

NORDICFORUM www.nordictraumarad.com
TRAUMA & EMERGENCY RADIOLOGY

Session5: Neuro Imaging

**New imaging- and
post-processing techniques
in emergency neuroimaging**

Koenraad (Hans) Nieboer, MD FASER FESER

Emergency Radiology

Frans Van den Bergh, MD

Interventional radiology

Sylvie De Raedt, PhD MD

Head Stroke Centre

Johan de Mey, PhD MD

Chair Radiology Department



Disclosure

Consultant & Speakers office: GE Healthcare

Outline:

Actual shortcomings of Stroke work-up

What to expect: 4 Statements

- MRI is most accurate
- The volume of Penumbra ~ Quality of Collaterals
- We can improve Core volume estimation @ NCCT
- We should rethink the use of CTP

**BRUSSELS
HEALTH
CAMPUS**



Universitair
Ziekenhuis
Brussel

ESU
STROKE CENTRE

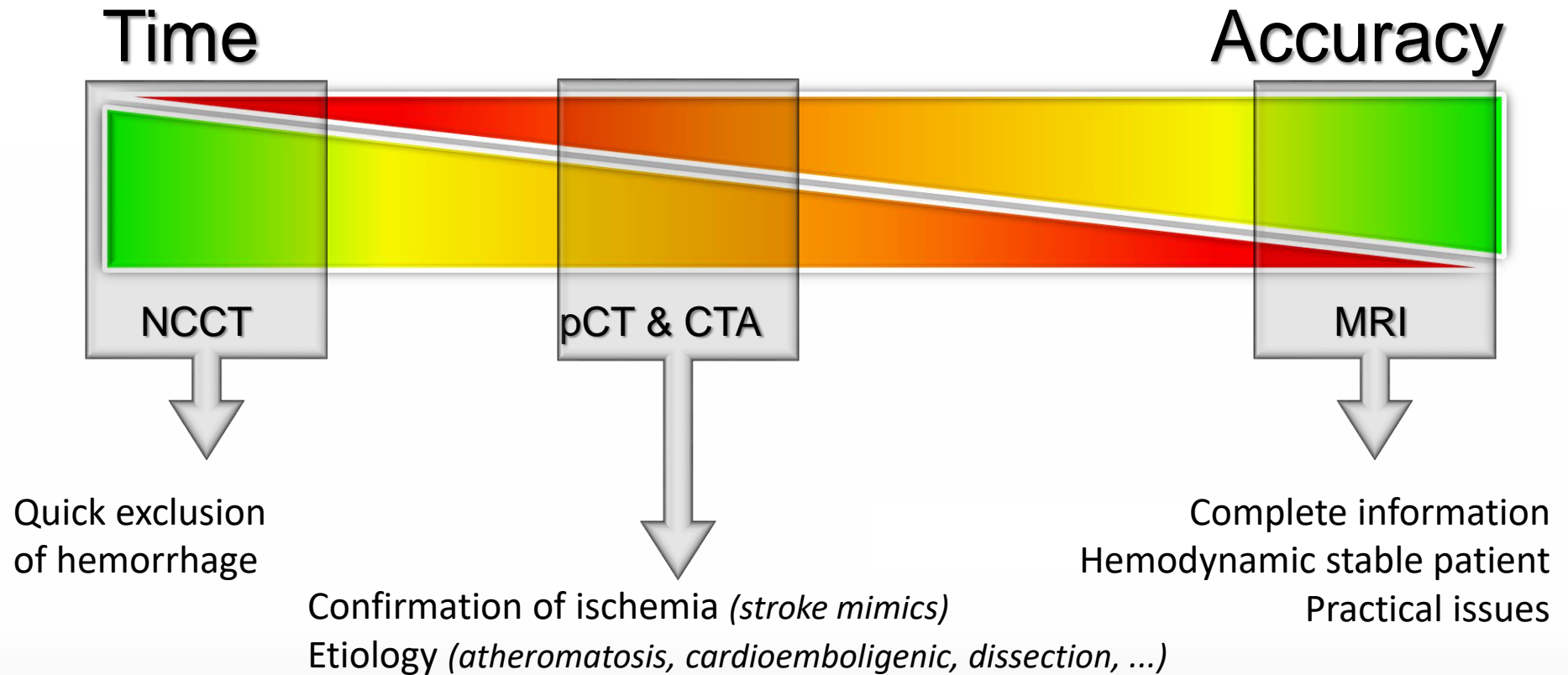


**STROKE
CENTRE**



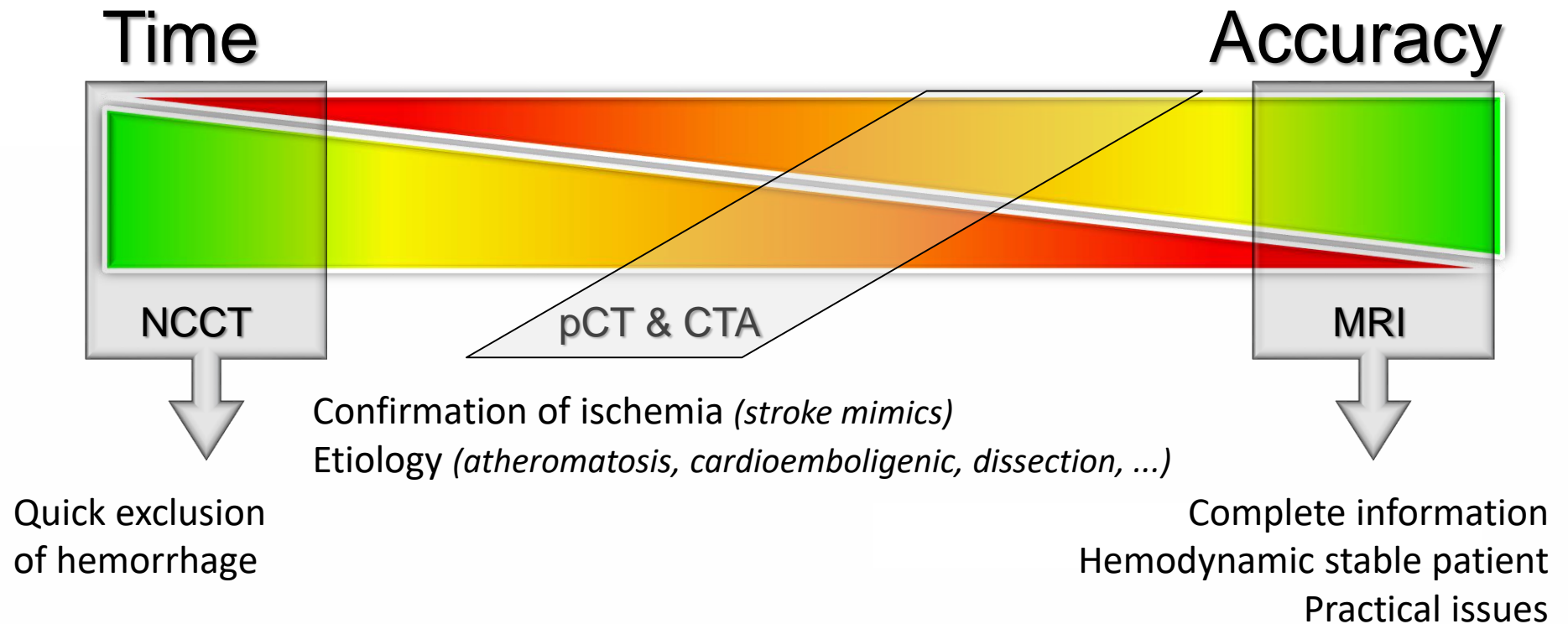
Actual Shortcomings

CT and MRI Stroke work up and Optimisation



Actual Shortcomings

CT and MRI Stroke work up and Optimisation



Actual Shortcomings

Why do we use CT- and MR- Perfusion?

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JANUARY 4, 2018 VOL. 378 NO. 1

Thrombectomy 6 to 24 Hours after Stroke with a Mismatch Between Deficit and Infarct

R.G. Nogueira, A.P. Jadhav, D.C. Haussen, A. Bonafe, R.F. Budzik, P. Bhaia, D.R. Yavagal, M. Ribo, C. Cognard, R.A. Hanel, C.A. Sila, A.E. Hassan, M. Miller, E.I. Levy, P. Mitchell, M. Chen, J.D. English, Q.A. Shah, F.L. Silver, V.M. Pereira, B.P. Mehta, B.W. Baster, M.G. Abraham, P. Cardona, E. Veznedaroglu, F.R. Hellinger, L. Feng, J.F. Kirmani, D.K. Lopes, B.T. Jankowitz, M.R. Frankel, V. Costalat, N.A. Vora, A.J. Yoo, A.M. Malik, A.J. Furlan, M. Rubiera, A. Aghababrahim, J.-M. Olivrot, W.G. Telle, R. Shields, T. Graves, R.J. Lewis, W.S. Smith, D.S. Liebeskind, J.L. Saver, and T.G. Jovin, for the DAWN Trial Investigators*

ABSTRACT

BACKGROUND: The effect of endovascular thrombectomy that is performed more than 6 hours after the onset of ischemic stroke is uncertain. Patients with a clinical deficit that is disproportionately severe relative to the infarct volume may benefit from late thrombectomy.

METHODS: We enrolled patients with occlusion of the intracranial internal carotid artery or proximal middle cerebral artery who had last been known to be well 6 to 24 hours earlier and who had a mismatch between the severity of the clinical deficit and infarct volume, with mismatch criteria defined according to age (40 years or older in the years). Patients were randomly assigned to thrombectomy plus standard care (thrombectomy group) or to standard care alone (control group). The primary outcome was the rate of functional independence at 90 days (modified Rankin scale score of 1 to 2).

RESULTS: Among 225 patients who had last been known to be well 6 to 24 hours earlier and who had a mismatch between clinical deficit and infarct, outcomes for disability at 90 days were better with thrombectomy plus standard care than with standard care alone. (Funded by Stryker Neurovascular; DAWN ClinicalTrials.gov number, NCT02142283.)

CONCLUSIONS: Among patients with acute stroke who had last been known to be well 6 to 24 hours earlier and who had a mismatch between clinical deficit and infarct, outcomes for disability at 90 days were better with thrombectomy plus standard care than with standard care alone. (Funded by Stryker Neurovascular; DAWN ClinicalTrials.gov number, NCT02142283.)

INTRODUCTION: The effect of endovascular thrombectomy that is performed more than 6 hours after the onset of ischemic stroke is uncertain. Patients with a clinical deficit that is disproportionately severe relative to the infarct volume may benefit from late thrombectomy.

METHODS: We enrolled patients with occlusion of the intracranial internal carotid artery or proximal middle cerebral artery who had last been known to be well 6 to 24 hours earlier and who had a mismatch between the severity of the clinical deficit and infarct volume, with mismatch criteria defined according to age (40 years or older in the years). Patients were randomly assigned to thrombectomy plus standard care (thrombectomy group) or to standard care alone (control group). The primary outcome was the rate of functional independence at 90 days (modified Rankin scale score of 1 to 2).

RESULTS: Among 225 patients who had last been known to be well 6 to 24 hours earlier and who had a mismatch between clinical deficit and infarct, outcomes for disability at 90 days were better with thrombectomy plus standard care than with standard care alone. (Funded by Stryker Neurovascular; DAWN ClinicalTrials.gov number, NCT02142283.)

CONCLUSIONS: Among patients with acute stroke who had last been known to be well 6 to 24 hours earlier and who had a mismatch between clinical deficit and infarct, outcomes for disability at 90 days were better with thrombectomy plus standard care than with standard care alone. (Funded by Stryker Neurovascular; DAWN ClinicalTrials.gov number, NCT02142283.)

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Thrombectomy for Stroke at 6 to 16 Hours with Selection by Perfusion Imaging

G.W. Albers, M.P. Marks, S. Kemp, S. Christensen, J.P. Tsai, S. Ortega-Gutierrez, R.A. McTaggart, M.T. Torbey, M. Kim-Tenser, T. Leslie-Mazwi, A. Sarraj, S.E. Kahn, S.A. Ansari, S.D. Yeatts, S. Hamilton, M. Mirshahi, J.J. Heit, G. Zaharchuk, S. Kim, J. Carrozella, Y.Y. Palesch, A.M. Demchuk, R. Bammer, P.W. Lavori, J.P. Broderick, and M.G. Lansberg, for the DEFUSE 3 Investigators*

ABSTRACT

BACKGROUND: Thrombectomy is currently recommended for eligible patients with stroke who are treated within 6 hours after the onset of symptoms.

METHODS: We conducted a multicenter, randomized, open-label trial, with blinded outcome assessment, of thrombectomy in patients 6 to 16 hours after they were last known to be well and who had remaining ischemic brain tissue that was not salvaged. Patients with proximal middle-cerebral-artery or internal-carotid-artery occlusion and an initial infarct size of less than 70 mL and a ratio of the volume of ischemic brain tissue on perfusion imaging to infarct volume of 1.9 or more were randomly assigned to endovascular thrombectomy plus medical therapy (thrombectomy group) or to medical therapy alone (control group). The primary outcome was the modified Rankin scale score (range, 0 to 6) at day 90.

RESULTS: The trial was terminated early for efficacy after 18 U.S. centers had completed 92 of the endovascular therapy group and 92 of the medical-therapy group. Endovascular therapy plus medical therapy, as compared with medical therapy alone, was associated with a favorable shift in the distribution of functional outcomes on the modified Rankin scale at 90 days (odds ratio, 2.77; P<0.001) and a higher percentage of patients who were functionally independent, defined as a score on the modified Rankin scale of 0 to 2 (46% vs. 17%; P<0.001). The 90-day mortality rate was 14% in the endovascular-therapy group and 26% in the medical-therapy group (P=0.05), and there was no significant between-group difference in the frequency of symptomatic intracranial hemorrhage (7% and 4%, respectively; P=0.75) or of serious adverse events (4% and 5%, respectively; P=0.18).

CONCLUSIONS: Endovascular thrombectomy for ischemic stroke 6 to 16 hours after a patient was last known to be well plus standard medical therapy resulted in better functional outcomes than standard medical therapy alone among patients with proximal middle-cerebral-artery or internal-carotid-artery occlusion and a region of tissue that was ischemic but not yet infarcted. (Funded by the National Institute of Neurological Disorders and Stroke; DEFUSE 3 ClinicalTrials.gov number, NCT02566415.)

