et al. Lancet Neurol 2008. Oppenheim et al. Stroke 2000

IRM en 1ère intention, c'est

- Définir simplement le volume de l'infarctus
- Définir la pénombre ischémique - la collatéralité
- Bilan vasculaire

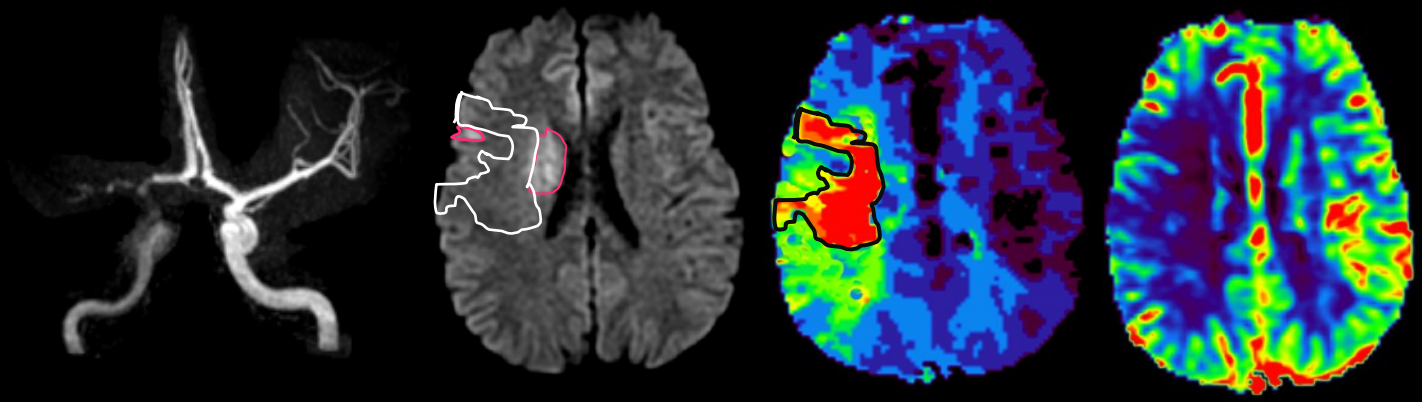


Gonzalez RG et al. J NeuroIntervent Surg 2013

- Penombre **jusqu'a 24-hrs**[1-3]
- Penombre sauvée → meilleur outcome [4-7]

  - > 6h ?
  - Sans heure de début (réveil) ?

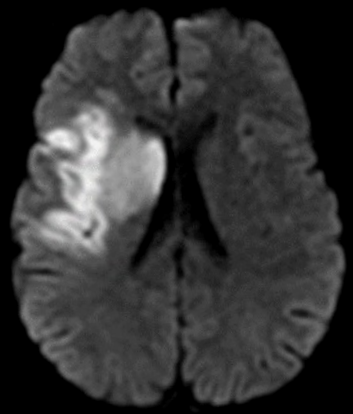
1. Marchal et al. 1996. Darby et al 1999; 2. Heiss et al 1992; 3. Markus et al; 2004
4. Lansberg et al. 2012; 5. Ma et al 2014; 6. Davis 2008; 7. Friedrich et al 2014 …



Tmax + 6s

DSC*
< 20 mL/100g/min

H 75 ans,
Déficit moteur gauche survenu il y a 5h30

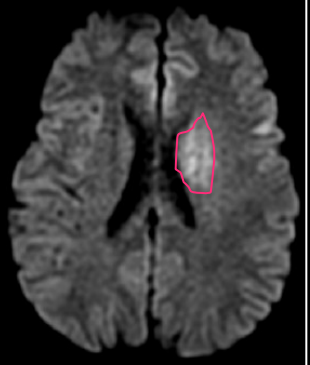


Suivi
(non recanalisation)

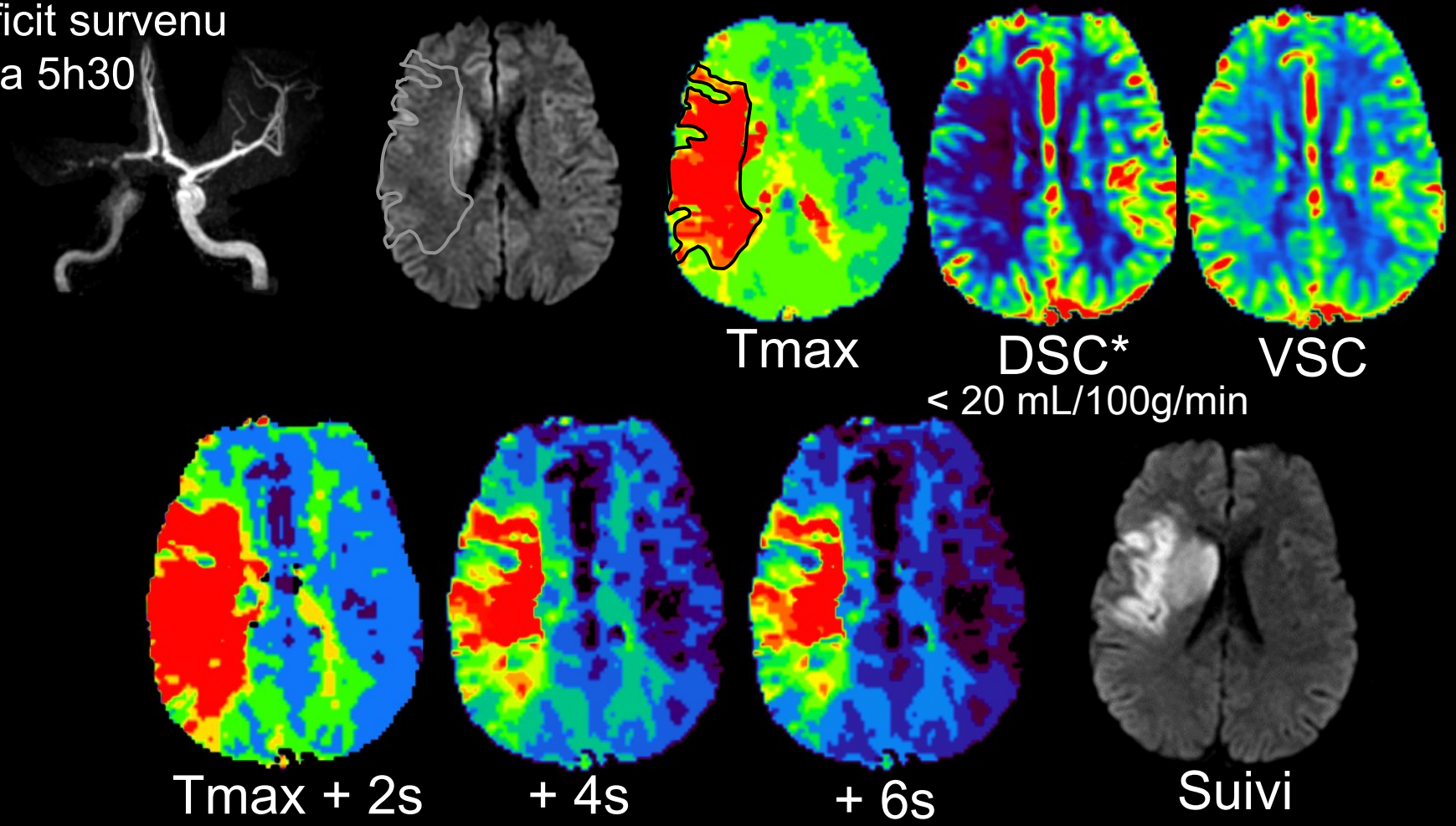
Objectif :
élargir la fenêtre de thrombolyse > 6h

** Zaro-Weber et al., Olivot et al. 2009; Takasawa et al. 2008.*

Marqueurs de pénombre ischémique
Les « mismatch »

MRA	Clinical
	
<15 cc	<25cc
	NIHSS> 8
Occlusion proximale	
Lansberg Stroke 2008	Davalos. Neurology 2004

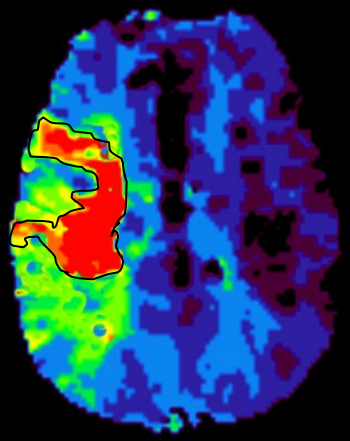
H 75 ans,
Déficit survenu
il y a 5h30



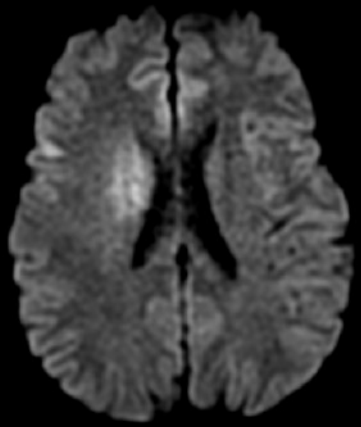
Objectif : Elargir la fenêtre thérapeutique

