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Universitair Ziekenhuis Brussel

STROKE CENTRE

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

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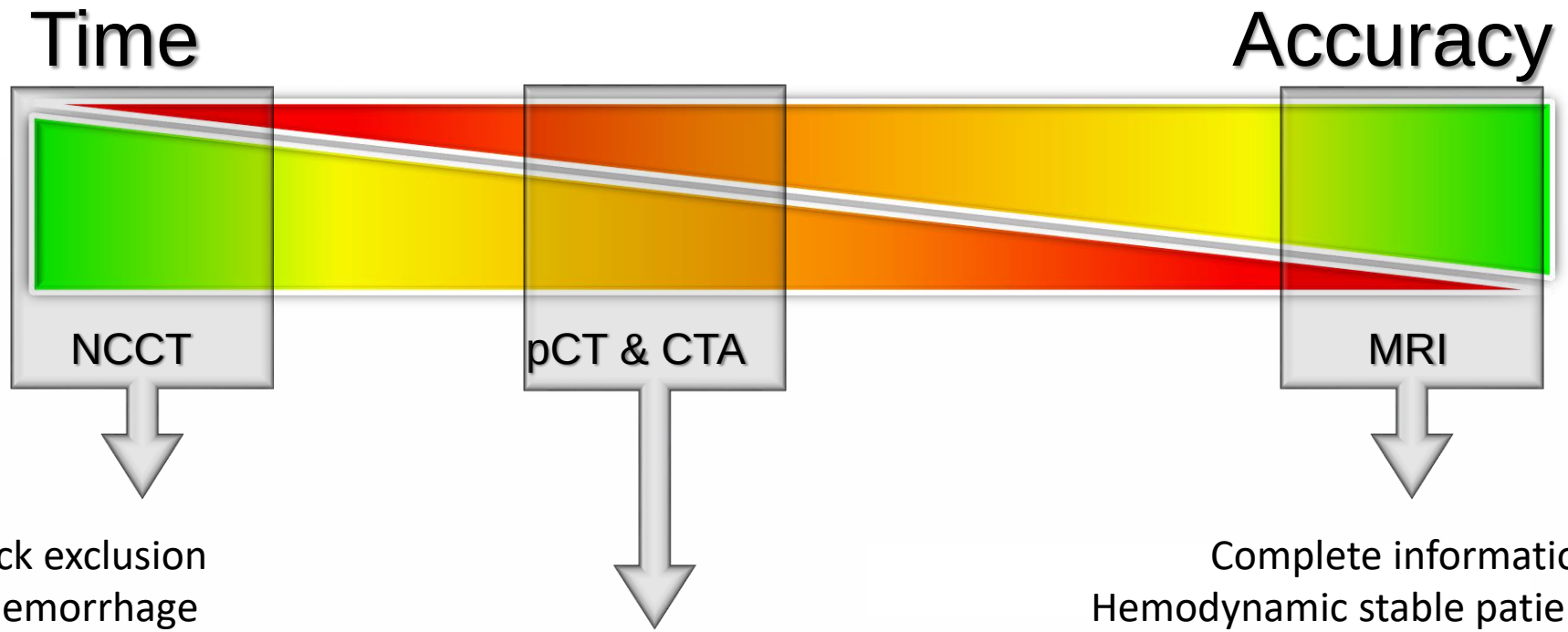
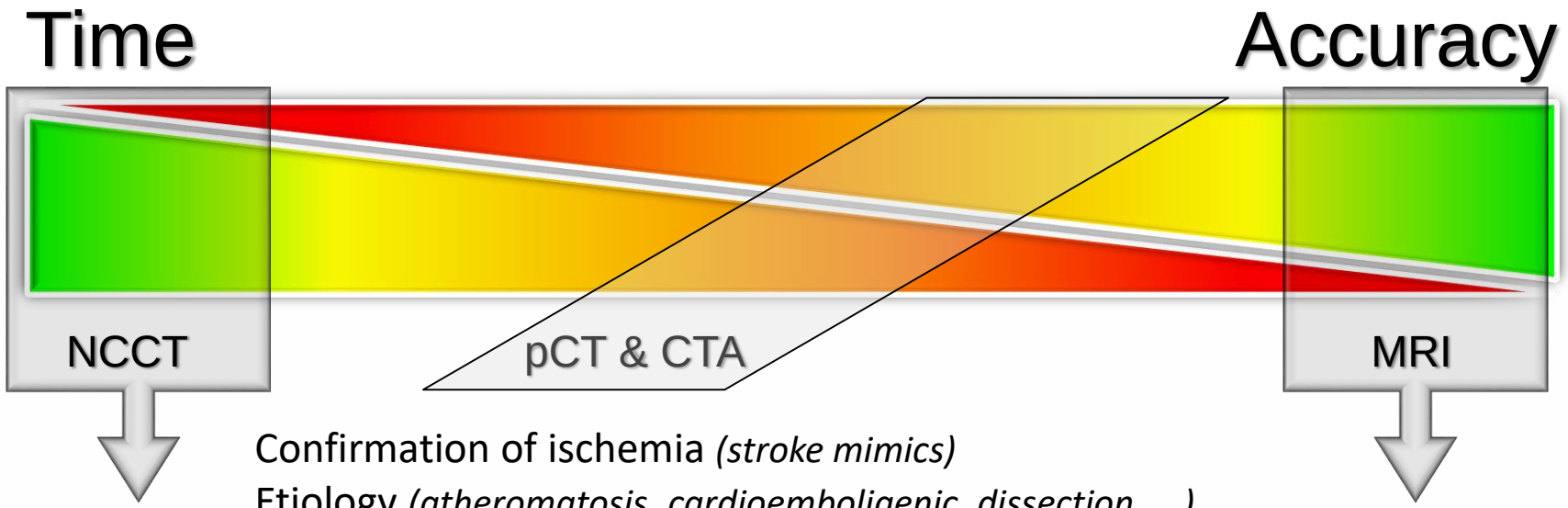
Actual Shortcomings