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 9, 2019 VOL. 380 NO. 19

Thrombolysis Guided by Perfusion Imaging up to 9 Hours after Onset of Stroke

H. Ma, B.C.V. Campbell, M.W. Parsons, L. Churilov, C.R. Levi, C. Hsu, T.J. Kleing, T. Wijeratne, S. Curtze, H.M. Dewey, F. Mitoff, C.-H. Tsai, J.-T. Lee, T.G. Phan, N. Mahant, M.-C. Sun, M. Krause, J. Sturm, R. Grimley, C.-H. Chen, C.-J. Hu, A.A. Wong, D. Field, Y. Sun, P.A. Barber, A. Sabert, J. James, J.-S. Jeng, B. Clissold, R. Markus, C.-H. Lin, L.-M. Lien, C.F. Blefin, S. Christensen, N. Yassi, G. Sharma, A. Bivard, P.M. Desmond, B. Yan, P.J. Mitchell, V. Thijs, L. Carey, A. Meretoja, S.M. Davis, and G.A. Donnan, for the EXTEND Investigators*

ABSTRACT

BACKGROUND: The time to initiate intravenous thrombolysis for acute ischemic stroke is generally limited to within 4.5 hours after the onset of symptoms. Some trials have suggested that the treatment window may be extended in patients who are shown to have ischemic but not yet infarcted brain tissue on imaging.

METHODS: We conducted a multicenter, randomized, placebo-controlled trial of intravenous alteplase guided by perfusion imaging up to 9 hours after the onset of symptoms. Patients with acute ischemic stroke who had by perfusion imaging shown to have ischemic but not yet infarcted brain tissue on imaging were randomly assigned to alteplase plus medical therapy (alteplase group) or to medical therapy alone (control group). The primary outcome was a score on the modified Rankin scale (range, 0 [no symptoms] to 6 [death]) at day 90.

RESULTS: After 225 of the planned 310 patients had been enrolled, the trial was terminated because of a lack of equipoise after the publication of positive results from a previous trial. A total of 113 patients were randomly assigned to the alteplase group and 112 to the placebo group. The primary outcome occurred in 40 patients (55.4%) in the alteplase group and in 33 patients (29.5%) in the placebo group (adjusted risk ratio, 1.44; 95% confidence interval [CI], 1.01 to 2.06; P=0.04). Symptomatic intracerebral hemorrhage occurred in 7 patients (6.2%) in the alteplase group and in 1 patient (0.9%) in the placebo group (adjusted risk ratio, 7.22; 95% CI, 0.97 to 51.5; P=0.05). A secondary ordinal analysis of the distribution of scores on the modified Rankin scale did not show a significant between-group difference in functional improvement at 90 days.

CONCLUSIONS: Among the patients in this trial who had ischemic stroke and salvageable brain tissue, the use of alteplase between 4.5 and 9.0 hours after stroke onset or at the time the patient awoke with stroke symptoms resulted in a higher percentage of patients with no or minor neurologic deficits than the use of placebo. There were more cases of asymptomatic cerebral hemorrhage in the alteplase group than in the placebo group. (Funded by the Australian National Health and Medical Research Council and others; EXTEND ClinicalTrials.gov numbers, NCT00878730 and NCT01508293.)

DAWN-study

DEFUSE 3-study

EXTEND-study



Actual Shortcomings

Questions we ask:

Hemorrhage?

Clot?

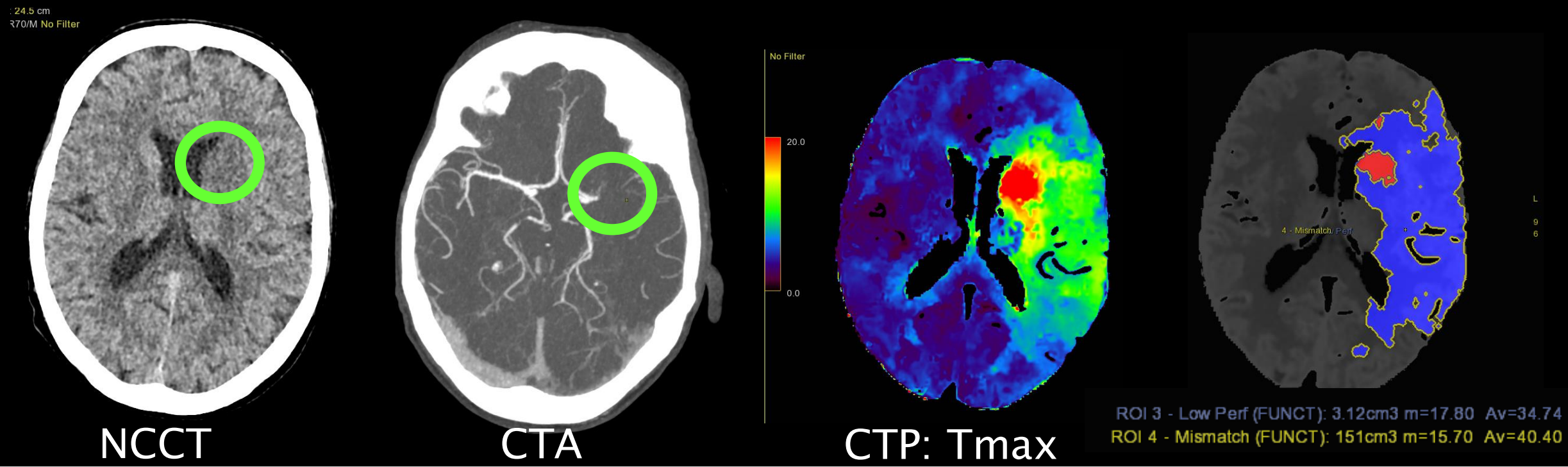
Perfusion defect?

Core volume estimation?

Actual Shortcomings

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

F 62 y: Acute right hemiplegia (Wake up): NIHSS 18



Actual Shortcomings

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

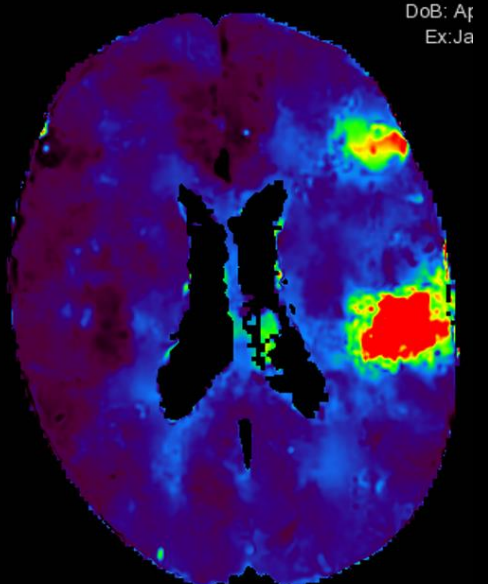
M 64 y: Acute right hemiplegia <4,5h NIHSS: 9



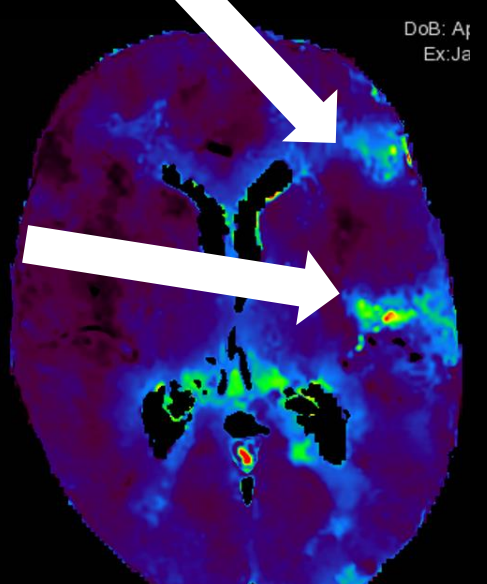
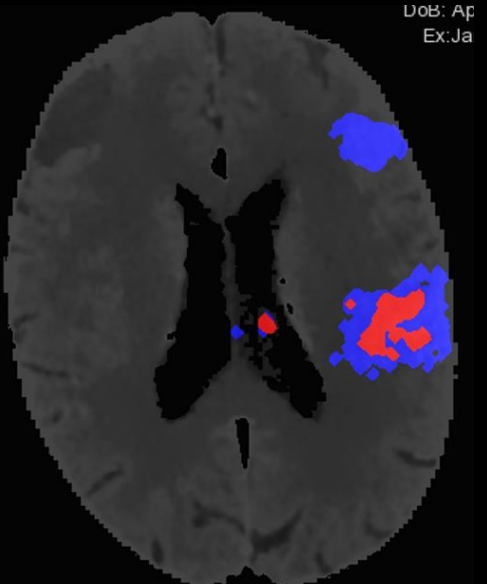
NCCT



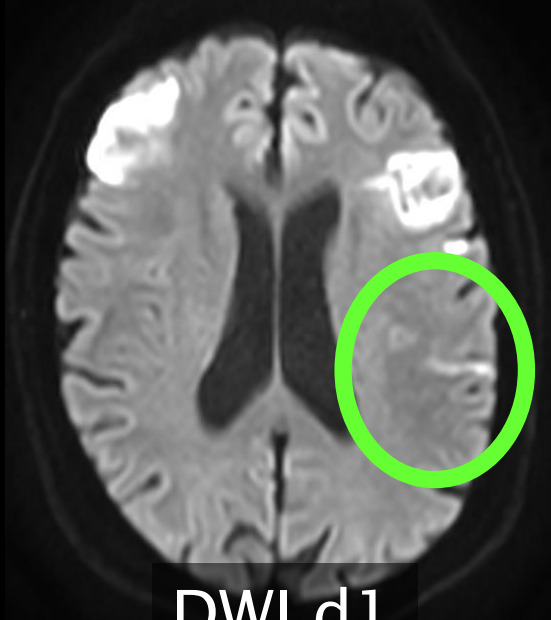
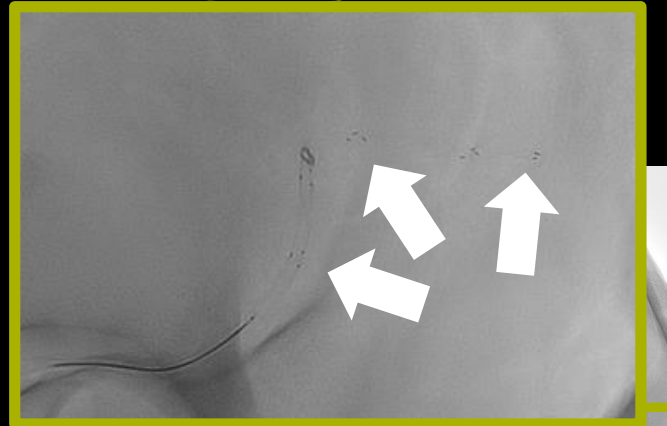
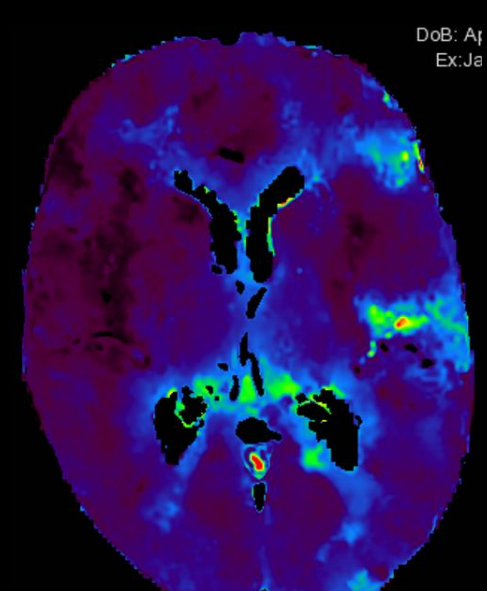
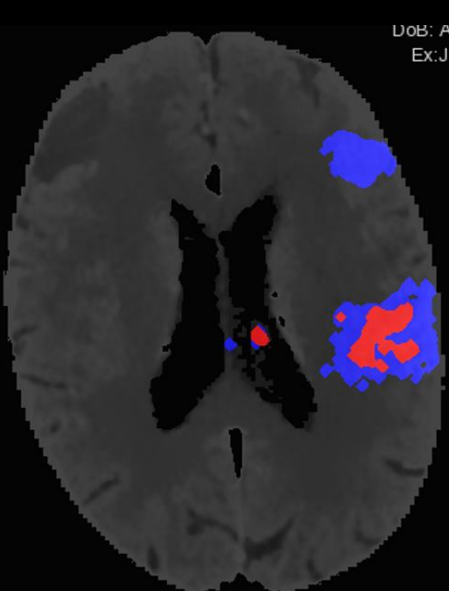
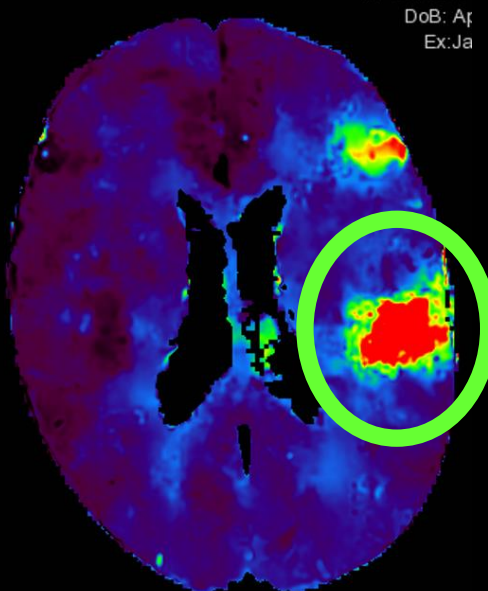
CTA