** Zaro-Weber et al., Olivot et al. 2009; Takasawa et al. 2008.*

PWI Tmax > 6s



DWI



TARGET MISMATCH (DEFUSE 2)

$$\frac{Vol_{PWI}\ (\ Tmax > 6s\ )}{Vol_{DWI}} \geq 1.8$$

and

$Vol_{DWI} < 70$ mL

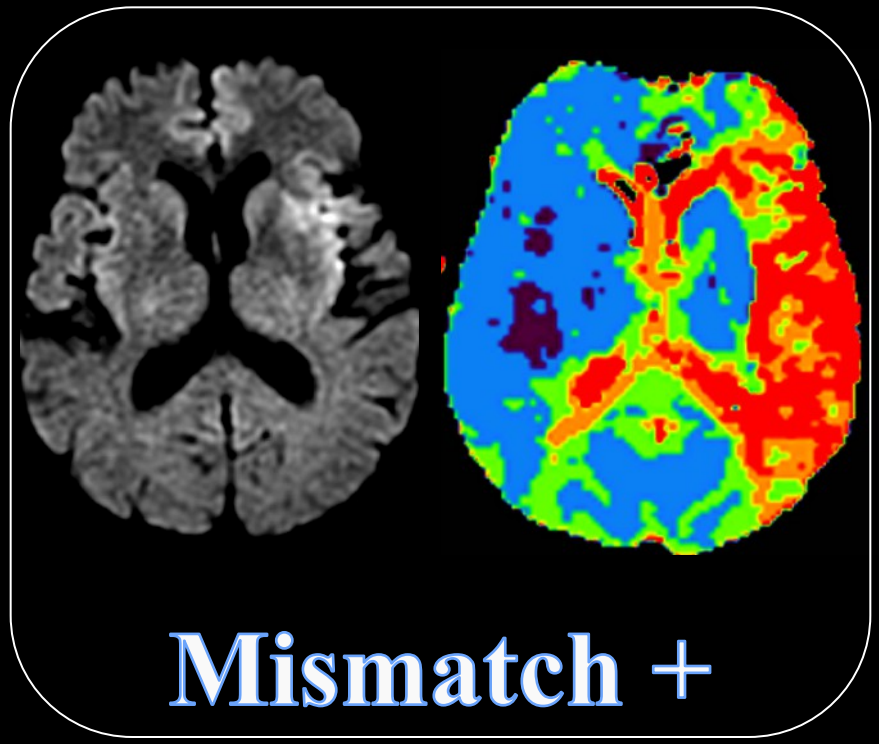
and

PWI (Tmax > 10s)< 100 mL

Olivot et al. Stroke 2009. Takasawa et al. Stroke 2008;
Christensen et al. Stroke 2010; Lansberg et al. Defuse 2 Lancet Neurol 2012

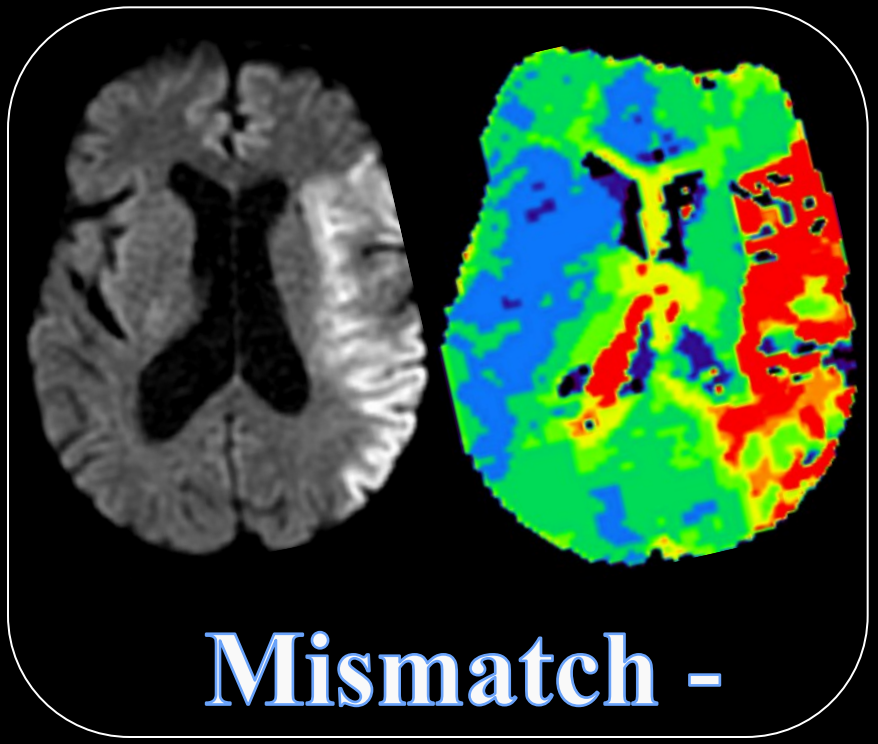
H + 3.5

NIHSS=17



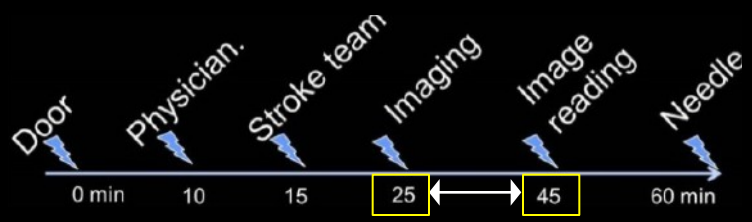
Mismatch +

NIHSS=17

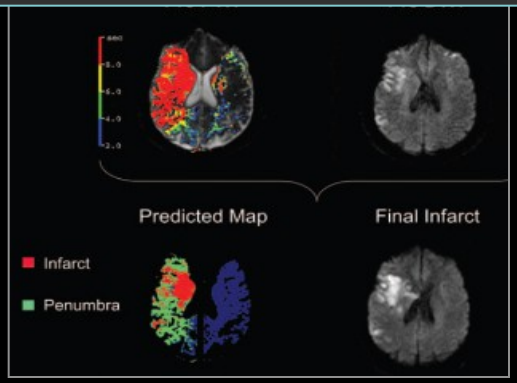


Mismatch -

Dans la vraie vie ?



MR RESCUE : Software failure: 42% patients

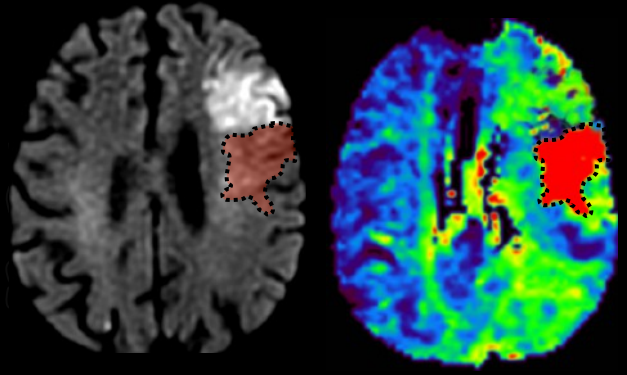


Kidwell et al. NEJM. 2013
Kidwell et al. Stroke 2013

Usability
Accuracy
Speed
Affordability
GA (portability)
Credibility

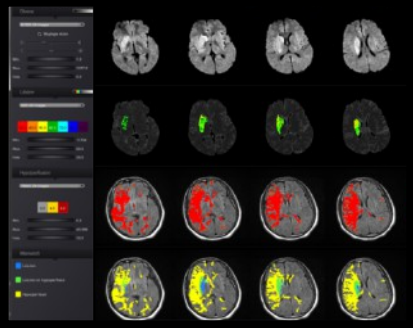
Churilov et al.
Int J Stroke 2013

+ manual interface in case of failure !

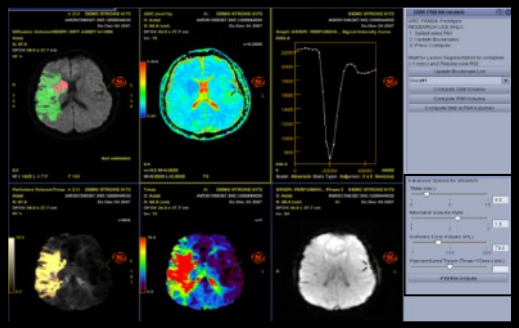


PWI/DWI=1

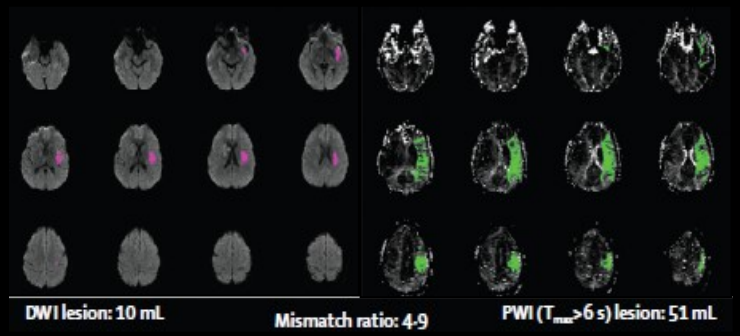
A few examples …



OLEA sphere

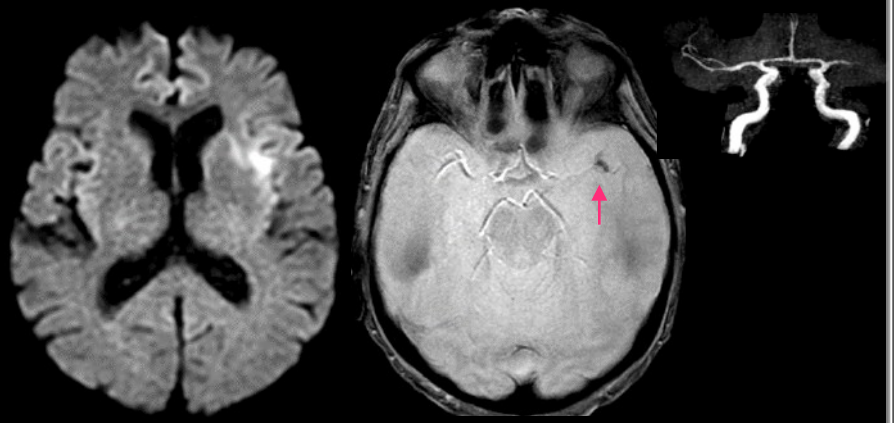


GE Healthcare “prototype”