CT and MRI Stroke work up and Optimisation



Actual Shortcomings

CT and MRI Stroke work up and Optimisation



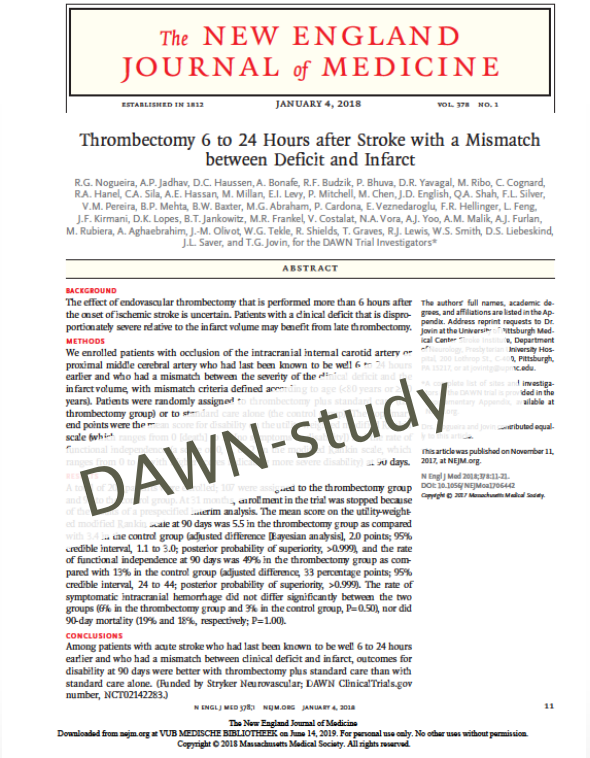
Confirmation of ischemia *(stroke mimics)*
Etiology *(atheromatosis, cardioemboligenic, dissection, ...)*

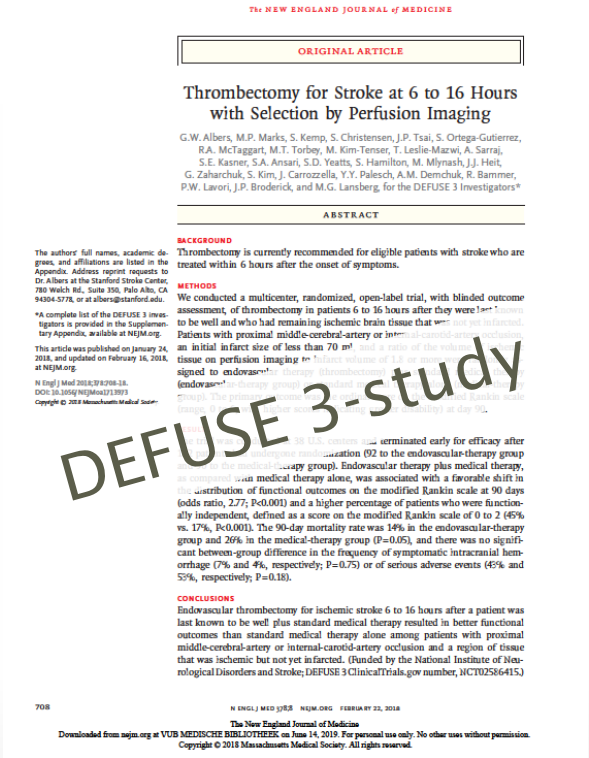
Quick exclusion
of hemorrhage

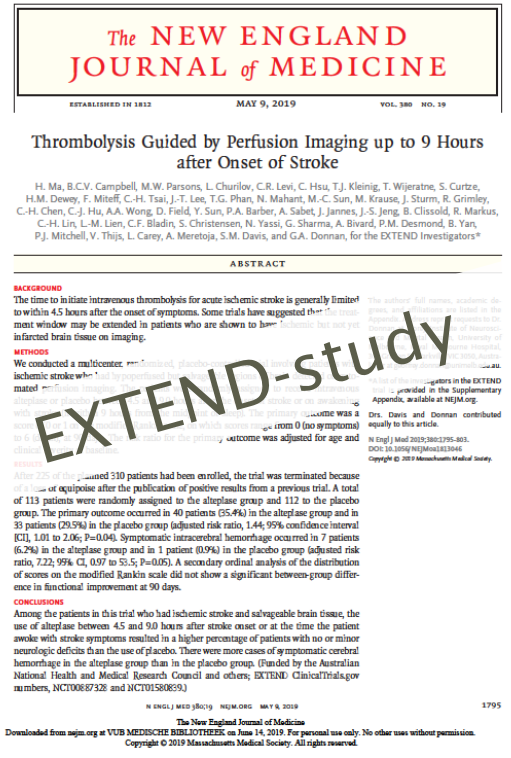
Complete information
Hemodynamic stable patient
Practical issues

Actual Shortcomings

Why do we use CT- and MR- Perfusion?