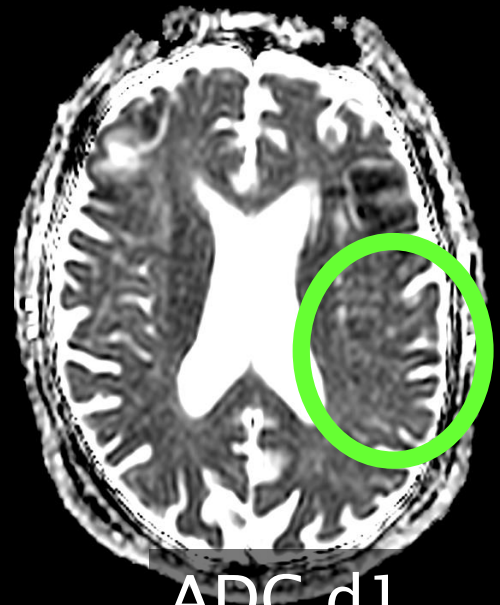
CTP: Tmax



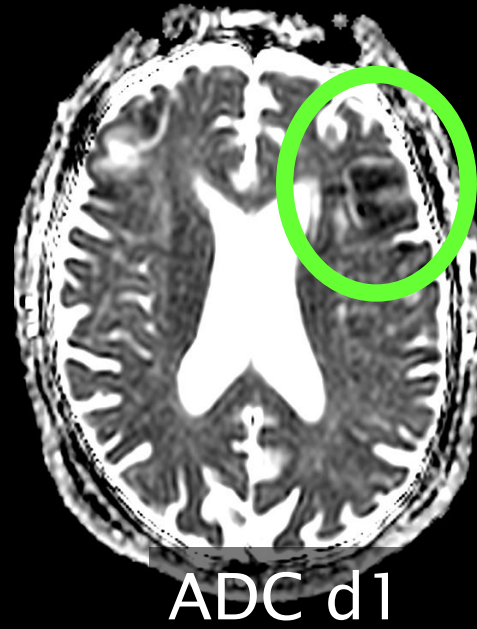
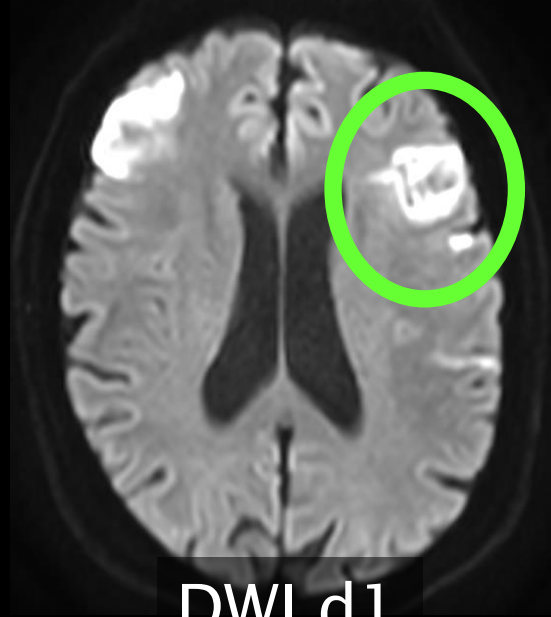
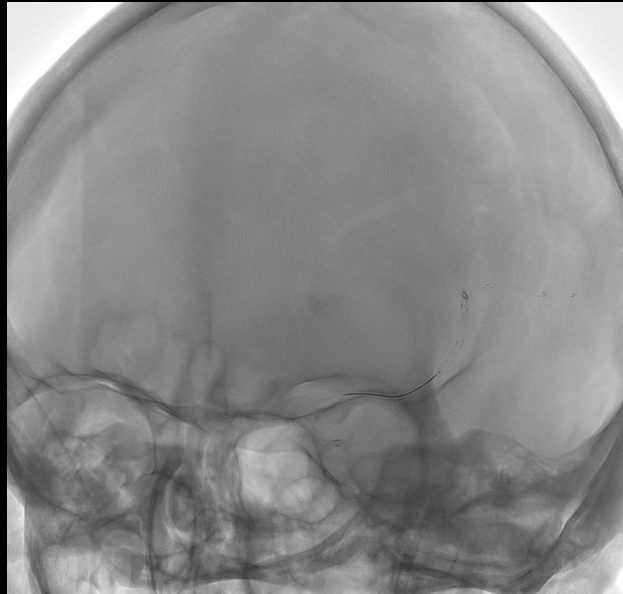
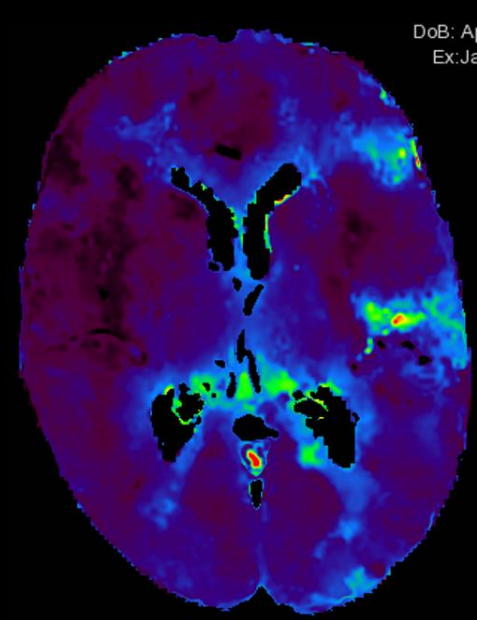
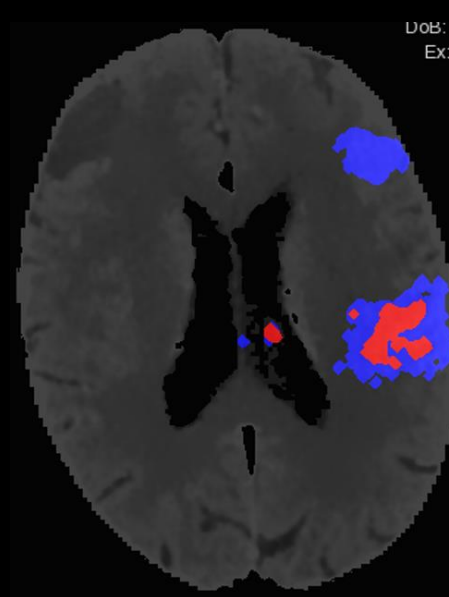
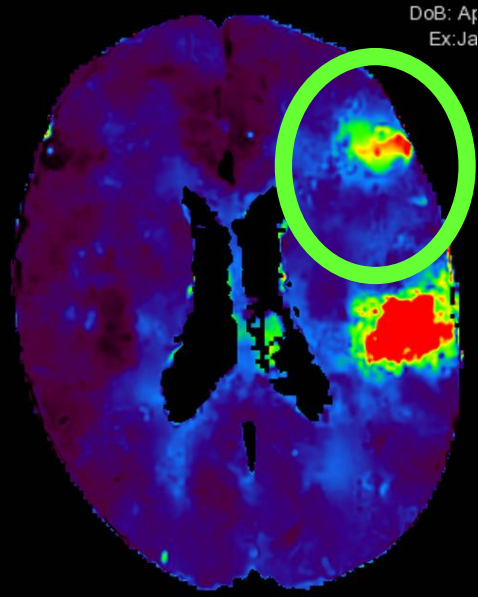
CTP: Tmax

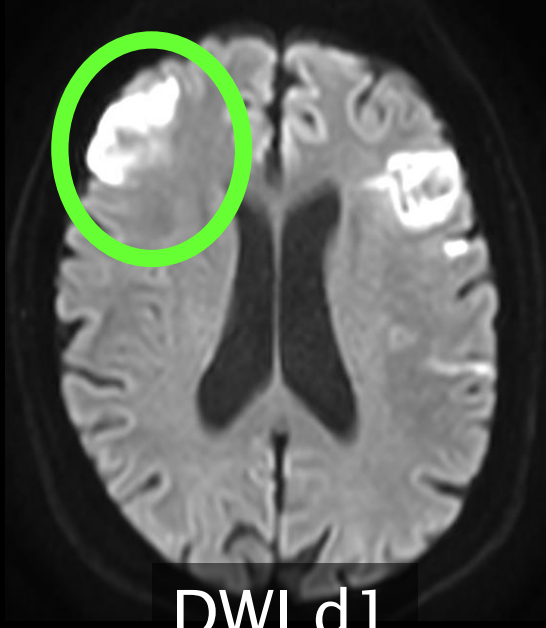
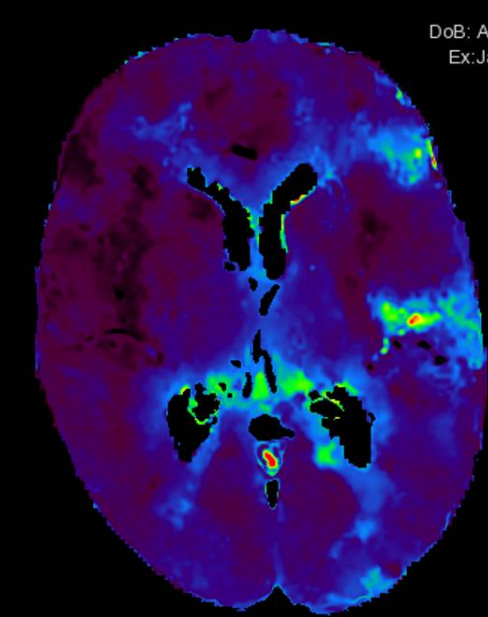
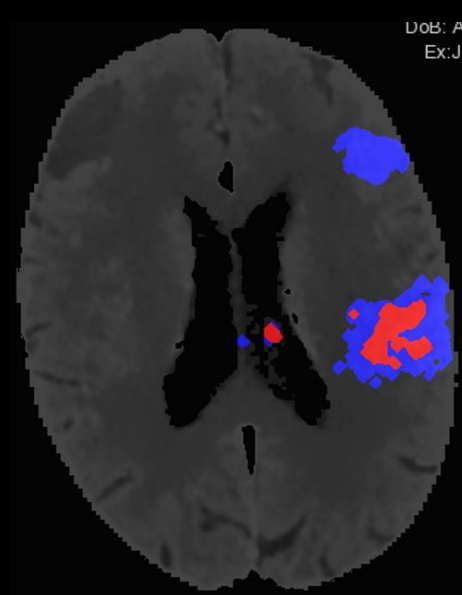
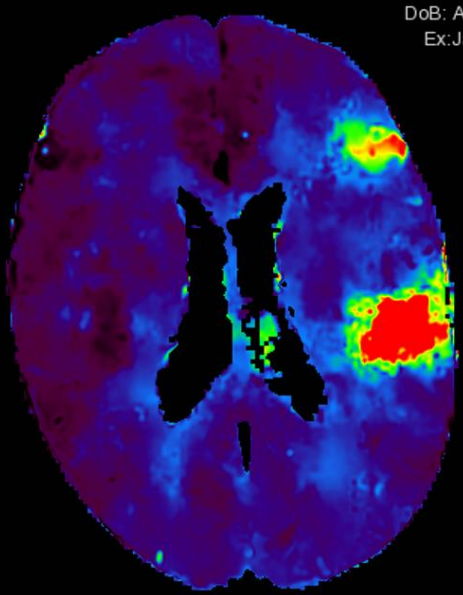


DWI d1



ADC d1





Discharge NIHSS:1 (Dysartria)

Actual Shortcomings

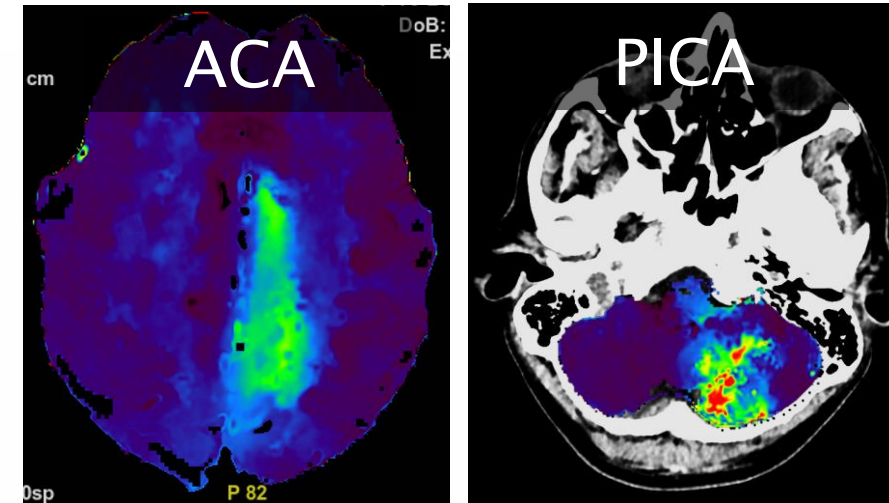
Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

Last case: <4,5h

No Hemorrhage (older infarct frontal right)

No LVO

- > No Perfusion CT
- > No Interventional procedure?



CT or MR Perfusion > Clots: M2 – M4, ACA, PCA, PICA, AICA and SCA)

Actual Shortcomings

Distal occlusions are under investigation:

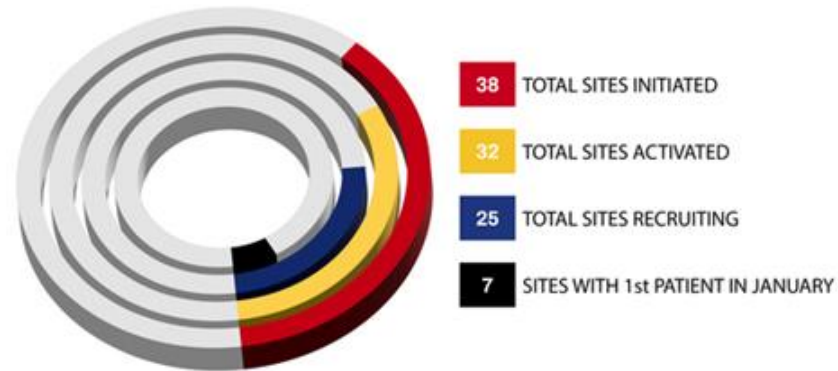
DISTAL

DUSK

DISTALS

DISCOUNT

.....