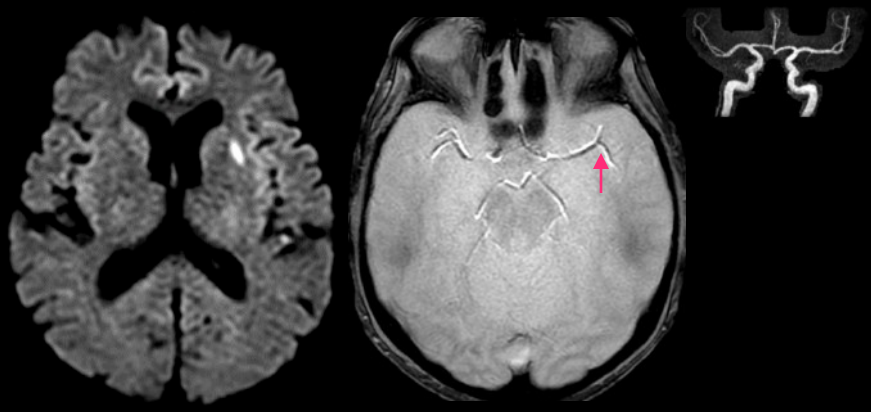


RAPID

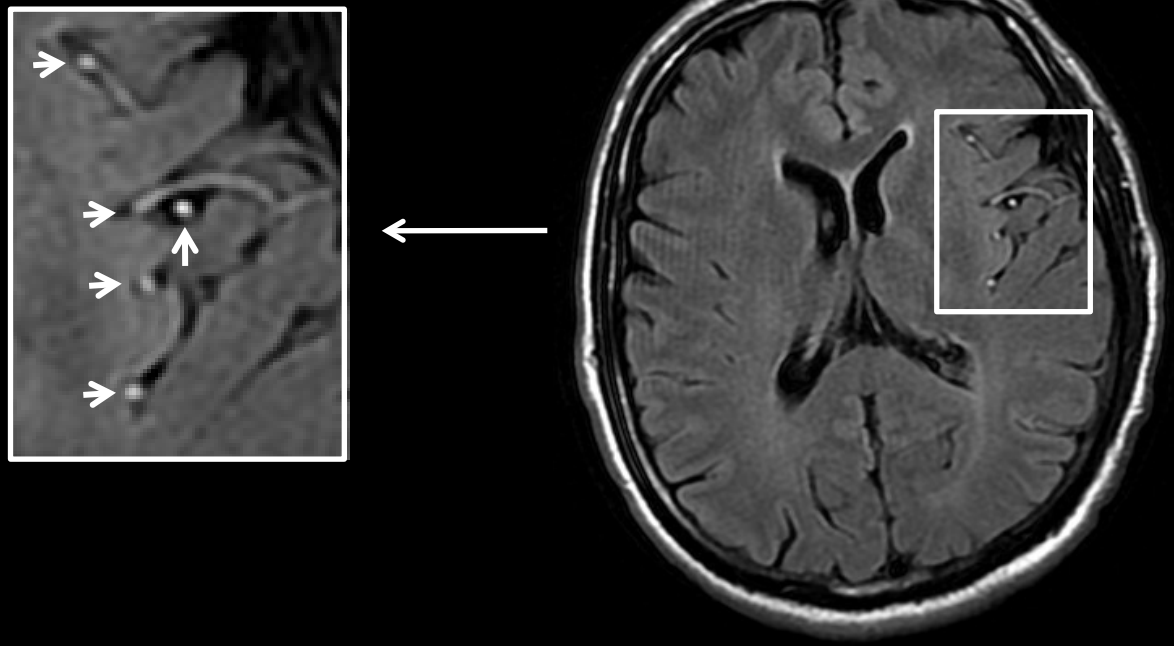
AVANT TRAITEMENT

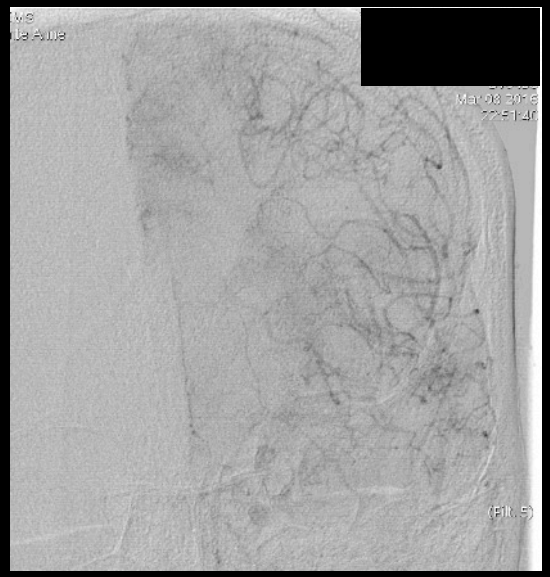


24 hrs après recanalisation



FLAIR vascular hyperintensities
la perfusion du pauvre ?

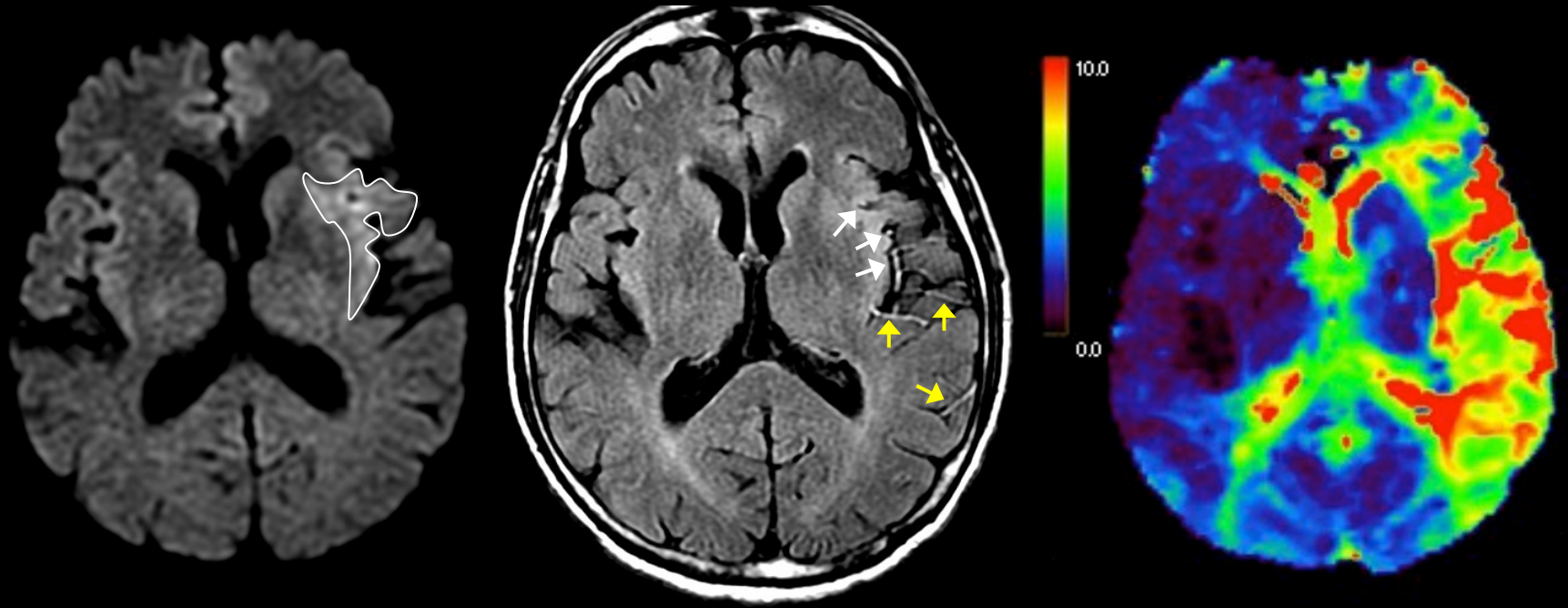




Sanossian, AJNR, 2009 Azizyan, AJNR, 2011

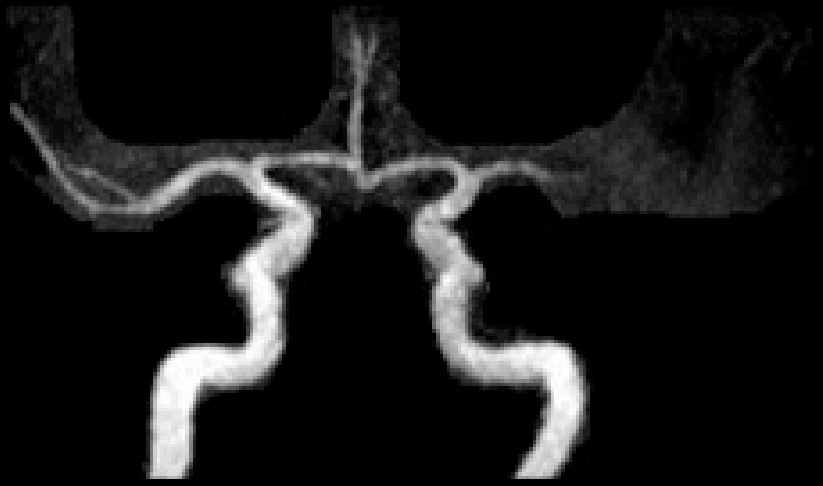
Mismatch FVH-DWI

Aphasie brutale chez un patient de 67 ans (NIHSS=5)



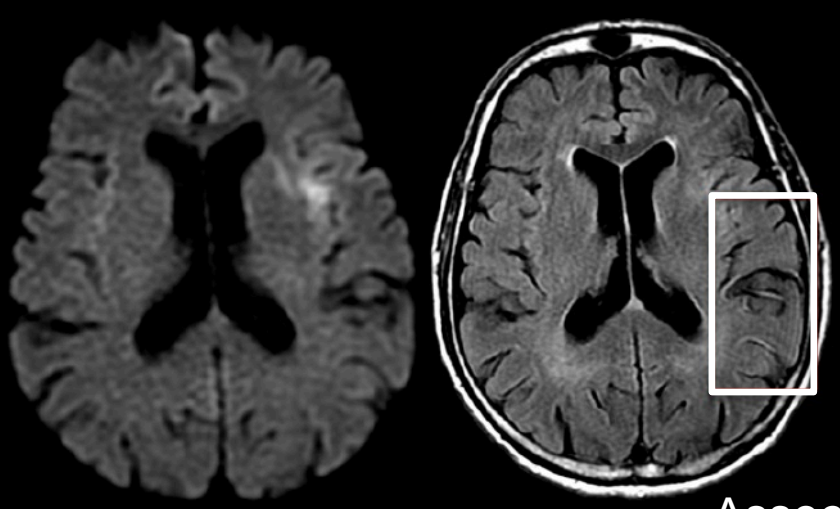
→ Association avec le mismatch PWI-DWI (Sen=92%)