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Actual Shortcomings

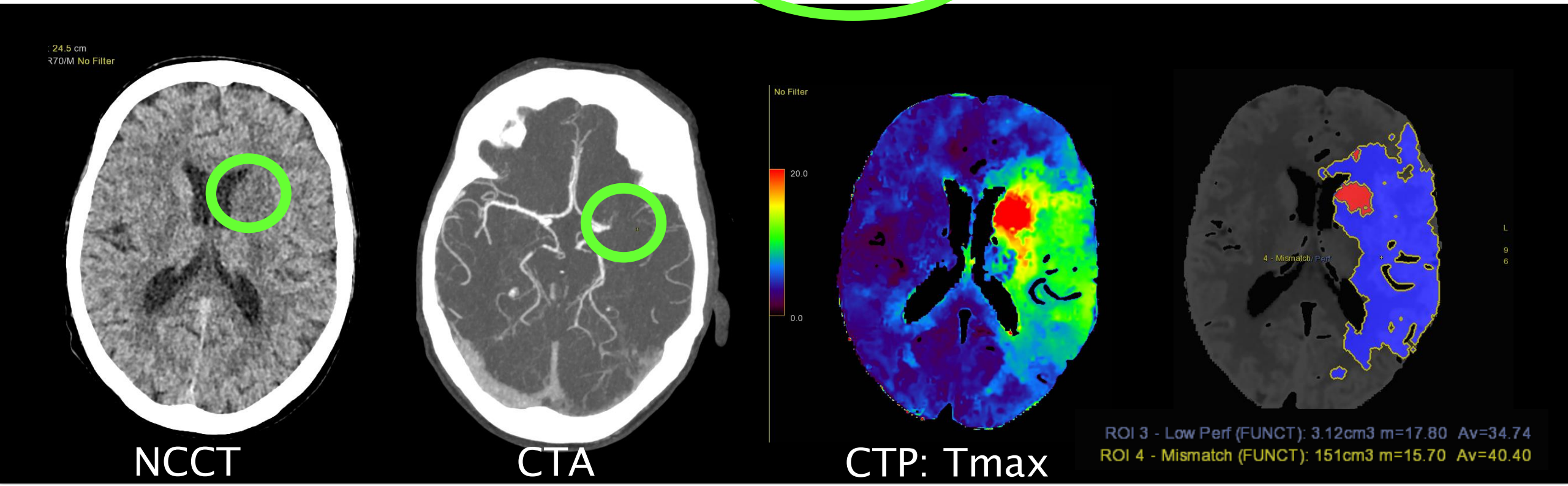
Questions we ask:

- 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

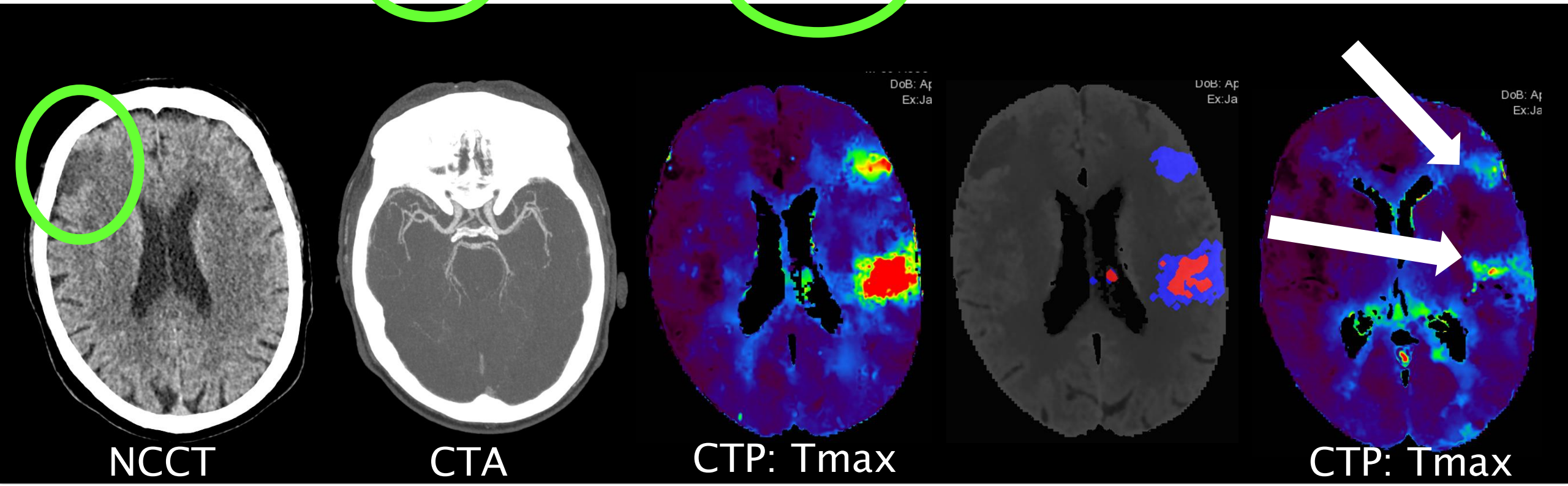


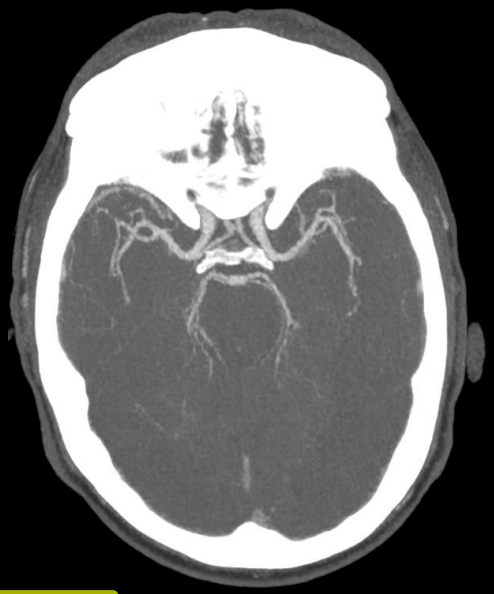
NCCT CTA CTP: Tmax

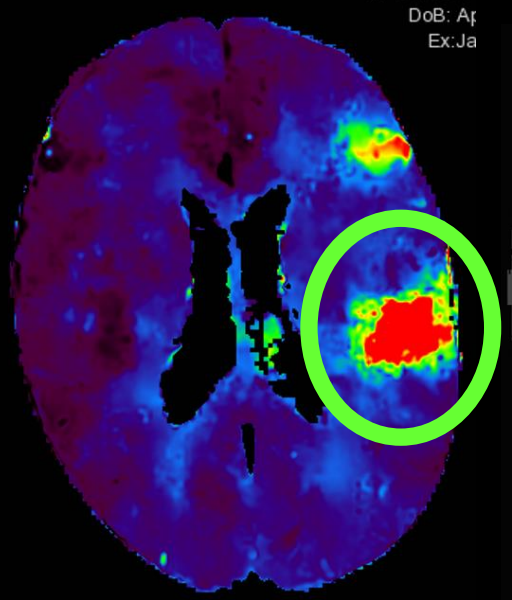
Actual Shortcomings

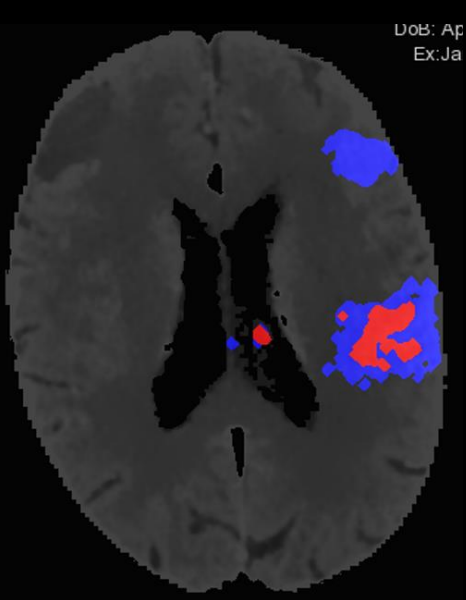
Questions we ask: Hemorrhage?
Clot?
Perfusion defect?
Core volume estimation?

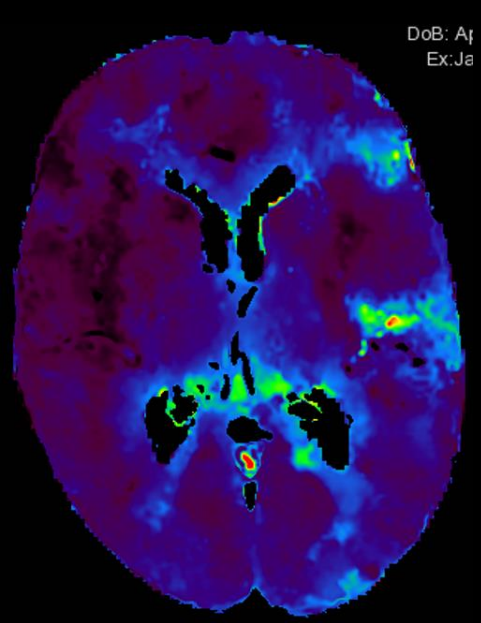
M 64 y: Acute right hemiplegia <4,5h NIHSS: 9