DISTAL Study

Endovascular therapy plus best medical treatment (BMT) versus BMT alone for Medium Vessel Occlusion sTroke- a prAgmatic, international, multicentre, randomized triaL (DISTAL)

Principal Investigators

Prof. Marios-Nikos Psychogios, Head of diagnost. and interv. Neuroradiology, and Prof. Urs Fischer, Head of Neurology, USB

Study design

International, multicentre, pragmatic, randomised clinical trial

Study centres

At least 20 in Switzerland, Germany, Belgium, Portugal, Spain, Finland and Israel

Planned patients

526

Project duration

2021-2026

Actual Shortcomings

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

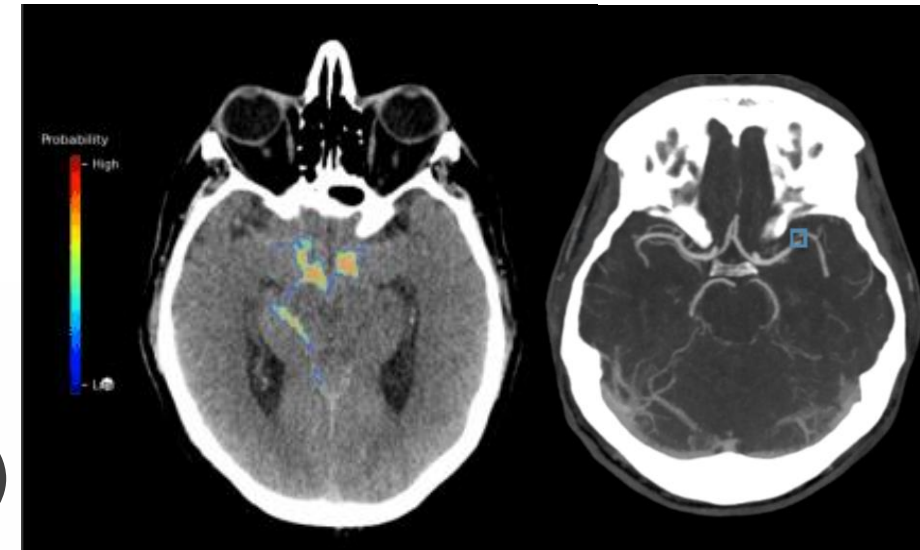
Lot of vendors offer (semi-) automated help

Actual Shortcomings

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

Lot of vendors offer (semi-) automated help

- auto Hemorrhage detection
- auto ASPECT-score
- auto LVO detection (M1, and beyond?)
- auto Perfusion Post-Processing + Core / Penumbra Volumes



But: Radiologists are responsible for the results!

Actual Shortcomings

But: Radiologists are responsible for the results

Bad perfusion acquisition > Bad volume calculations

- Movement artifacts with bad registration
- Suboptimal contrast bolus injection
- Suboptimal arterial input / venous output detection
- Truncation artefacts

Actual Shortcomings

Perfusion imaging is the best we have now.

What to expect?

What to expect?

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

Statement 1: MRI is most accurate

Statement 2: The volume of Penumbra ~ Quality of Collaterals

Statement 3: We can improve Core volume estimation @ NCCT

Statement 4: We should rethink the use of CTP

MRI: what's new

Metabolic Imaging:

APT (Amide Proton Transfer) imaging: based on pH changes

Glucose driven research

Oxygen driven research

Better discrimination: Core / Penumbra / Benign oligemia

Research: Rodent models, preliminary clinical



CATEGORIES AND TAGS

Refresher Courses: Emergency Imaging

RC 517 - Stroke revisited: imaging algorithms and protocols

March 1, 15:00 - 16:00 CET

LEVEL I

Emergency Imaging

Imaging Methods

Neuro

Professional Issues



Imaging Acute Stroke: From One-Size-Fit-All to Biomarkers

Jianfei Lu^{1†}, Qiyong Mei^{2†}, Xianhua Hou^{3†}, Anatol Manaenko⁴, Lili Zhou⁵, David S. Liebeskind⁶, John H. Zhang⁷, Yao Li^{8*} and Qin Hu^{1*}

September 2021 | Volume 12 | Article 697779

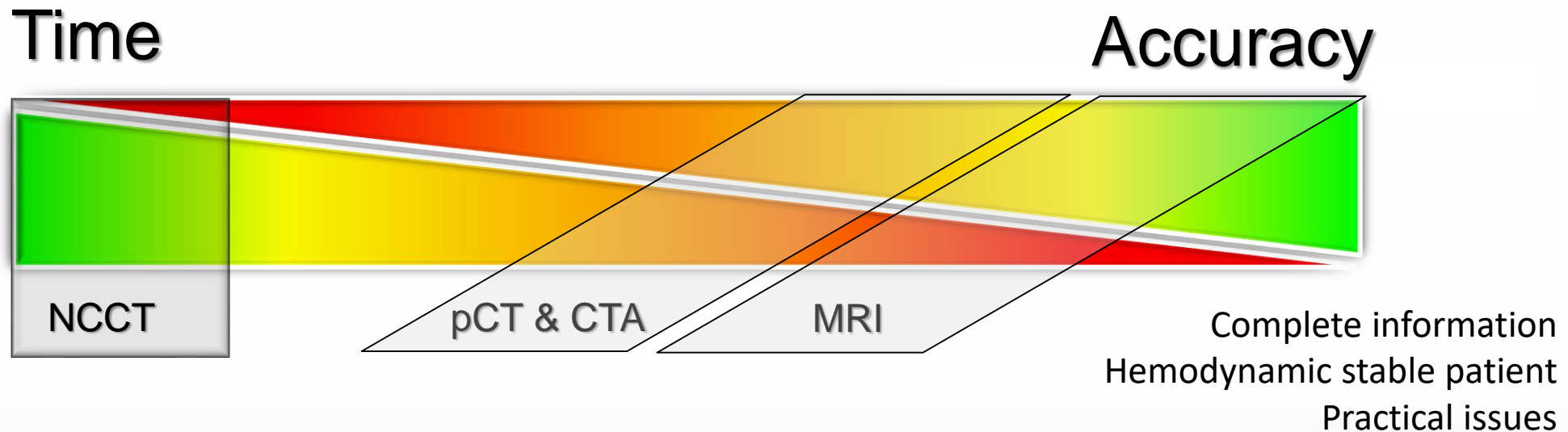
Clinical trials		CTP DWI/PWI	
Human study	MRS GluCEST SPIO/USPIO	OEF rCBF CMRO ₂ DWI/SWI Sodium MRI	¹¹ C-FMZ ¹⁸ F-FMISO Cu-ATSM MRS ATP-MRI
Rodent study	MNP-PBP DCE-MRI/CT MPIO-MRI TSPO-PET	²³ Na/ ¹ H MRI T2* OC/PWI	OCI
	Metabolism	Penumbra	Pathophysiology

FIGURE 5 | Current imaging practices in stroke studies. MRS, magnetic resonance spectroscopy; GluCEST, glutamate weighted chemical exchange saturation transfer; SPIO, superparamagnetic iron oxide; USPIO, ultrasmall superparamagnetic iron oxide; MNP-PBP, magnetic nanoparticles-P-selectin binding peptide; MRI, magnetic resonance imaging; DCE, dynamic contrast enhanced; CT, computed tomography; MPIO, microparticles of iron oxide; TSPO-PET, translocator protein-positron emission tomography; OEF, oxygen extraction fraction; rCBF, regional cerebral blood flow; CMRO₂, cerebral metabolic rate of oxygen; DWI/SWI, diffusion weighted imaging/susceptibility weighted imaging; T₂*OC/PWI, oxygen challenge/perfusion-weighted imaging; ¹¹C-FMZ, ¹¹C-flumazenil; ¹⁸F-FMISO, ¹⁸F-Fluoromisonidazole; Cu-ATSM, copper-diacyl-bis(N-methylthiosemicarbazone); ATP, adenosine triphosphate; OCI, oxygen challenge imaging.

MRI: what's new

Statement 1: MRI

- is most accurate
- will become more accurate with metabolic imaging
- will become faster
- but practical issues will stay



What to expect?

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

Statement 1: MRI is most accurate

Statement 2: The volume of Penumbra ~ Quality of Collaterals

Statement 3: We can improve Core volume estimation @ NCCT

Statement 4: We should rethink the use of CTP

Collateral Imaging

Literature:

Multiphase CT Angiography: A New Tool for the Imaging Triage of Patients with Acute Ischemic Stroke¹

Bijoy K. Menon, MD
 Christopher D. d'Estere, PhD
 Emmad M. Qazi, BSc
 Mohammed Almekhlafi, MD²
 Leszek Hahn, PhD
 Andrew M. Demchuk, MD
 Mayank Goyal, MD

Purpose: To describe the use of an imaging selection tool, multiphase computed tomographic (CT) angiography, in patients with acute ischemic stroke (AIS) and to demonstrate its interrater reliability and ability to help determine clinical outcome.

Materials and Methods: The local ethics board approved this study. Data are from the pilot phase of PROveIT, a prospective observational study analyzing utility of multimodal imaging in the triage of patients with AIS. Patients underwent baseline unenhanced CT, single-phase CT angiography of the head and neck, multiphase CT angiography, and perfusion CT. Mul-

Radiology

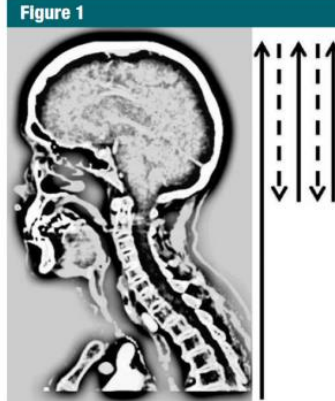


Figure 1: Multiphase CT angiography image, with each phase represented by an arrow. The first phase (long solid arrow) is conventional arch-to-vertex CT angiography. The next two phases (short solid arrows) are sequential skull base-to-vertex acquisitions performed in the midvenous and late venous phases.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

or therapy; and (f) any terminal illness



Collateral Imaging

Literature:

Stroke 2019;50:632- 638.

Results From DEFUSE 3 Good Collaterals Are Associated With Reduced Ischemic Core Growth but Not Neurologic Outcome

Adam de Havenon, MD; Michael Mlynash, MD, MS; May A. Kim-Tenser, MD;
Maarten G. Lansberg, MD, PhD; Thalabe Leslie-Mazwi, MD; Soren Christensen, PhD;
Ryan A. McTaggart, MD; Matthew Alexander, MD; Gregory Albers, MD; Joseph Broderick, MD;
Michael P. Marks, MD; Jeremy J. Heit, MD, PhD; on behalf of the DEFUSE 3 Investigators

Radiology 2022; 302:400–407

Symmetric CTA Collaterals Identify Patients with Slow- progressing Stroke Likely to Benefit from Late Thrombectomy

Robert W. Regenhardt, MD, PhD* • R. Gilberto González, MD, PhD* • Julian He, MD • Michael H. Lev, MD •
Aneesh B. Singhal, MD

Stroke 2022;53:742–748. DOI: 10.1161/STROKEAHA.121.034471

CLINICAL AND POPULATION SCIENCES

Collateral Circulation in Thrombectomy for Stroke After 6 to 24 Hours in the DAWN Trial

David S. Liebeskind, MD; Hamidreza Saber, MD; Bin Xiang, PhD; Ashutosh P. Jadhav, MD, PhD; Tudor G. Jovin, MD;
Diogo C. Haussen, MD; Ronald F. Budzik, MD; Alain Bonafe, MD; Parita Bhuva, MD; Dileep R. Yavagal, MD;
Ricardo A. Hanel, MD; Marc Ribo, MD; Christophe Cognard, MD; Cathy Sila, MD; Ameer E. Hassan, DO;
Wade S. Smith, MD; Jeffrey L. Saver, MD; Raul G. Nogueira, MD; DAWN Investigators

AJNR Am J Neuroradiol 43:1424–30 Oct 2022

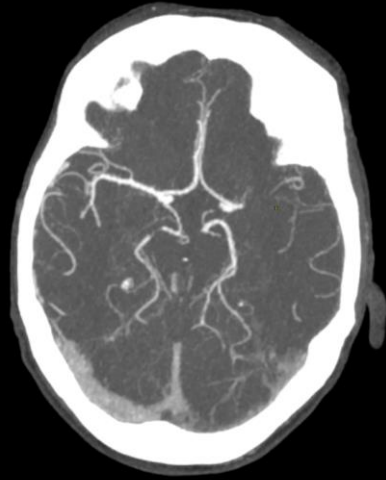
ORIGINAL RESEARCH
ADULT BRAIN

Association between Early Ischemic Changes and Collaterals in Acute Stroke: A Retrospective Study

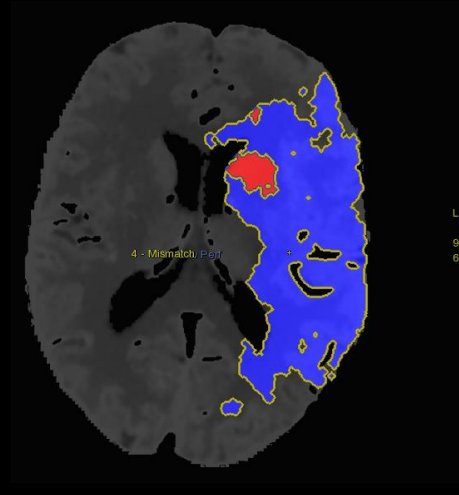
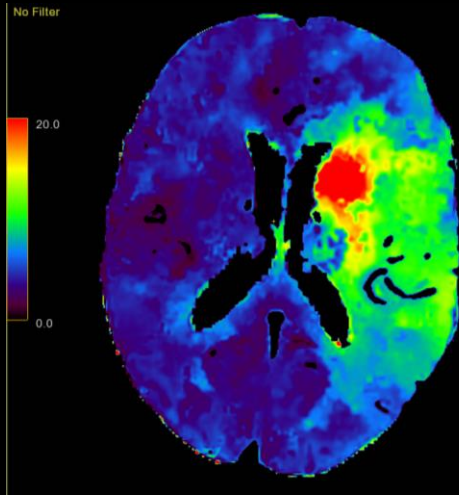
M. Laflamme, S. Carrondo-Cottin, M.-M. Valdès, D. Simonyan, M.-È. Audet, J.-L. Gariépy, M.-C. Camden,
C. Gariépy, S. Verreault, and P. Lavoie