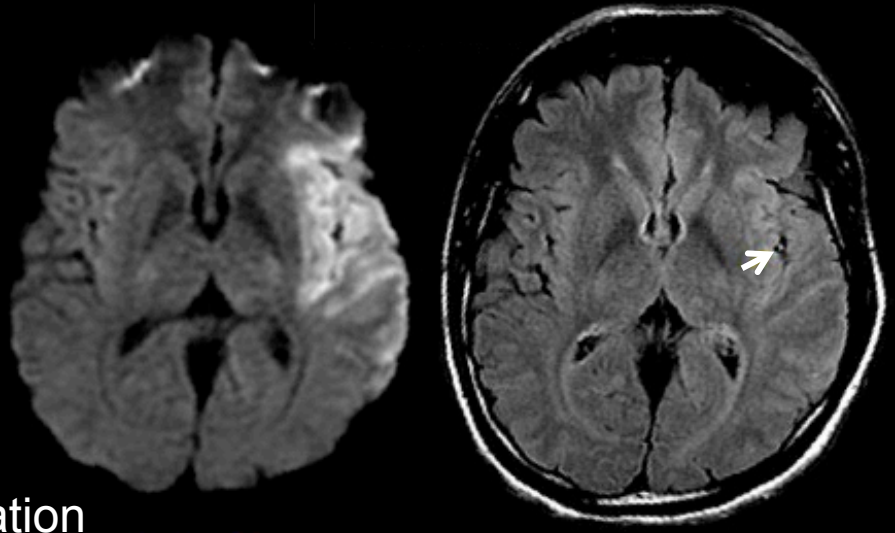
Legrand, AJNR, 2015



Mismatch FVH-DWI +

Mismatch FVH-DWI -



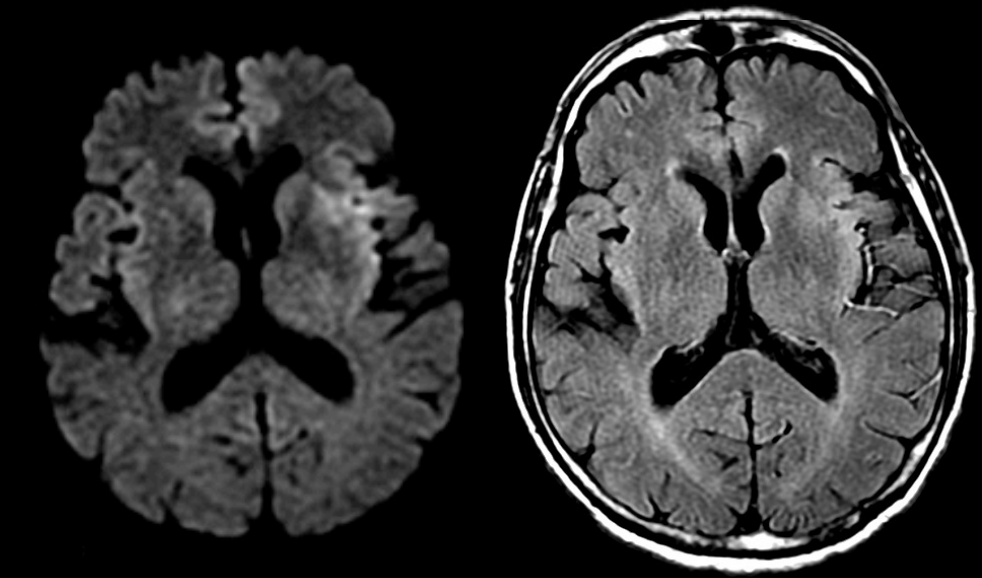


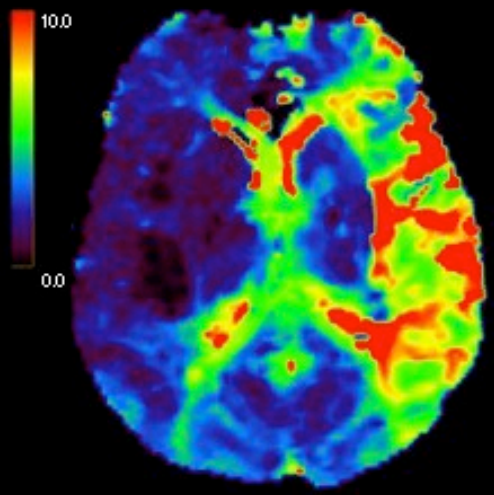
Association

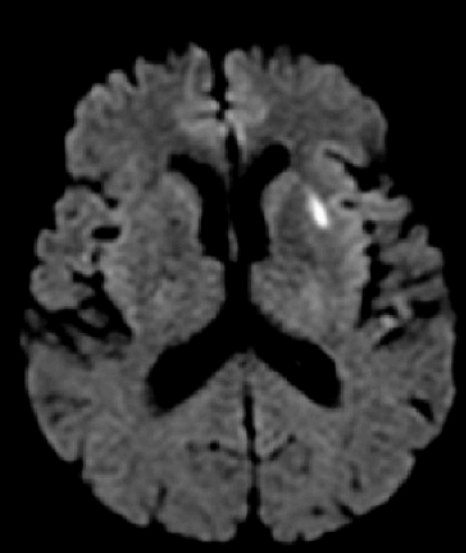
- recanalisation (ARM à 24h)
- évolution clinique favorable (mRS à 3 mois ≤2)

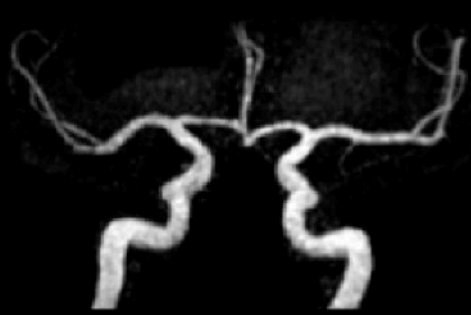
IRM initiale (86 min)

IRM à H24





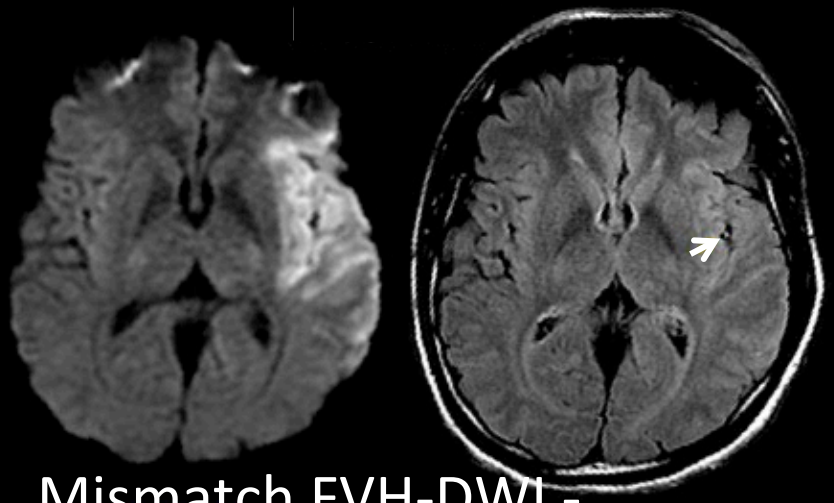




mRS à 3 mois = 0

FLAIR vascular hyperintensities la perfusion du pauvre ?

- Association entre recanalisation et évolution clinique favorable à 3 mois significative chez les patients avec mismatch FVH-DWI (OR de 16.2)
- Non significative chez les patients sans mismatch FVH-DWI



Mismatch FVH-DWI -

Fluid-Attenuated Inversion Recovery Vascular Hyperintensities–Diffusion-Weighted Imaging Mismatch Identifies Acute Stroke Patients Most Likely to Benefit From Recanalization

Laurence Legrand, MD; Marie Tisserand, PhD*; Guillaume Turc, PhD*; Myriam Edjlali, MD; David Calvet, PhD; Denis Trystram, MD; Pauline Roca, PhD; Olivier Naggara, PhD; Jean-Louis Mas, MD; Jean-Francois Méder, PhD; Jean-Claude Baron, ScD; Catherine Oppenheim, PhD

Background and Purpose—Fluid-attenuated inversion recovery vascular hyperintensities (FVH) beyond the boundaries of diffusion-weighted imaging (DWI) lesion (FVH-DWI mismatch) have been proposed as an alternative to perfusion-weighted imaging (PWI)-DWI mismatch. We aimed to establish whether FVH-DWI mismatch can identify patients most likely to benefit from recanalization.

Methods—FVH-DWI mismatch was assessed in 164 patients with proximal middle cerebral artery occlusion before intravenous thrombolysis. PWI-DWI mismatch ($PWI_{Tmax>6sec}$/DWI>1.8) was assessed in the 104 patients with available PWI data. We tested the associations between 24-hours complete recanalization on magnetic resonance angiography and 3-month favorable outcome (modified Rankin Scale score ≤2), stratified on FVH-DWI (or PWI-DWI) status.

Results—FVH-DWI mismatch was present in 121/164 (74%) patients and recanalization in 50/164 (30%) patients. The odds ratio for favorable outcome with recanalization was 16.2 (95% confidence interval, 5.7–46.5; $P<0.0001$) in patients with FVH-DWI mismatch and 2.6 (95% confidence interval, 0.6–12.1; $P=0.22$) in those without FVH-DWI mismatch ($P=0.048$ for interaction). Recanalization was associated with favorable outcome in patients with PWI-DWI mismatch (odds ratios, 9.9; 95% confidence interval, 3.1–31.3; $P=0.0001$) and in patients without PWI-DWI mismatch (odds ratios, 7.0; 95% confidence interval, 1.1–44.1; $P=0.047$), $P=0.76$ for interaction.