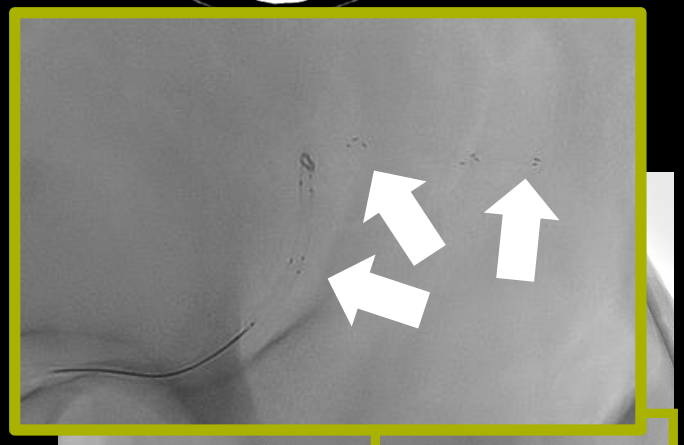


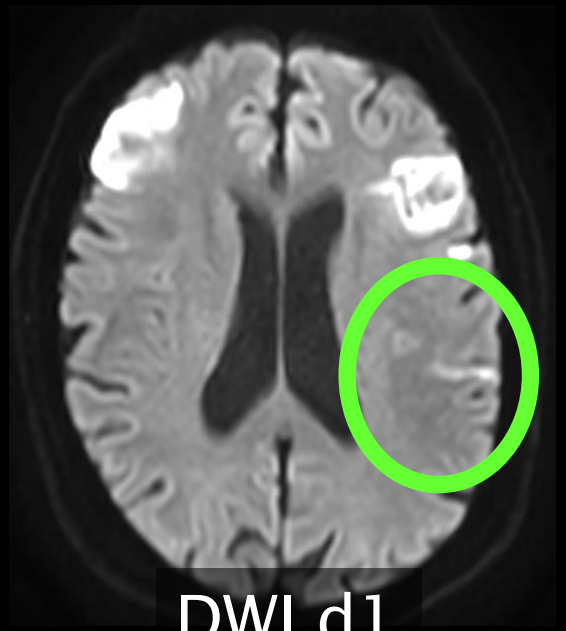






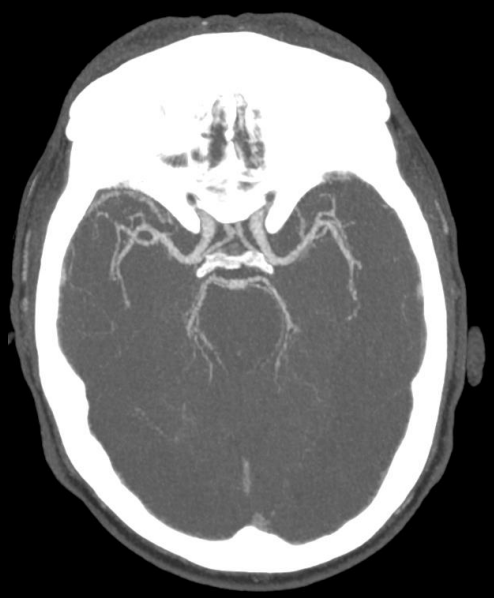
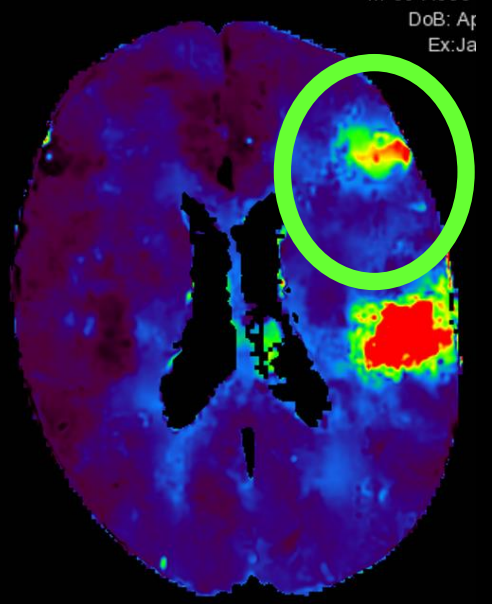