Collateral imaging

Technique: single-phase vs multi-phase CTA

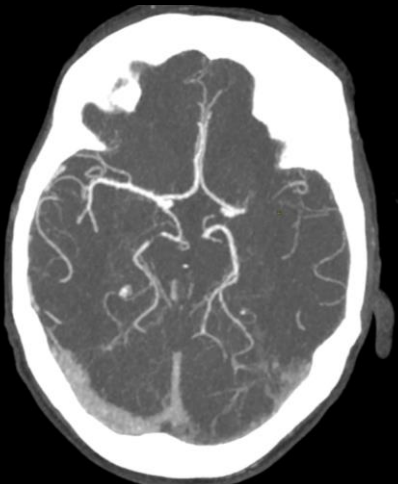
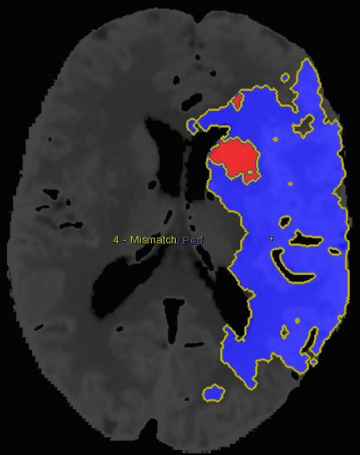
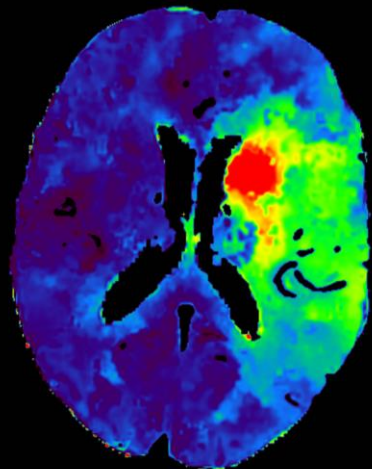
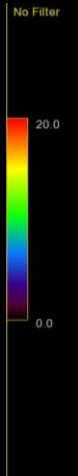
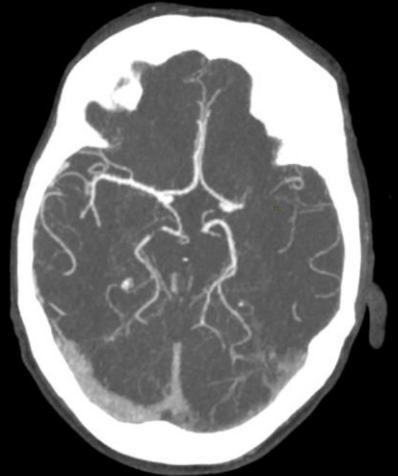


CTA COW = sCTA



Collateral imaging

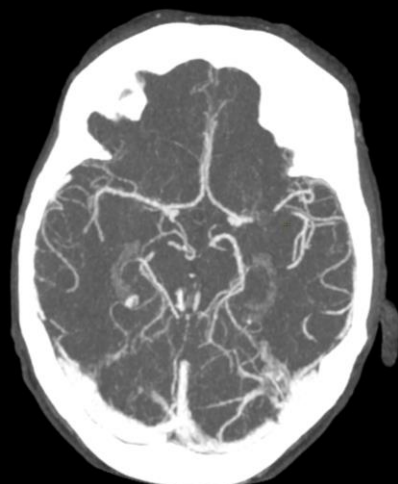
Technique: single-phase vs multi-phase CTA



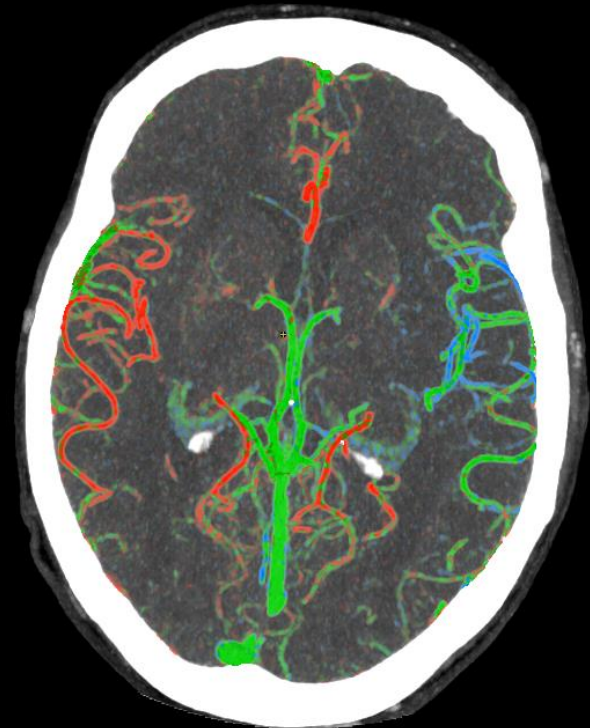
Phase 1 mCTA



Phase 2 mCTA



Phase 3 mCTA



Red Pre-Venous Phase
Green Venous Phase
Blue Post-Venous Phase

The assigned colors can be interactively modified using sliders.

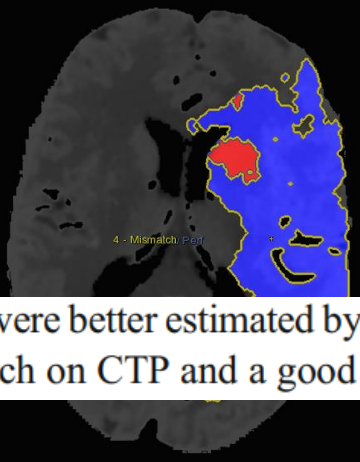
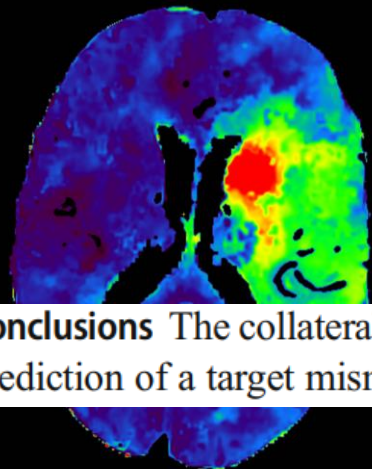
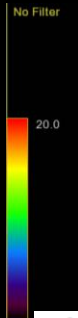
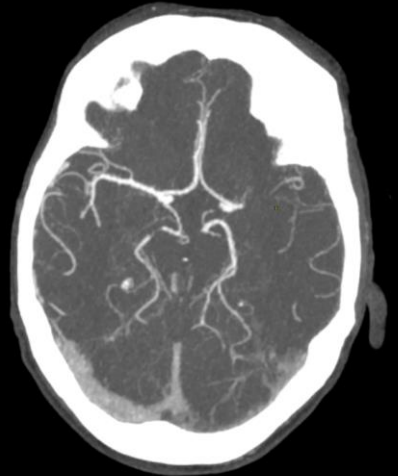
Time periods (sec):
8.24 9.74

Reset

Difference =
Temporal information
+
Cloth length

Collateral imaging

Technique: single-phase vs multi-phase CTA



European Radiology (2019) 29:4922–4929
<https://doi.org/10.1007/s00330-019-06027-9>

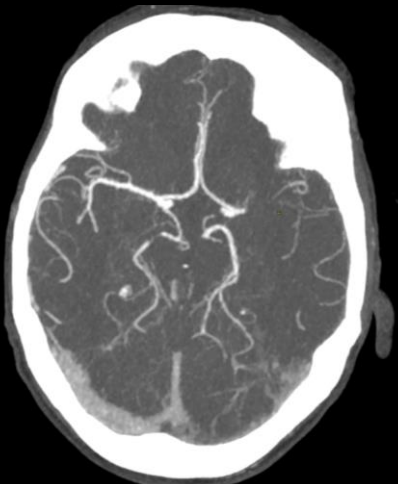
NEURO

CrossMark

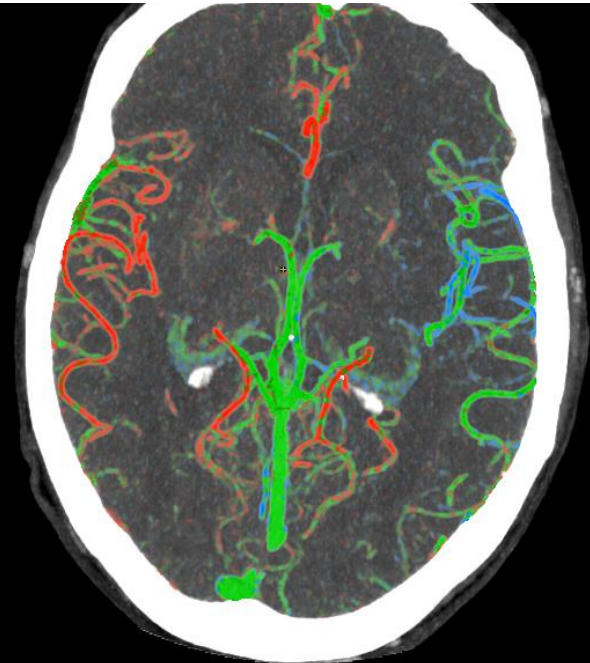
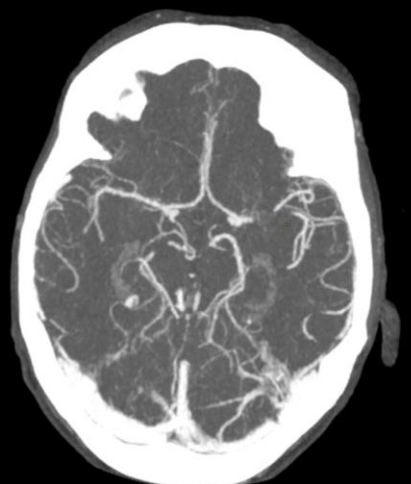
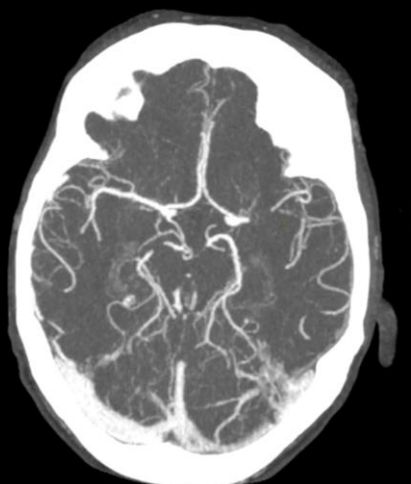
Comparison of CT angiography collaterals for predicting target perfusion profile and clinical outcome in patients with acute ischemic stroke

Shan-shan Lu¹ · Xuan Zhang¹ · Xiao-quan Xu¹ · Yue-zhou Cao² · Lin bo Zhao² · Qiang-hui Liu³ · Fei-yun Wu¹ · Sheng Liu² · Hai-bin Shi²

Conclusions The collaterals were better estimated by mCTA compared with sCTA. A mCTA collateral score of > 3 optimized the prediction of a target mismatch on CTP and a good clinical outcome in patients with AIS.