Conclusion—The FVH-DWI mismatch may rapidly identify patients with proximal occlusion most likely to benefit from recanalization. **(*Stroke*. 2016;47:424-427. DOI: 10.1161/STROKEAHA.115.010999.)**

Résultats

Evolution clinique favorable à 3 mois

Mismatch PWI-DWI +

$OR_{recanalisation}$=9.9

(95%CI, 3.1-31.3; *P*<0.0001)

Mismatch PWI-DWI -

$OR_{recanalisation}$=7.0

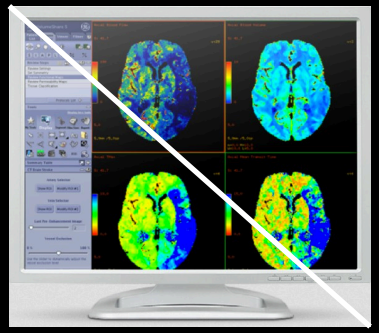
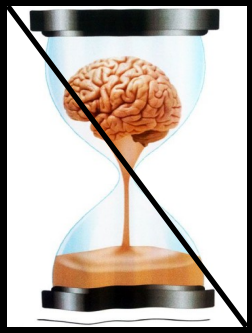
(95%CI, 1.1-44.1; *P*=0.047)

P=0.76 (interaction)

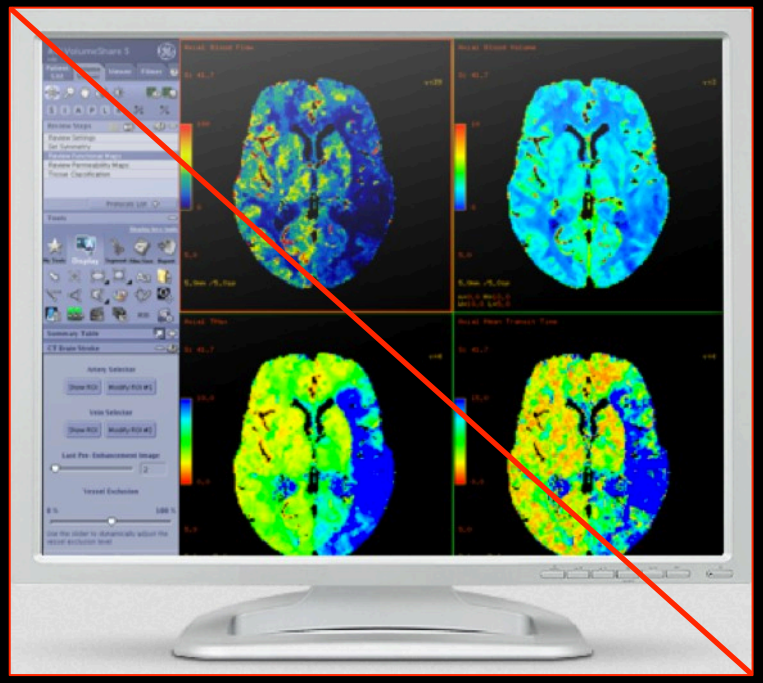
Discussion

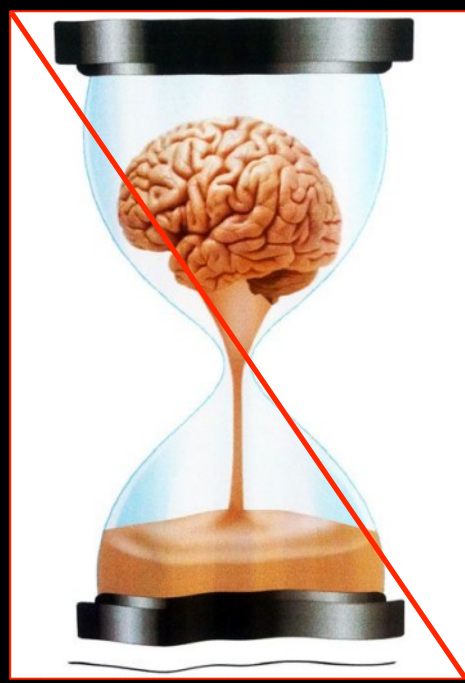
Mismatch FVH-DWI

- Identifier patients avec occlusion M1 susceptibles de bénéficier de la recanalisation après thrombolyse IV
- Avantages nombreux/mismatch PWI-DWI
  - Pas de gadolinium
  - Pas de post-traitement
  - Gain de temps

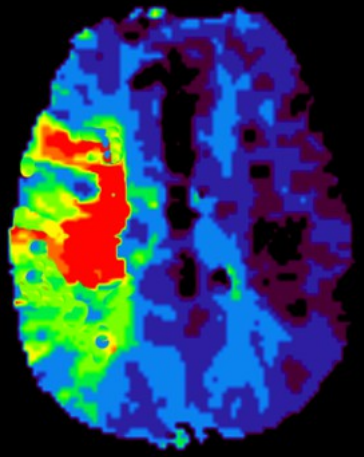
Mismatch: que retenir ?



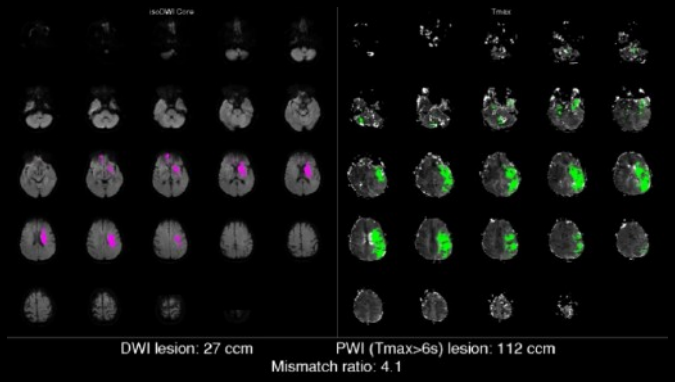


Mismatch: que retenir ?

- Tmax de plus en plus utilisé
- Logiciel de post ttt automatique
  - Hypoperfusion (Tmax >6 sec)
  - Vol Diffusion
  - Essais randomisés en cours



+ 6s



ECASS 4

- Essai randomisé de phase III
- rt-PA versus placebo
- 4.5-9h ou AVC du réveil
- Inclusion : **MISMATCH**

1) a ratio between the volumes of critically hypoperfused tissue and the ischemic core ≥1·8, with an absolute difference ≥ 15 mL; 2) ischemic core volume <70 mL and; 3) volume of tissue with a severe delay in bolus arrival (Tmax>10 sec) <100 mL.

AHA/ASA Guideline

2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Imaging

1. **Emergency imaging of the brain is recommended before any specific treatment for acute stroke is initiated *(Class I; Level of Evidence A)*. In most instances, nonenhanced CT will provide the necessary information to make decisions about emergency management.** (Unchanged from the 2013 guideline)
2. **If endovascular therapy is contemplated, a noninvasive intracranial vascular study is strongly recommended during the initial imaging evaluation of the acute stroke patient but should not delay intravenous r-tPA if indicated. For patients who qualify for intravenous r-tPA according to guidelines from professional medical societies, initiating intravenous r-tPA before noninvasive vascular imaging is recommended for patients who have not had noninvasive vascular imaging as part of their initial imaging assessment for stroke. Noninvasive intracranial vascular imaging should then be obtained as quickly as possible *(Class I; Level of Evidence A)*.** (New recommendation)

Stroke Oct 2015

AHA/ASA Guideline

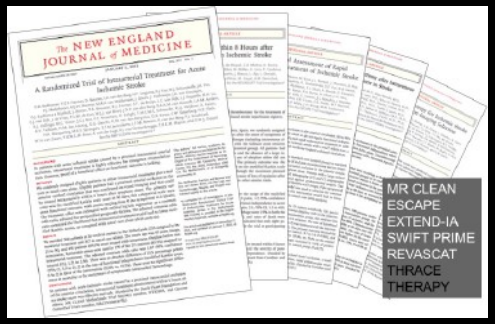
2015 American Heart Association/American Stroke Association Focused Update of the 2013 Guidelines for the Early Management of Patients With Acute Ischemic Stroke Regarding Endovascular Treatment

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

The benefits of additional imaging beyond CT and CTA or MRI and MRA such as CT perfusion or diffusion- and perfusion-weighted imaging for selecting patients for endovascular therapy are unknown *(Class IIb; Level of Evidence C)*. Further randomized, controlled trials may be helpful to determine whether advanced imaging paradigms using CT perfusion, CTA, and MRI perfusion and diffusion imaging, including measures of infarct core, collateral flow status, and penumbra, are beneficial for selecting patients for acute reperfusion therapy who are within 6 hours of symptom onset and have an ASPECTS <6. Further randomized, controlled trials should be done to determine whether advanced imaging paradigms with CT perfusion, MRI perfusion, CTA, and diffusion imaging, including measures of infarct core, collateral flow status, and penumbra, are beneficial for selecting patients for acute reperfusion therapy who are beyond 6 hours from symptom onset. (New recommendation)

Stroke Oct 2015

Sélection des patients



- Pas d'imagerie avancée

REVASCAT – MR CLEAN – THRACE – THERAPY

  - Absolute benefit: 13% NTT=7.7 (5.6-12.5)

- Imagerie avancée
  - EXTEND IA - SWIFT PRIME – ESCAPE
  - Absolute benefit: 25%, NTT=4 (3-5.9)

Metanalysis on agreggated data. Unpublished

L'IRM est elle indispensable pour une thrombectomie

- Non

Pas pour l'indication

Pas pour aider à sa réalisation

→ Raisonnement similaire à celui pour la recanalisation IV

- Oui

AVC sans heure de début

Sélection individualisée des patients

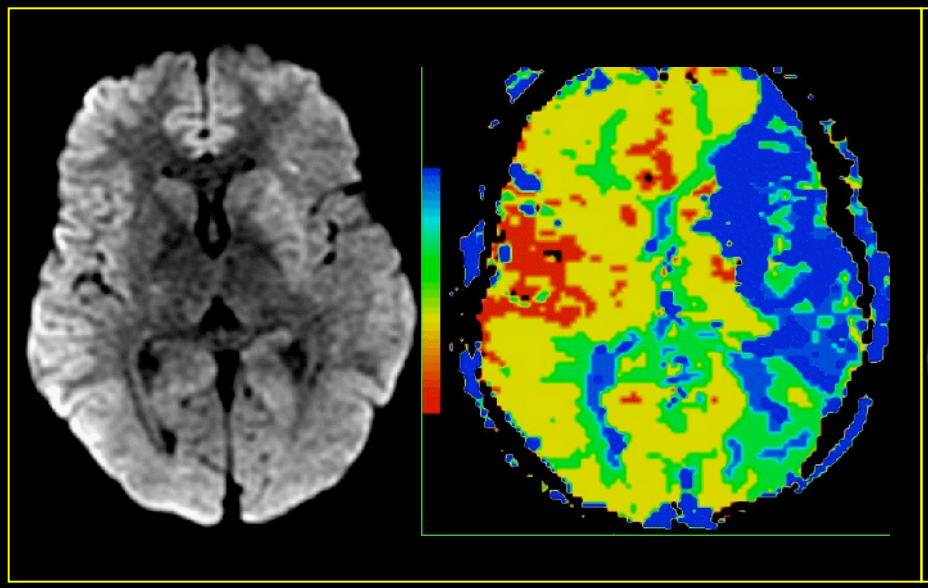
Déficit constaté
au réveil.
IRM 5 h plus tard