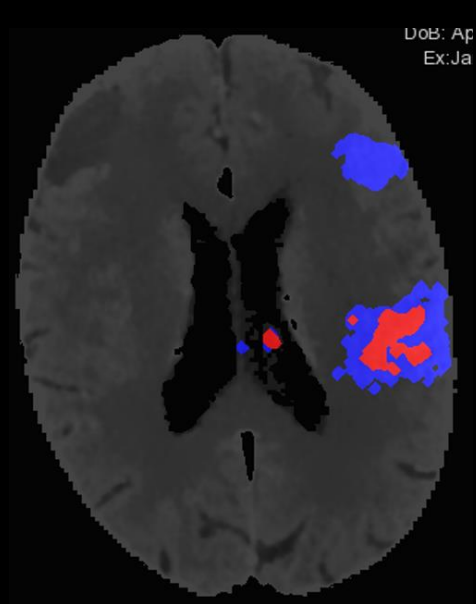


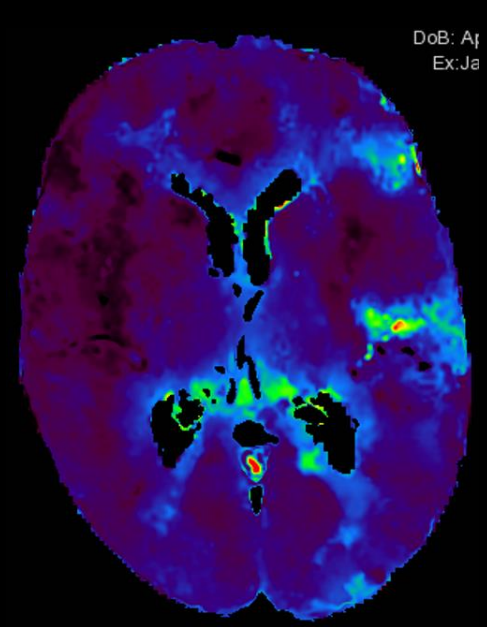


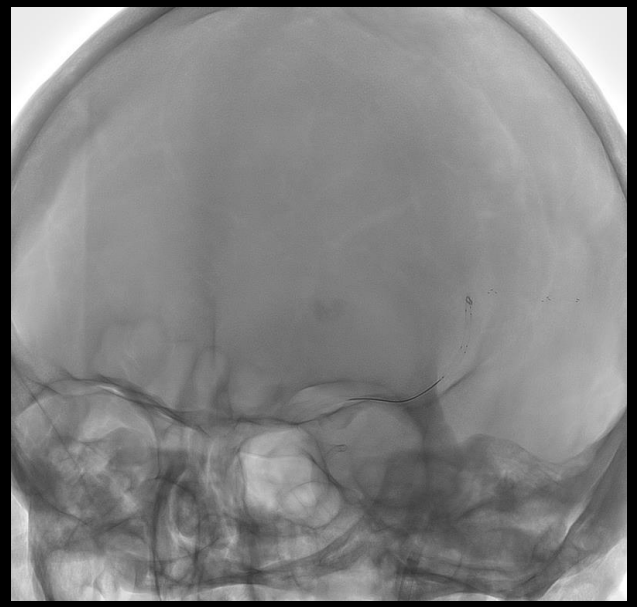
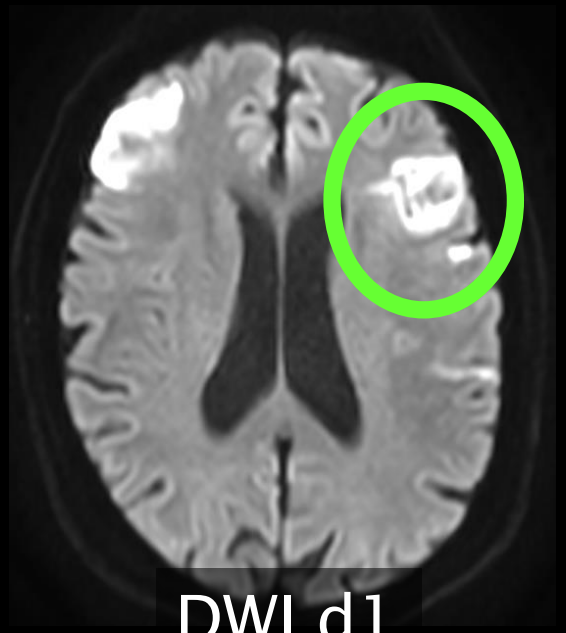
DWI d1