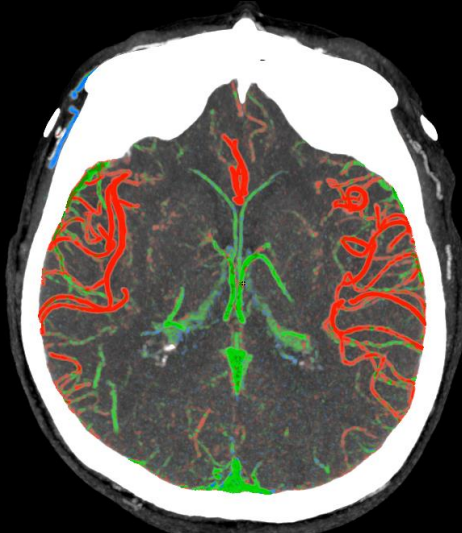


Ph1 mCTA

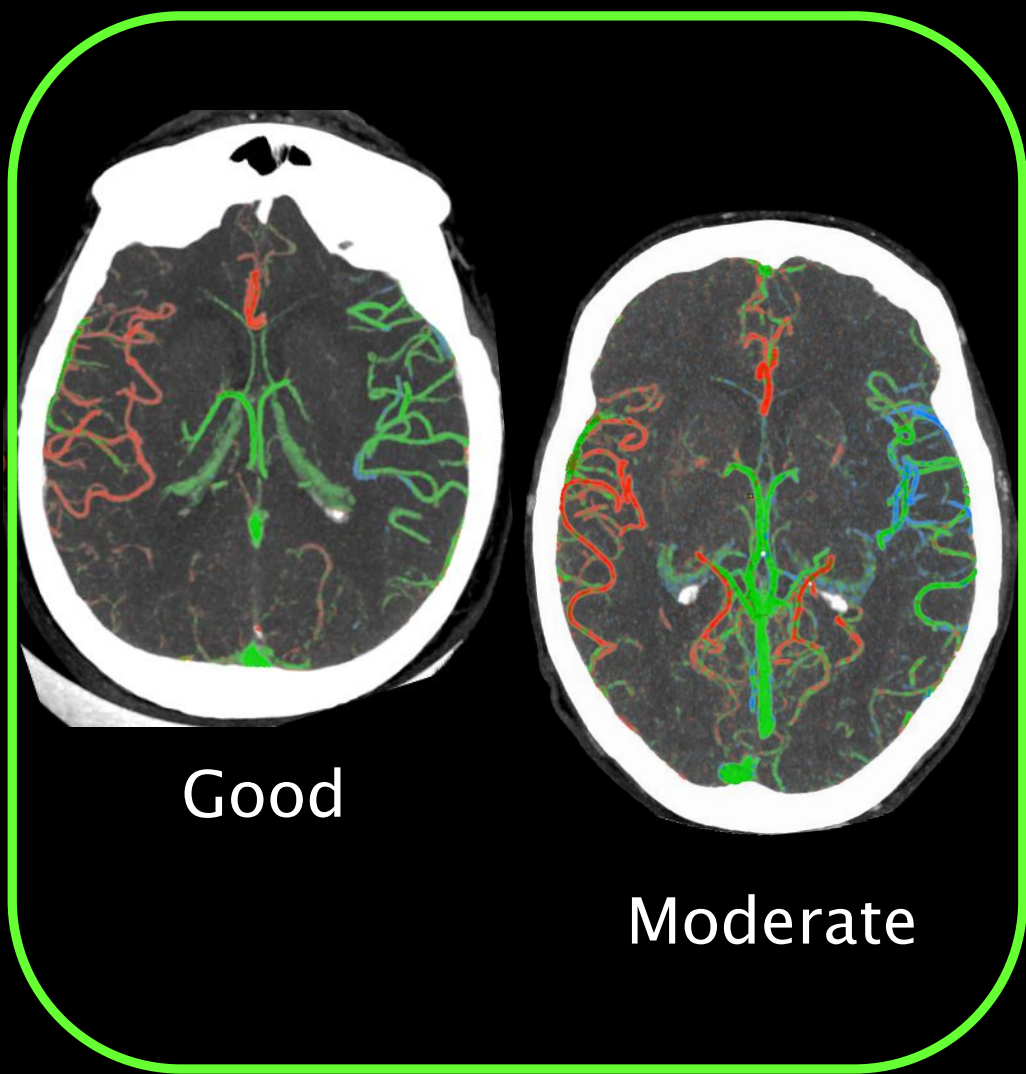


Difference =
Temporal information
+
Cloth lenght

Collateral imaging

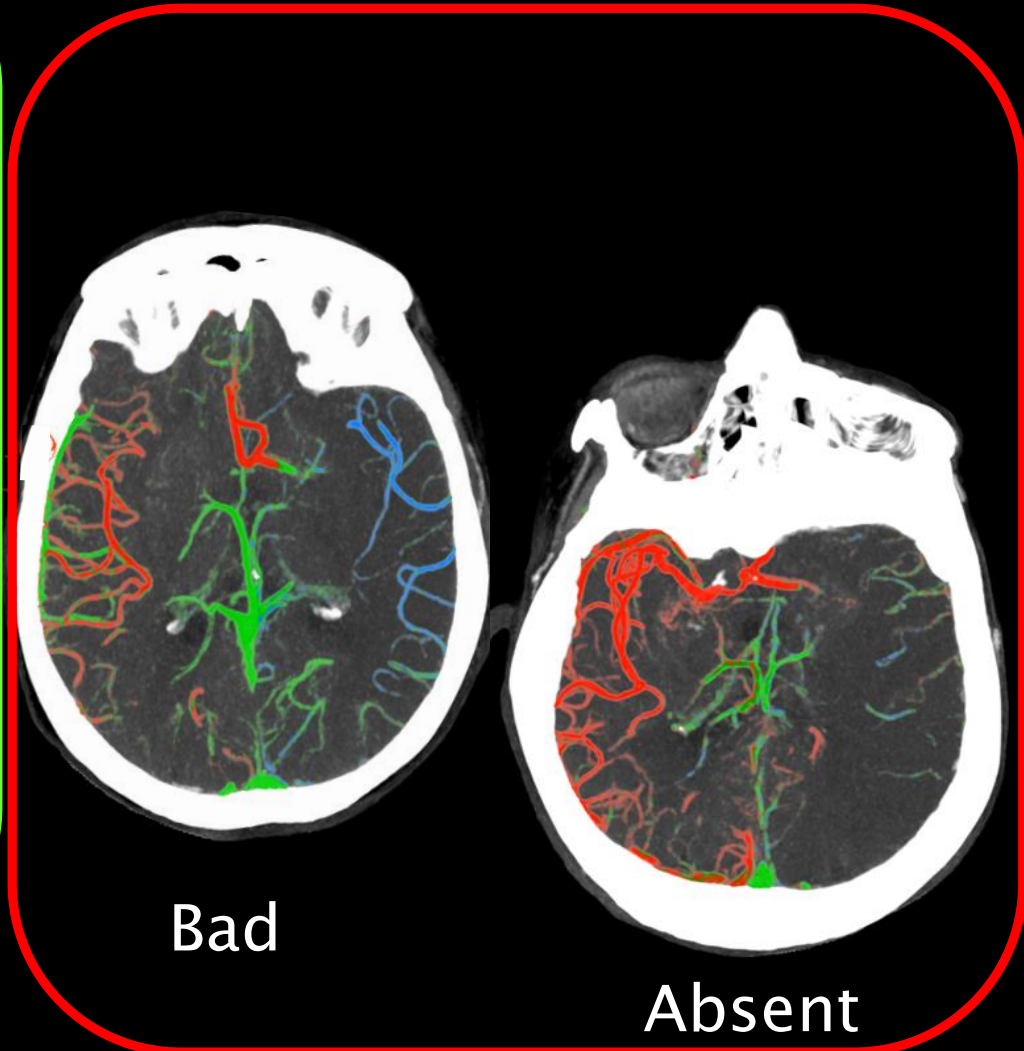


Symmetric
Normal



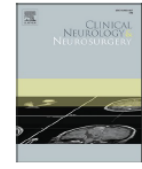
Good

Moderate



Bad

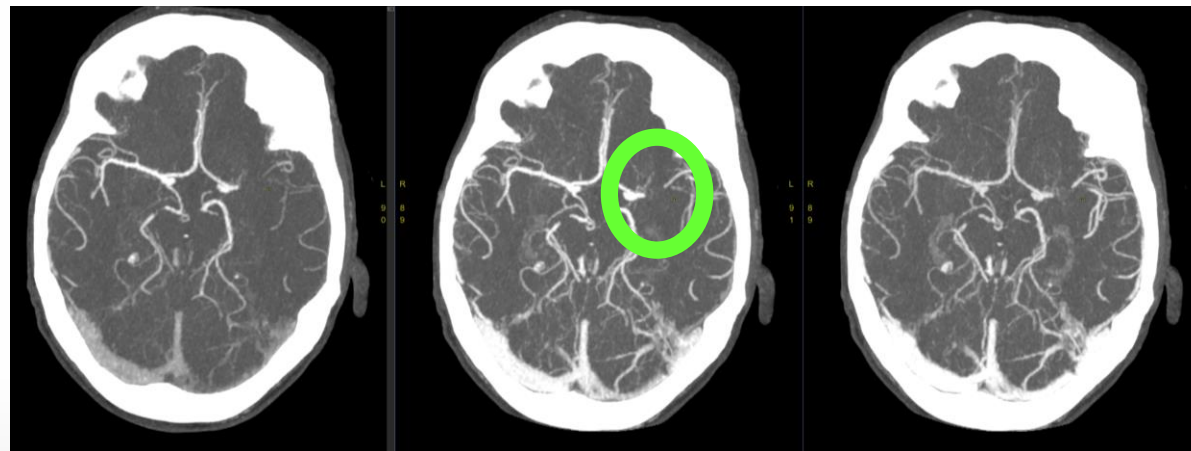
Absent



Collateral imaging

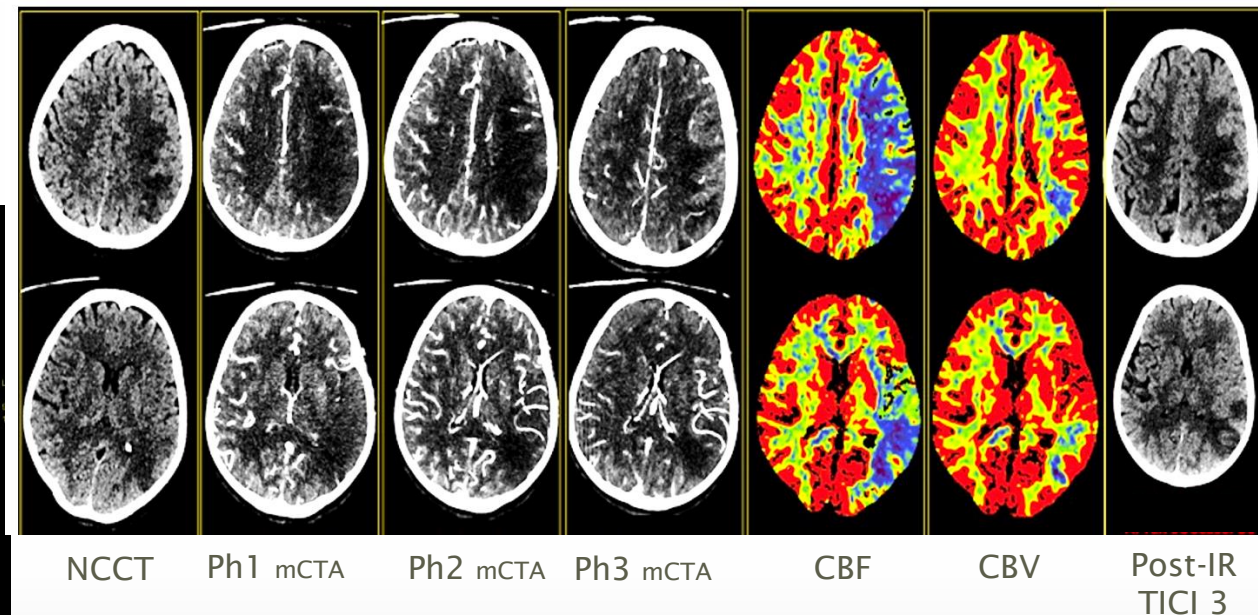
- Compared to CTP:
- No extra contrast injection
 - Less radiation dose
 - (Always) Full brain coverage
 - Less motion / flow artefacts

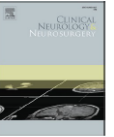
- Advantages:
- Clot length visualization
 - No complex post processing
 - Easier interpretation



Multiphase computed tomography angiography (mCTA) derived source images in acute ischemic stroke: Beyond collaterals. Can it obviate the need for computed tomography perfusion (CTP)?

Aanchal Gupta^a, Pawan K. Garg^{a,*}, Pushpinder S. Khera^a, Samhita Panda^b, Gopal K. Bohra^c, Taruna Yadav^a, M.K. Garg^c, Sarbesh Tiwari^a

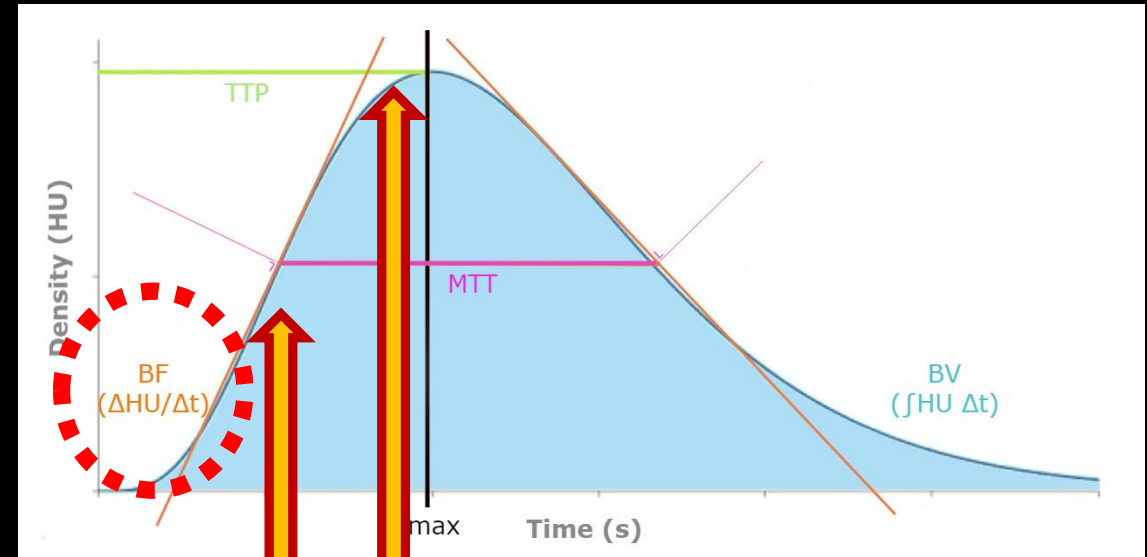
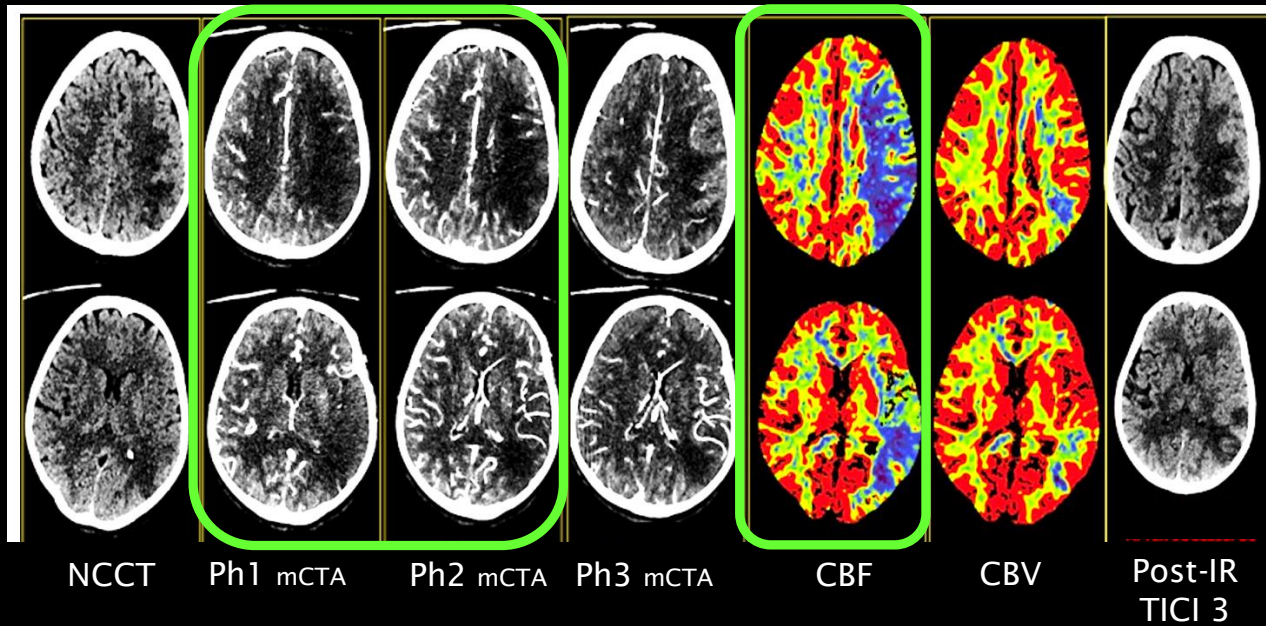




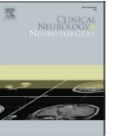
Collateral imaging

Multiphase computed tomography angiography (mCTA) derived source images in acute ischemic stroke: Beyond collaterals. Can it obviate the need for computed tomography perfusion (CTP)?