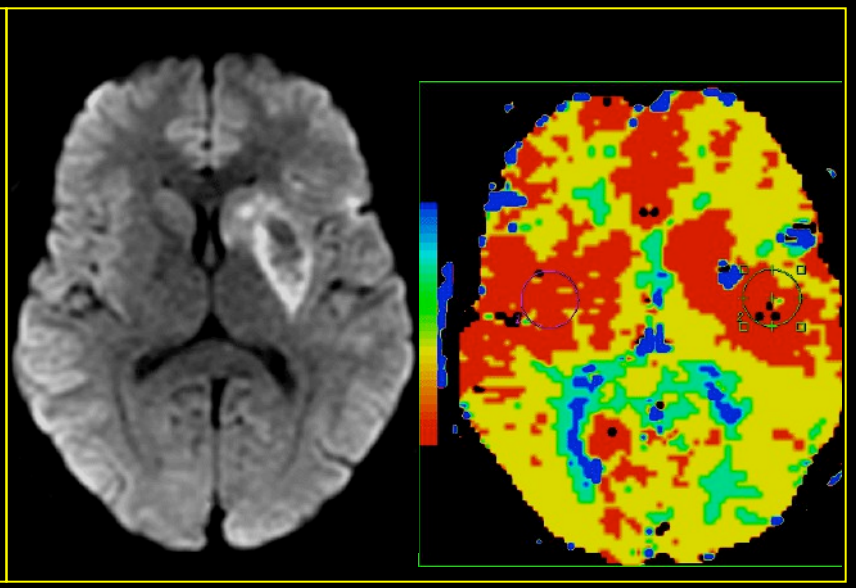
FLAIR

Diffusion

MTT

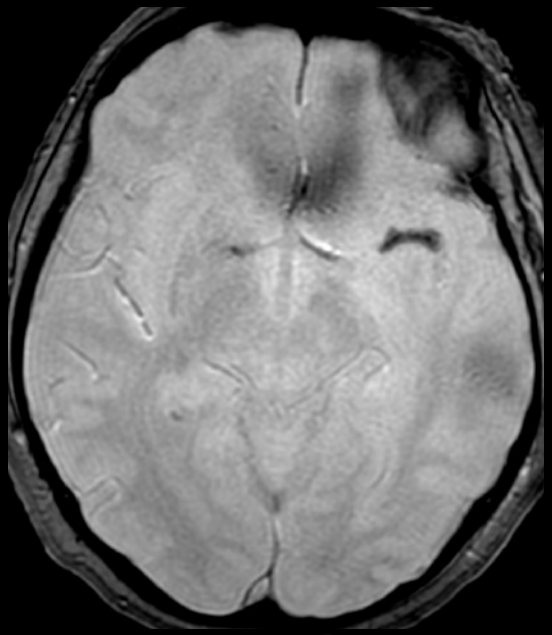
Traitement par rtPA Intra Artériel

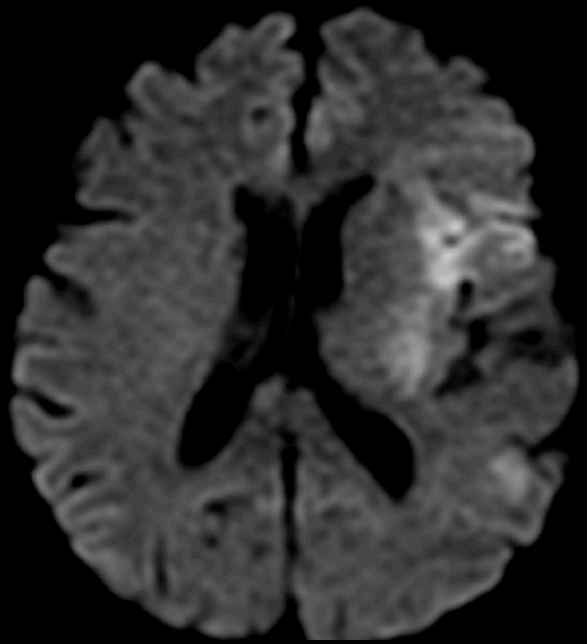


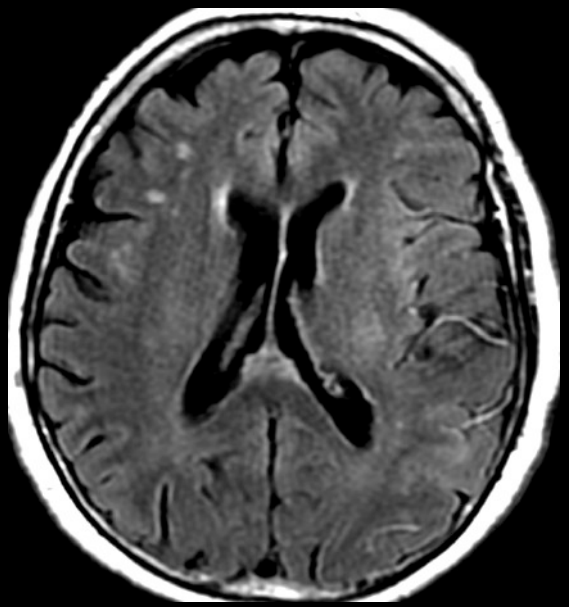


IRM initiale

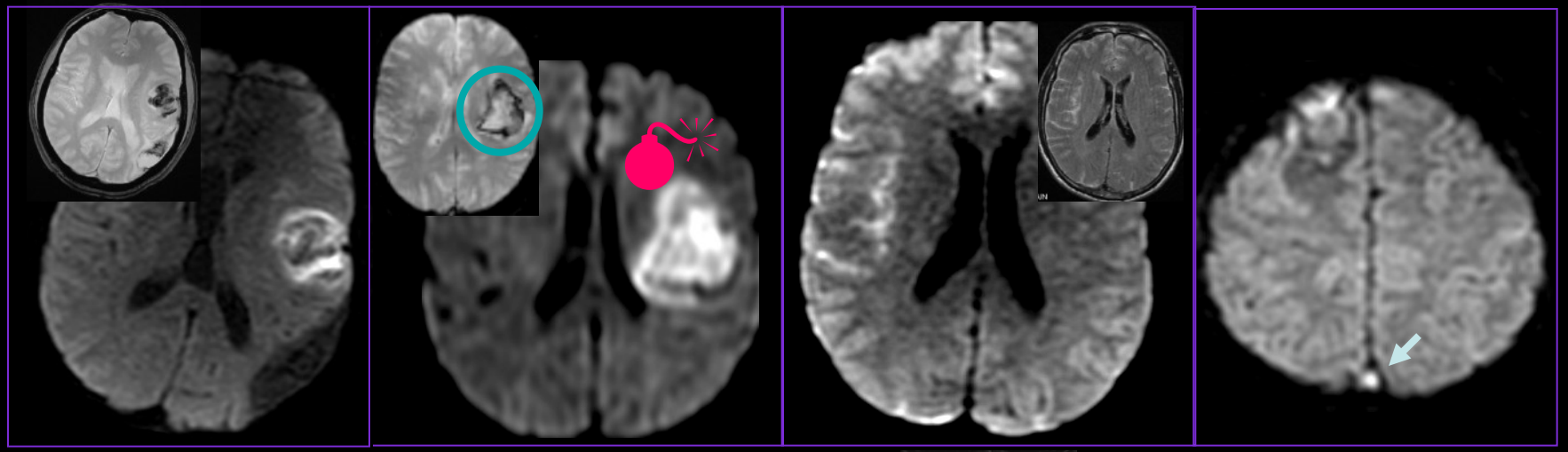
Contrôle précoce

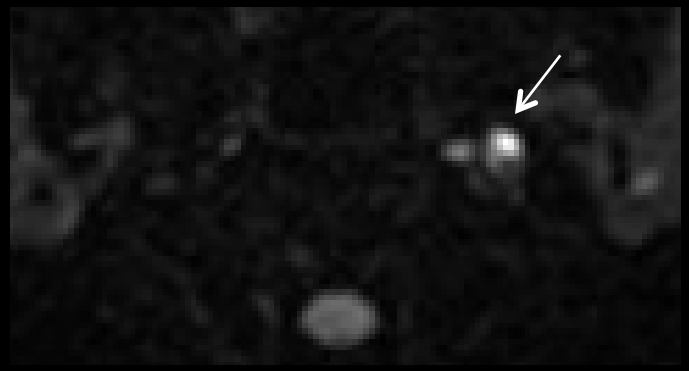




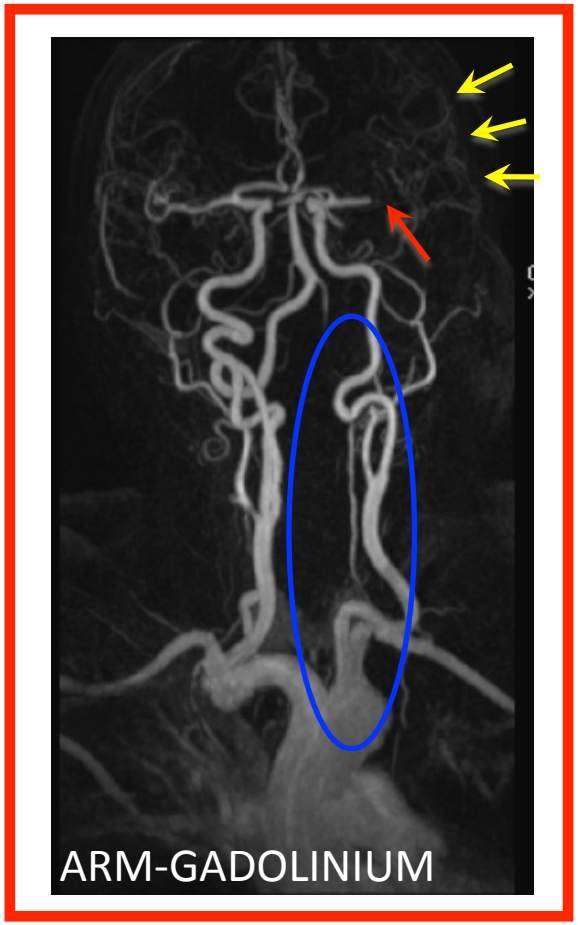


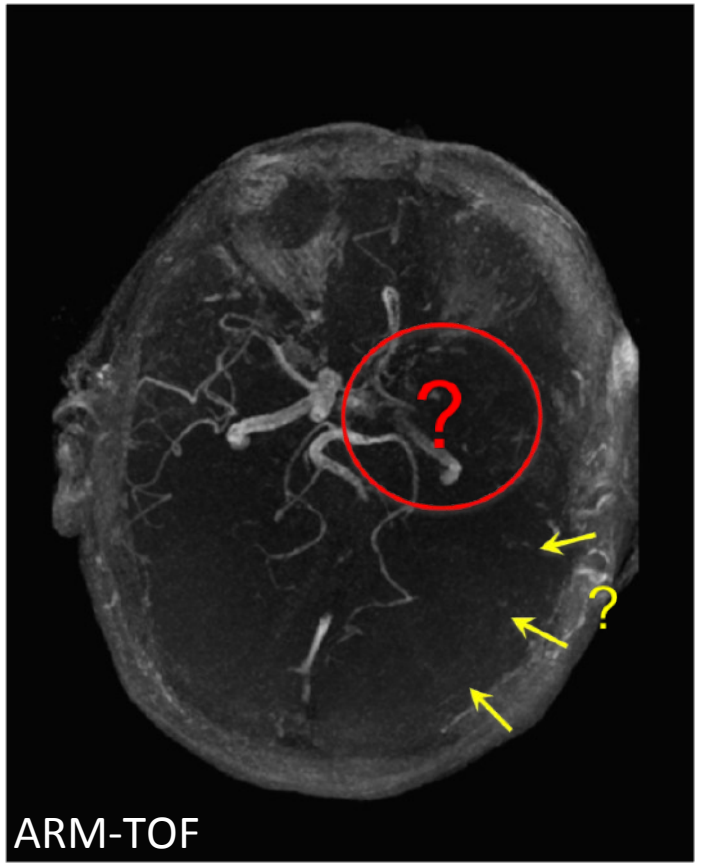
sang et diffusion





Ischémie cérébrale en IRM
Angio-RM





VISUALISATION DU SITE DE L'OCCLUSION

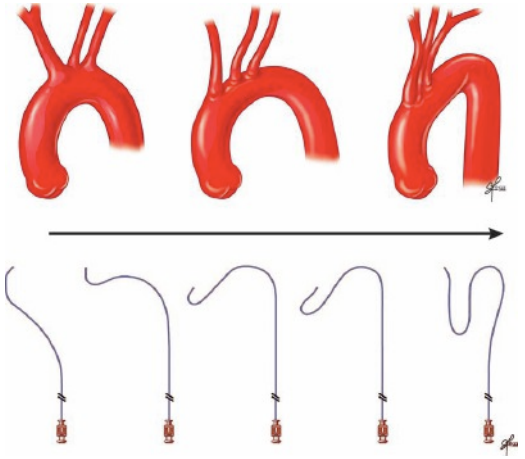
ÉVALUATION DE LA CIRCULATION COLLATERALE

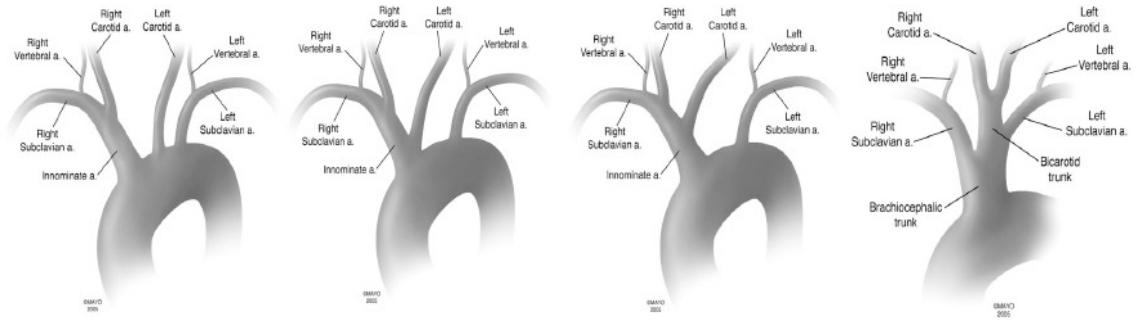
ÉVALUATION DE L'ATTEINTE OU DE LA COMPLEXITÉ ANATOMIQUE DES TSA

Angio-RM

Troncs supra-aortiques

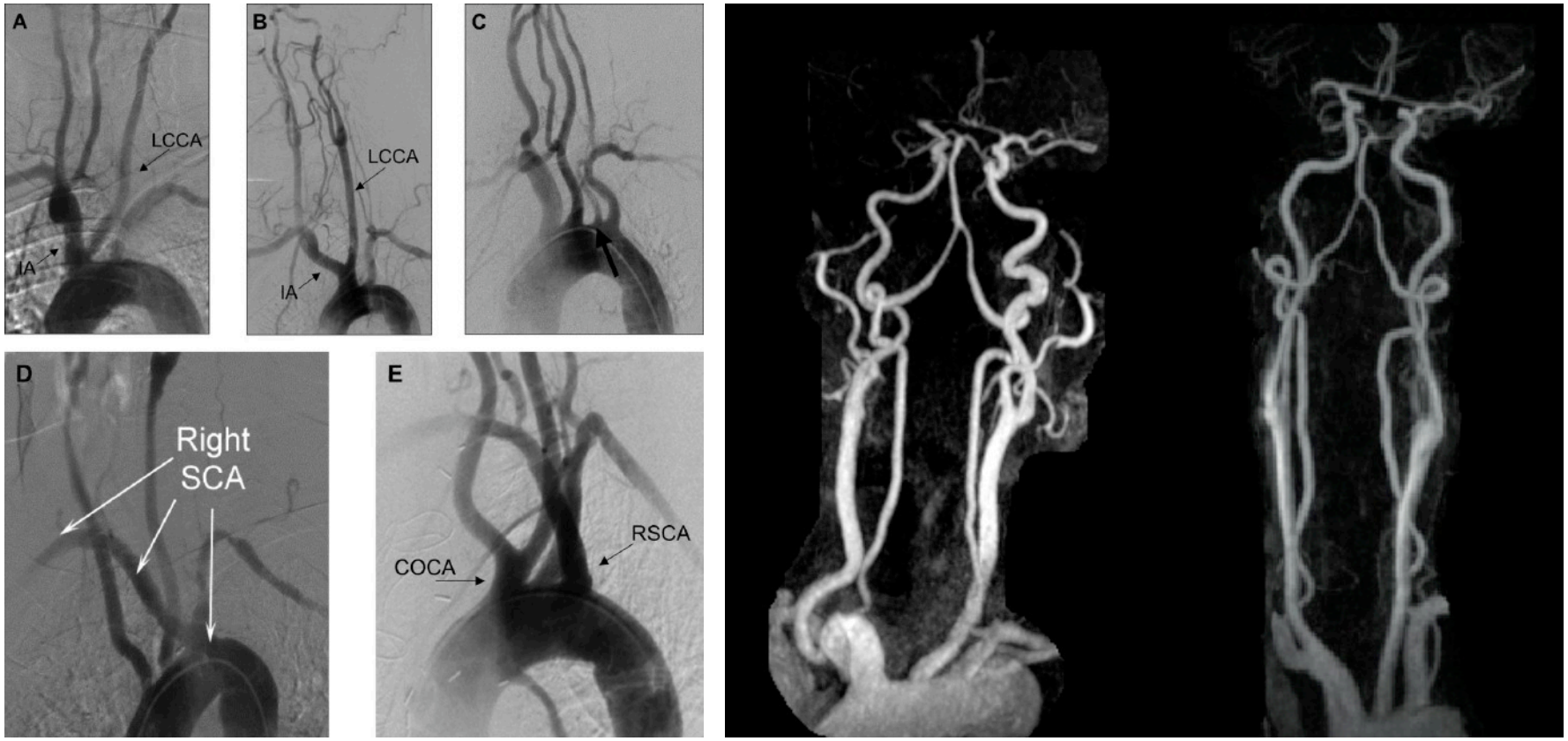