ADC d1

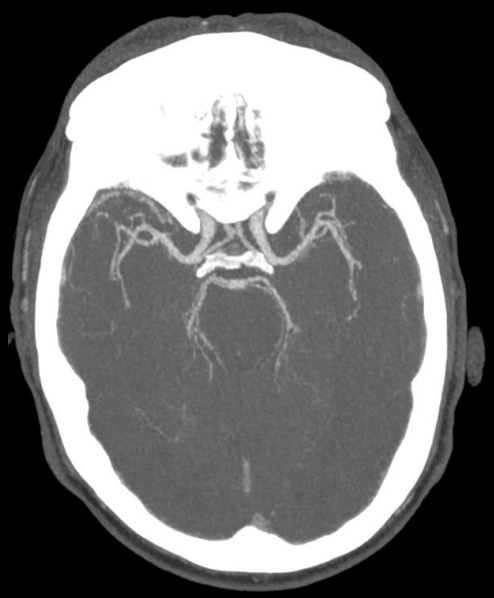




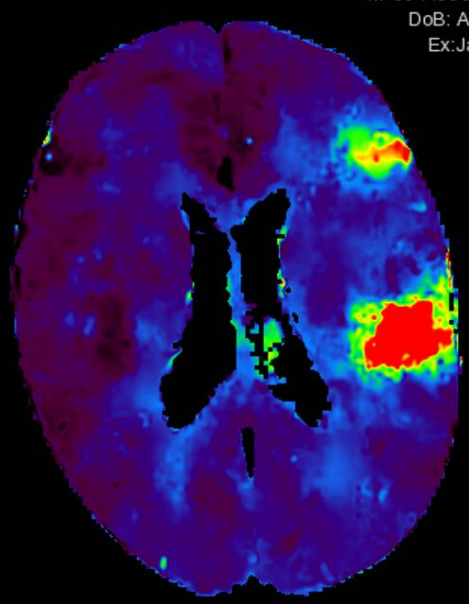


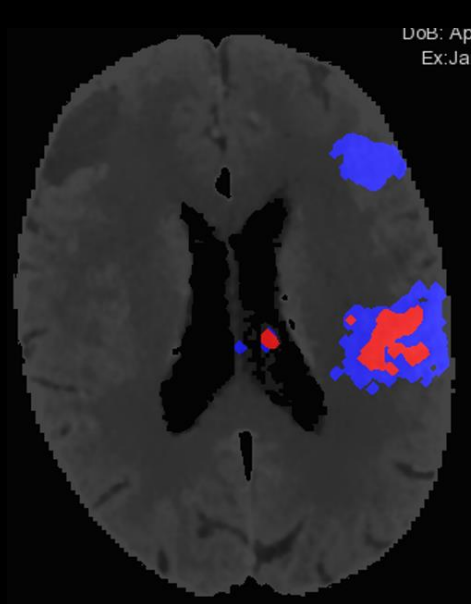


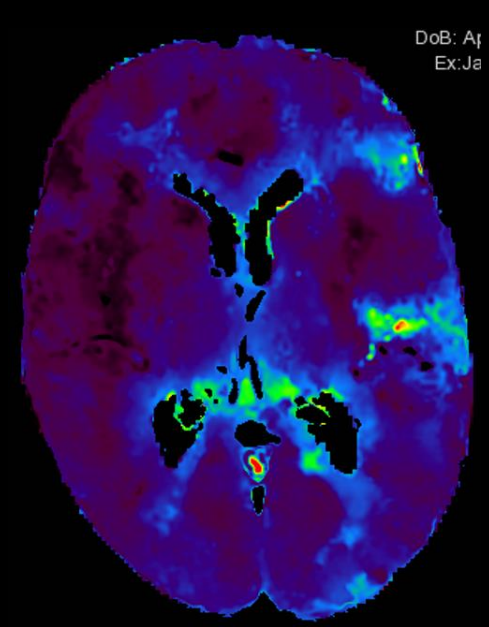


DWI d1

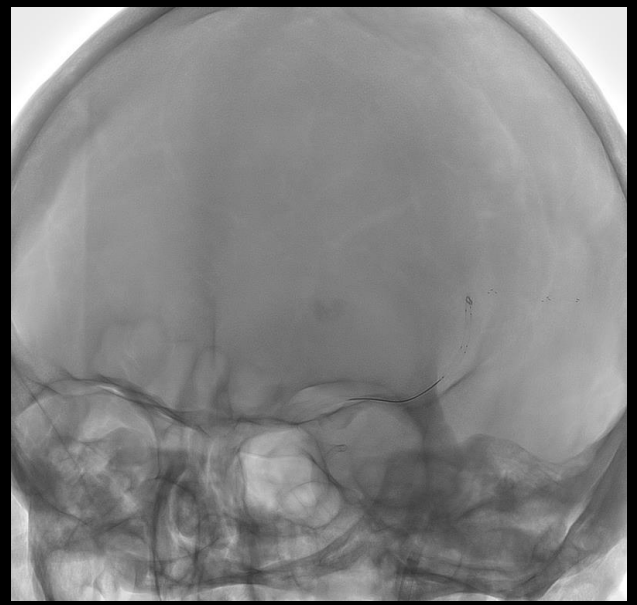
ADC d1

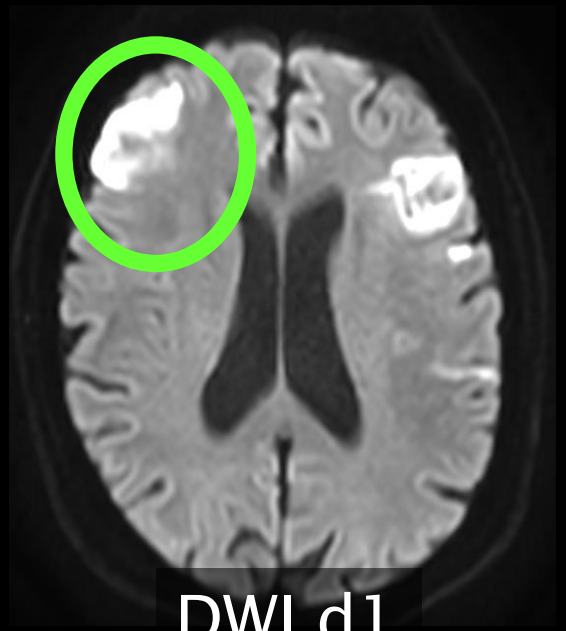












DWI d1

ADC d1

Discharge NIHSS:1 (Dysartria)