Aanchal Gupta^a, Pawan K. Garg^{a,*}, Pushpinder S. Khera^a, Samhita Panda^b, Gopal K. Bohra^c, Taruna Yadav^a, M.K. Garg^c, Sarbesh Tiwari^a



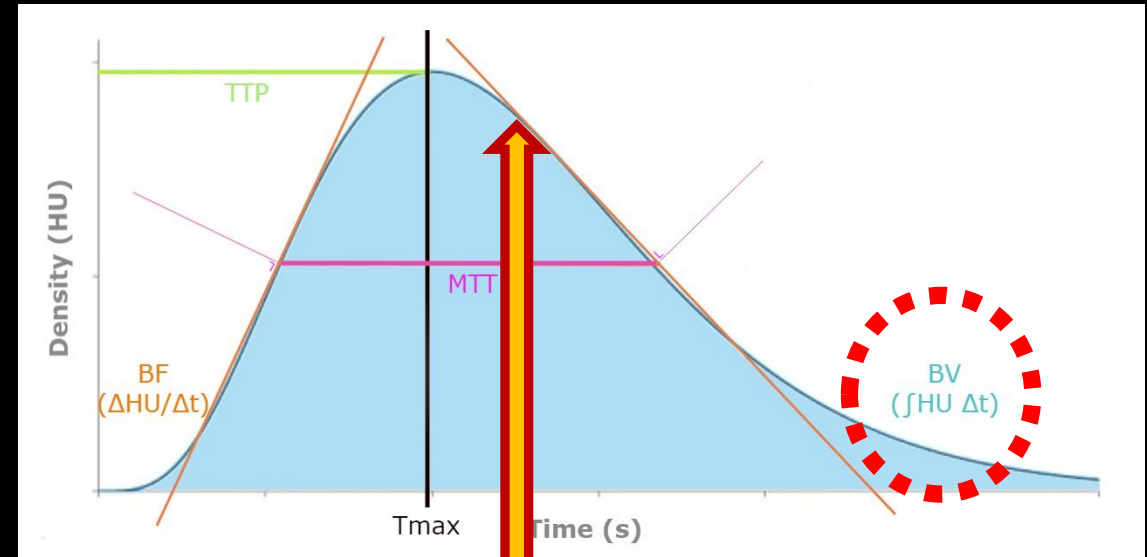
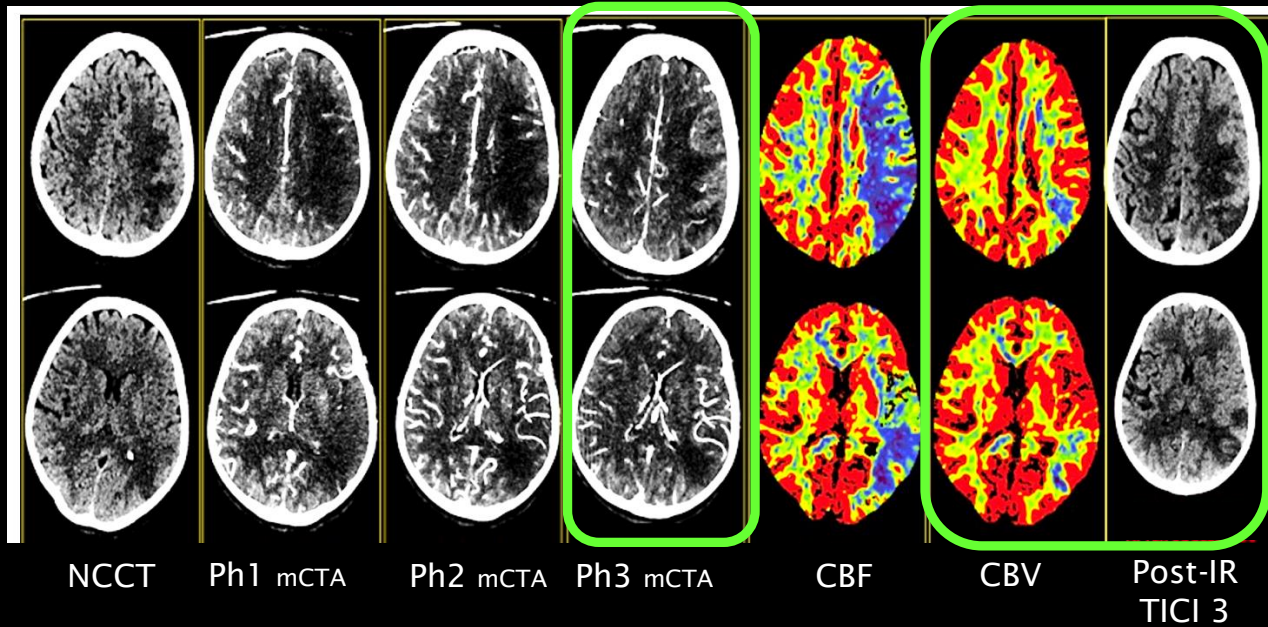
Ph1 mCTA Ph2 mCTA



Collateral imaging

Multiphase computed tomography angiography (mCTA) derived source images in acute ischemic stroke: Beyond collaterals. Can it obviate the need for computed tomography perfusion (CTP)?

Aanchal Gupta^a, Pawan K. Garg^{a,*}, Pushpinder S. Khera^a, Samhita Panda^b, Gopal K. Bohra^c, Taruna Yadav^a, M.K. Garg^c, Sarbesh Tiwari^a



What to expect?

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

Statement 1: MRI is most accurate

Statement 2: The volume of Penumbra ~ Quality of Collaterals

Statement 3: We can improve Core volume estimation @ NCCT

Statement 4: We should rethink the use of CTP

Non Contrast CT

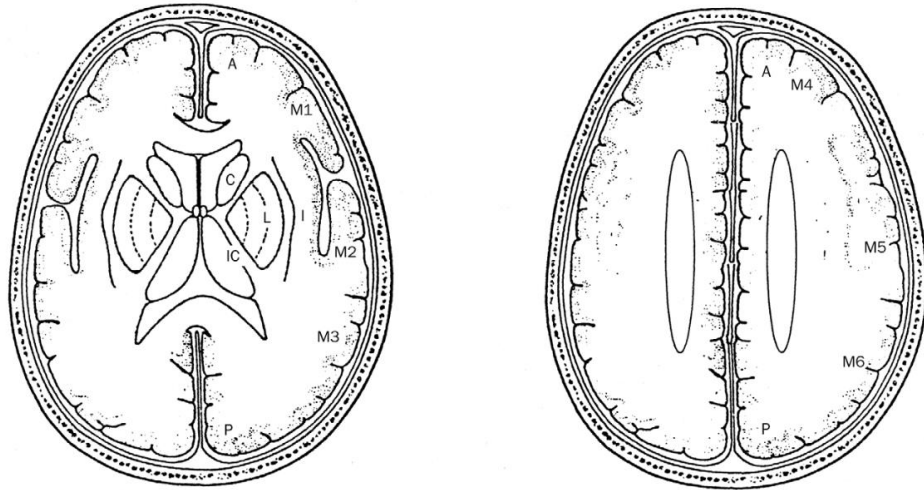
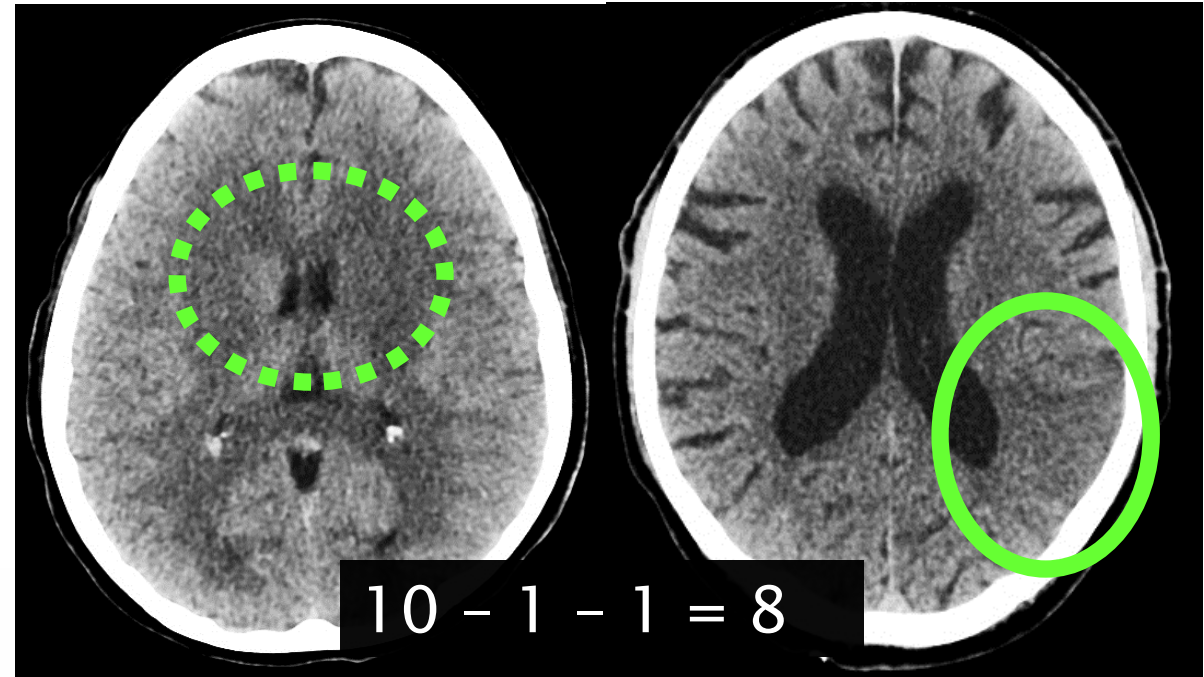


Figure 1: **ASPECTS study form**
 A=anterior circulation; P=posterior circulation; C=caudate; L=lentiform; IC=internal capsule; I=insular ribbon; MCA=middle cerebral artery; M1=anterior MCA cortex; M2=MCA cortex lateral to insular ribbon; M3=posterior MCA cortex; M4, M5, and M6 are anterior, lateral, and posterior MCA territories immediately superior to M1, M2, and M3, rostral to basal ganglia.
 Subcortical structures are allotted 3 points (C, L, and IC). MCA cortex is allotted 7 points (insular cortex, M1, M2, M3, M4, M5, and M6).



$$10 - 1 - 1 = 8$$

THE LANCET

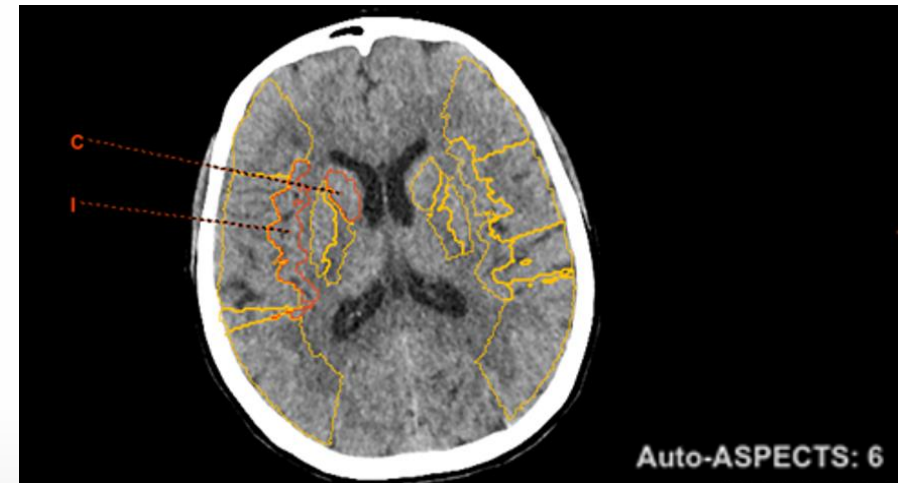
ARTICLES | VOLUME 355, ISSUE 9216, P1670-1674, MAY 13, 2000

Validity and reliability of a quantitative computed tomography score in predicting outcome of hyperacute stroke before thrombolytic therapy

Philip A Barber, MRCP • Andrew M Demchuk, FRCPC • Jinjin Zhang, MSC • Prof Alastair M Buchan, FRCPE

for the ASPECTS Study Group

Published: May 13, 2000 • DOI: [https://doi.org/10.1016/S0140-6736\(00\)02237-6](https://doi.org/10.1016/S0140-6736(00)02237-6)



Non Contrast CT

Neuroradiology (2020) 62:1231–1238
<https://doi.org/10.1007/s00234-020-02439-3>

DIAGNOSTIC NEURORADIOLOGY



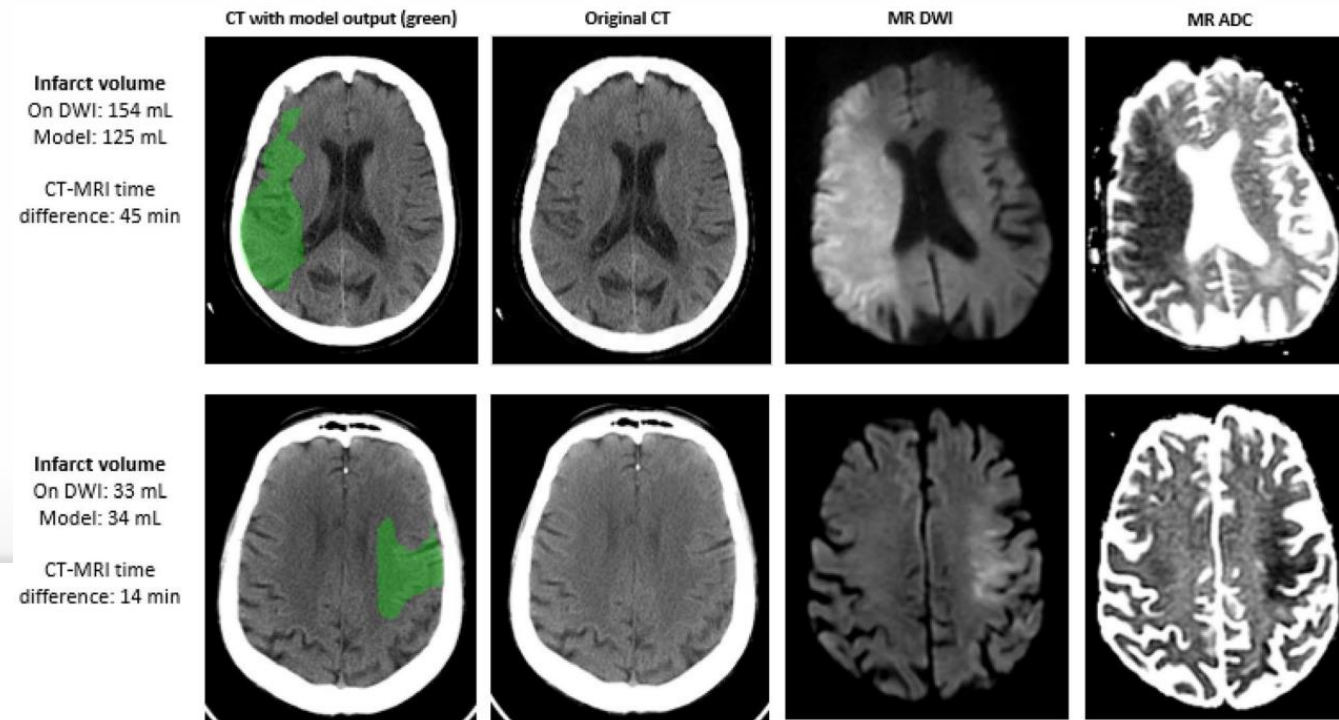
Automated ASPECT scoring in acute ischemic stroke: comparison of three software tools

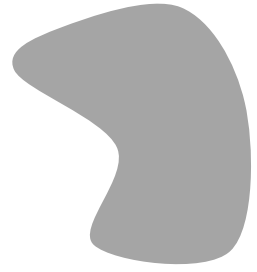
Philip Hoelter¹ · Iris Muehlen¹ · Philipp Goelitz¹ · Vanessa Beuscher² · Stefan Schwab² · Arnd Doerfler¹

In conclusion, our study reveals a plausible performance of three different fully automated analysis software solutions for ASPECT scoring when compared with each other and with expert consensus reading. This underlines the potential of software solutions as decision supporting tools. However, expert analysis of ASPECTS remains mandatory.