- FACTEUR IMPORTANT conditionnant la durée de la procédure endovasculaire
- Variations
  - >50% origines séparées des TSA
  - 25% origine commune TABC et ACCG
  - 16% ACCG naissant du TABC
  - <3% AV ou ASCD naissant de l'Aorte
  - RARE : right sided AA





Angio-RM

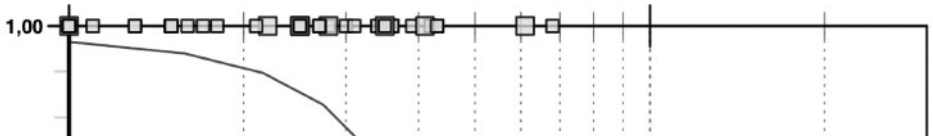
Troncs supra-aortiques



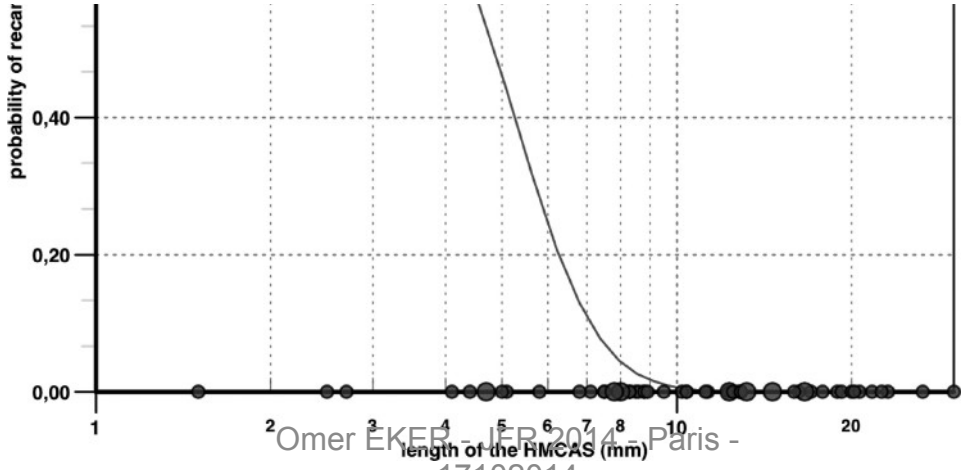
Rationnel recanalisation mécanique

Limites de la Fibrinolyse IV

- **Importance de la taille du thrombus pour la recanalisation**
- Stroke. 2011; PMID: 21474810



Le fibrinolyse IV est quasiment inefficace pour des thrombus ≥ 8mm



N=138
62 recanalisations

- Longueur du thrombus aspi vs stent
- Penombre – collatéralité
- Reveil

L'IRM est elle indispensable pour la thrombectomie ?

- **NON ! Certainement pas indispensable**

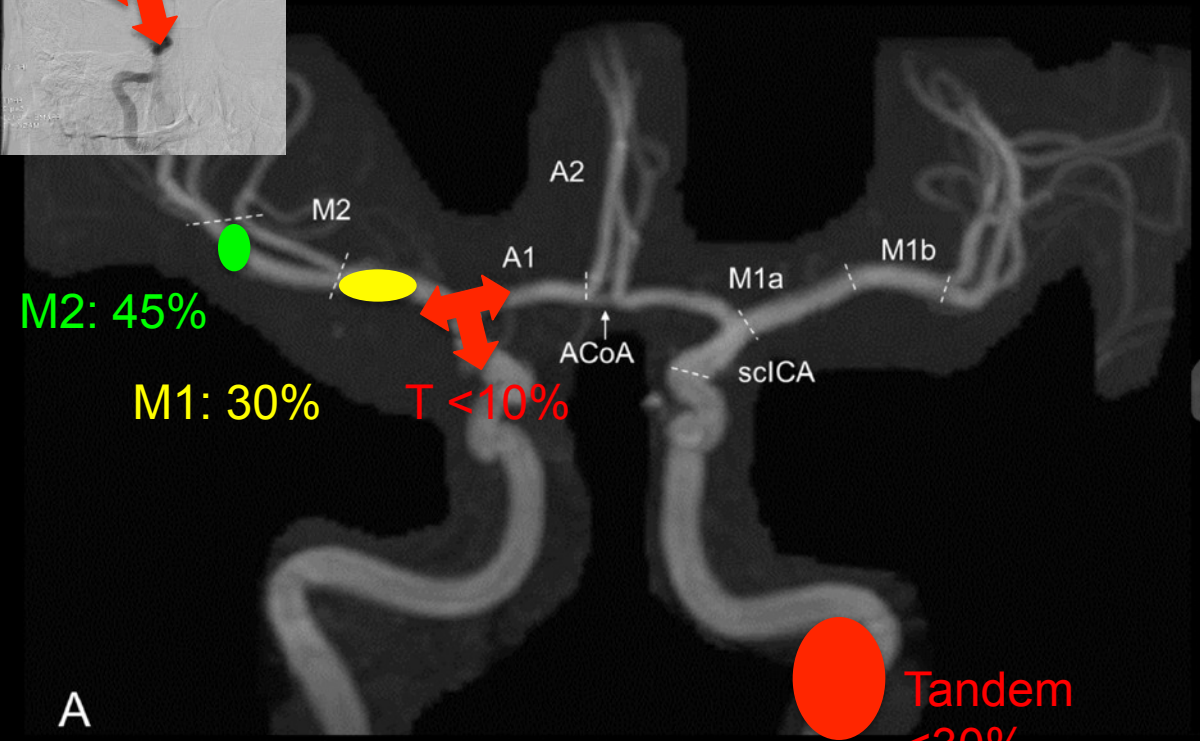
Time is brain ?

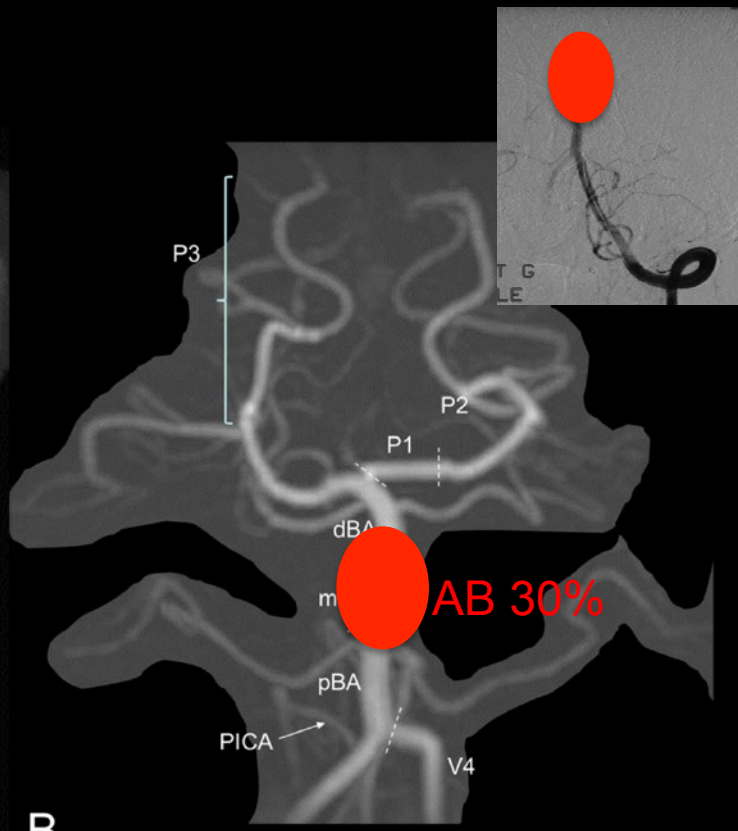
La thrombolyse intraveineuse (IV) dans les 4.5 h est le seul traitement :

- **ayant fait la preuve de son efficacité**
- **autorisé dans l'infarctus cérébral**

- **Le bénéfice clinique de la thrombolyse IV est basé sur la désobstruction artérielle**

Objectif : recanalisation





Alexandrov. *J Int Med* 2010;267:209-19.
Saqqur et al. *Stroke* 2007;38:948-54.

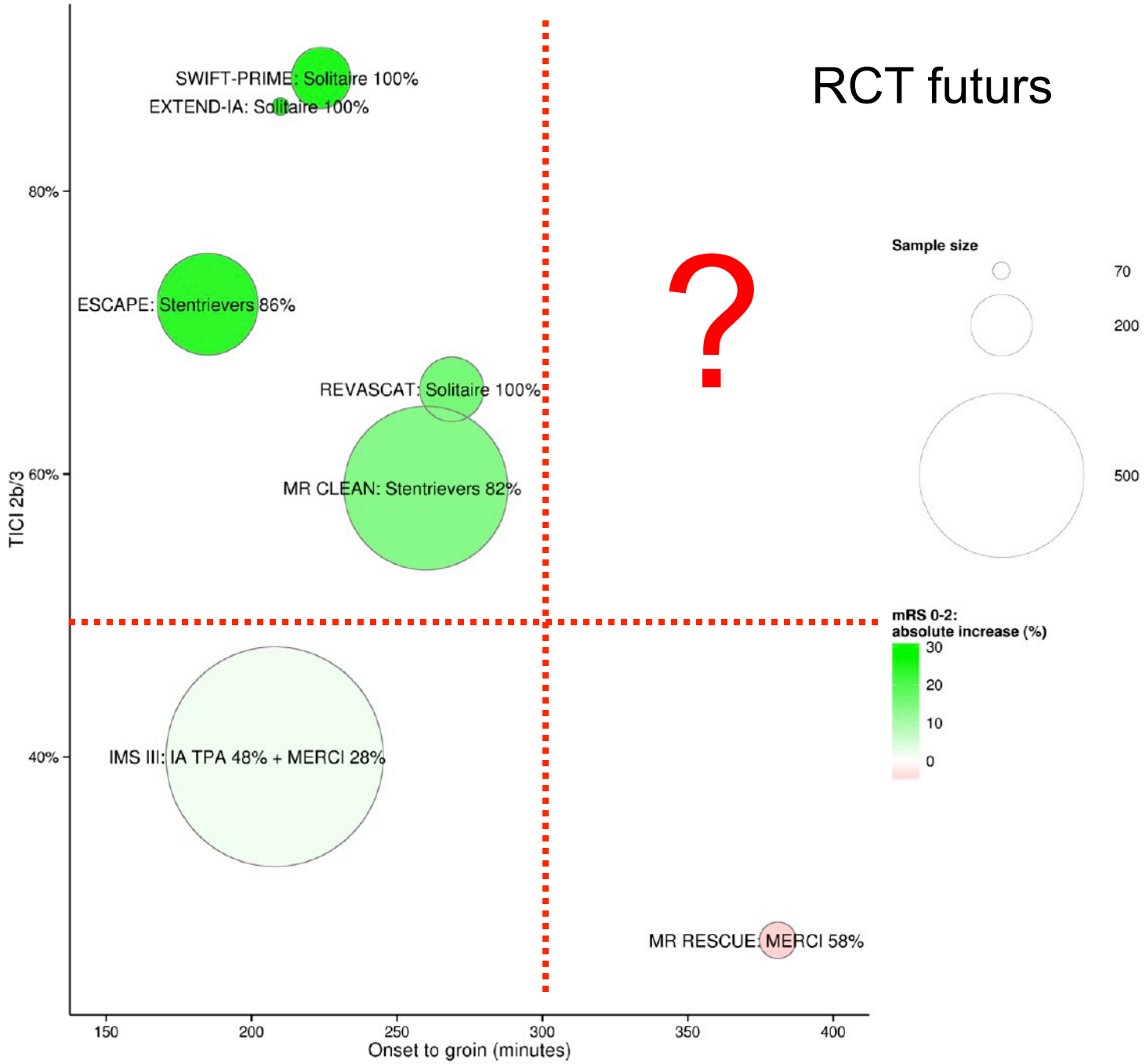
Pluridisciplinarité !

- La thrombectomie mécanique est un traitement en « bout de chaine »

- Filière fluide

→ Urgences – SAMU – Pompiers
→ Neuroradiologie diagnostic
→ Neurologie vasculaire – UNV
→ Neuro- anesthésiste –réanimateur

RCT futurs


SWIFT-PRIME: Solitaire 100%
EXTEND-IA: Solitaire 100%
ESCAPE: Stentrievers 86%
REVASCAT: Solitaire 100%
MR CLEAN: Stentrievers 82%
IMS III: IA TPA 48% + MERCI 28%
MR RESCUE: MERCI 58%
?
Sample size
70
200
500
mRS 0-2:
absolute increase (%)
30
20
10
0
80%
60%
40%
TICI 2b/3
150
200
250
300
350
400
Onset to groin (minutes)