Head CT deep learning model is highly accurate for early infarct estimation

Romane Gauriau^{1,7}, Bernardo C. Bizzo^{1,2,3,7}✉, Donnella S. Comeau¹, James M. Hillis^{1,5}, Christopher P. Bridge^{1,2}, John K. Chin¹, Jayashri Pawar¹, Ali Pourvaziri^{1,2}, Ivana Sestic¹, Elshaima Sharaf¹, Jinjin Cao^{1,2}, Flavia T. C. Noro¹, Walter F. Wiggins^{1,4}, M. Travis Caton^{1,4}, Felipe Kitamura³, Keith J. Dreyer^{1,2}, John F. Kalafut⁶, Katherine P. Andriole^{1,4}, Stuart R. Pomerantz^{1,2}, Ramon G. Gonzalez^{1,2} & Michael H. Lev^{1,2}





A Matter of Grayscale: Understanding Dicom Windows

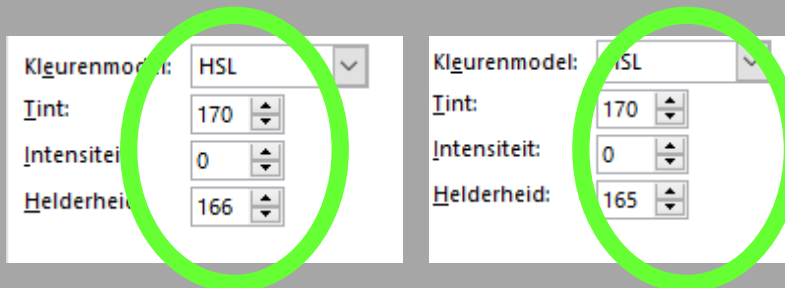
DICOM images can contain a high amount of voxel values and windowing can be thought of as a means of manipulating these values in order to change the appearance of the image so particular structures are highlighted

Nov 4, 2020 • 8 min read

medical_imaging windowing dicoms



Limited discrimination of grayscales



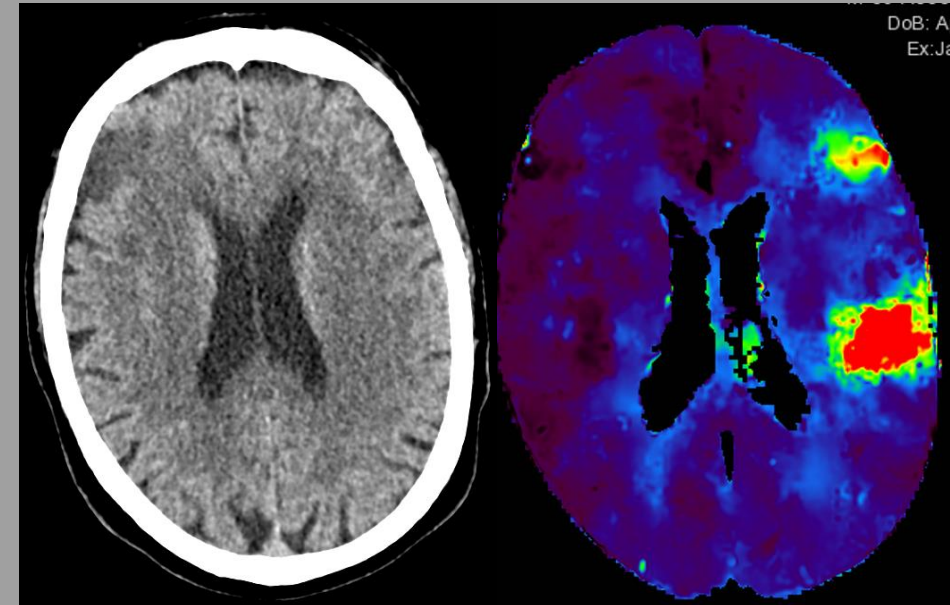
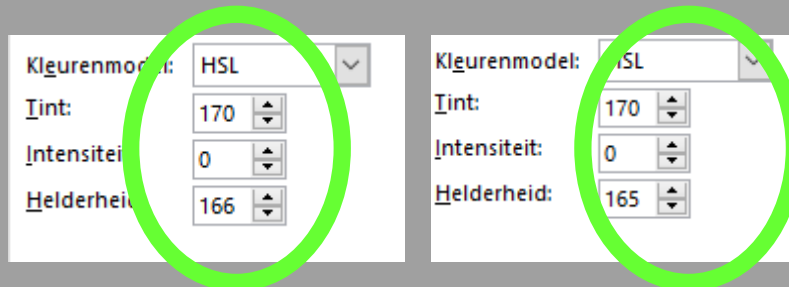
A Matter of Grayscale: Understanding Dicom Windows

DICOM images can contain a high amount of voxel values and windowing can be thought of as a means of manipulating these values in order to change the appearance of the image so particular structures are highlighted

Nov 4, 2020 • 8 min read

medical_imaging windowing dicoms

This is why Radiologist have to Window / Level



But Deep Learning can detect these differences

What to expect?

Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

Statement 1: MRI is most accurate

Statement 2: The volume of Penumbra ~ Quality of Collaterals

Statement 3: We can improve Core volume estimation @ NCCT

Statement 4: We should rethink the use of CTP

We should rethink the use of CTP

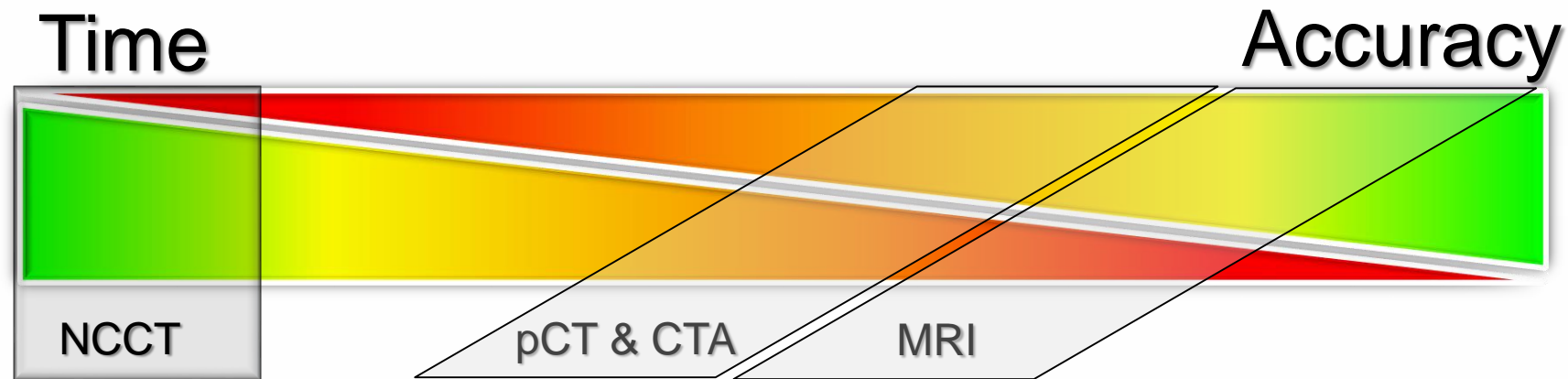
Nevertheless we made CTperfusion more performant, with Automated tools:

- High radiation dose
- Extra contrast load
- High risk for Movement / Registration Artefacts
- Suboptimal Bolus injection / Cardiac failure / Low Blood pressure
- Suboptimal Arterial input / Venous output detection
- Truncation artefacts
- No standardization of post processing algorithms / thresholding over multiple vendors
- Interpretation difficulties in less trained users
- Blind trust in automated software solutions (using disclaimers)
- Radiologists stay responsible for CTP results and interpretation

Future perspectives for Radiologic Stroke Work Up:

Best in Class = MRI (Biomarkers on pH, O₂ or glucose) + DWI

- Still time consuming ~ Time is Brain
- Organizational / practical issues

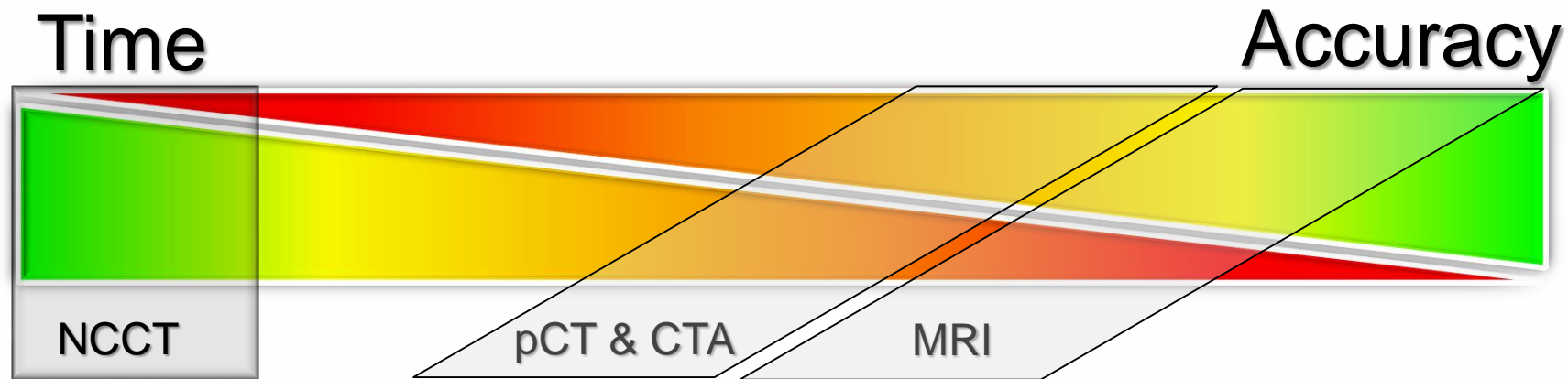


Future perspectives for Radiologic Stroke Work Up:

NCCT evaluate Hypo-perfused areas: Auto-ASPECTS > Core estimation

Deep Learning > Improved Core estimation

mCTA estimate the Core and Penumbra Volumes + Collateral evaluation

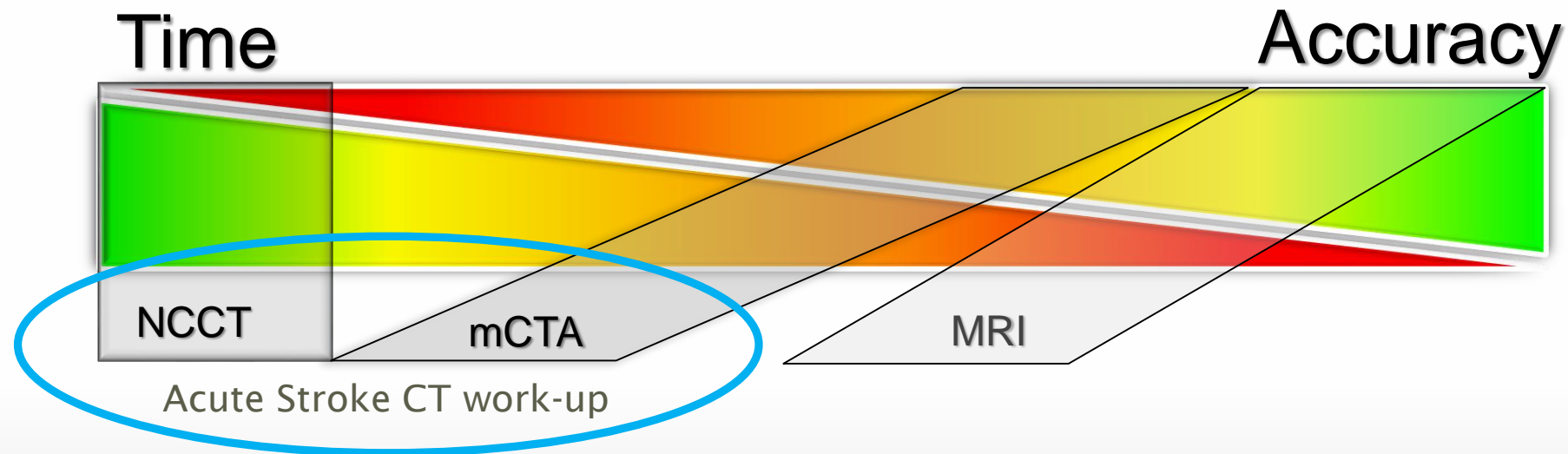


Future perspectives for Radiologic Stroke Work Up:

NCCT evaluate Hypo-perfused areas: Auto-ASPECTS > Core estimation

Deep Learning > Improved Core estimation

mCTA estimate the Core and Penumbra Volumes + Collateral evaluation



SAVE THE DATE



14-15 September 2023
Annual Congress



Thank you for your attention

koenraad.nieboer@uzbrussel.be