Actual Shortcomings

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

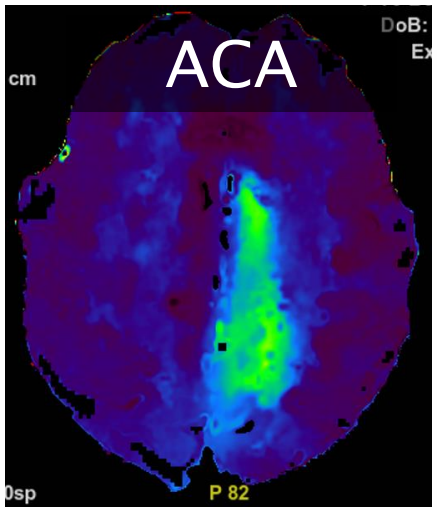
Last case: <4,5h

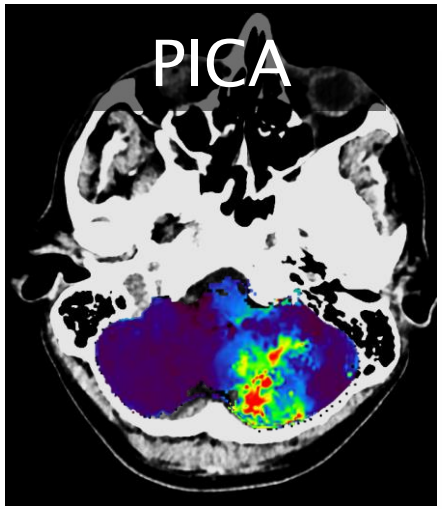
No Hemorrhage (older infarct frontal right)

No LVO

> No Perfusion CT

> No Interventional procedure?





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

Actual Shortcomings

University of Basel
Department of Clinical Research
Universitätsspital Basel

Distal occlusions are under investigation:

DISTAL

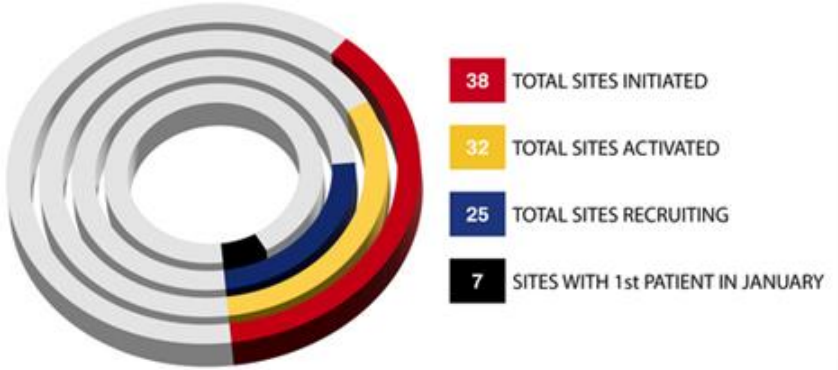
DUSK

DISTALS

DISCOUNT

.....

endovascular therapy trial
DISTAL



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

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Actual Shortcomings

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

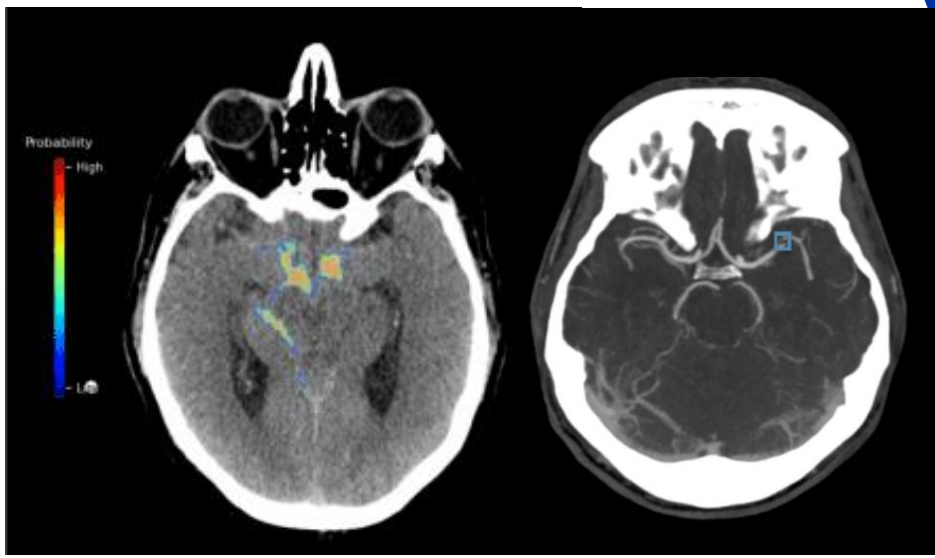
Lot of vendors offer (semi-) automated help

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

CATEGORIES AND TAGS

Refresher Courses: Emergency Imaging

RC 517 - Stroke revisited: imaging algorithms and protocols

March 1, 15:00 - 16:00 CET

LEVEL I

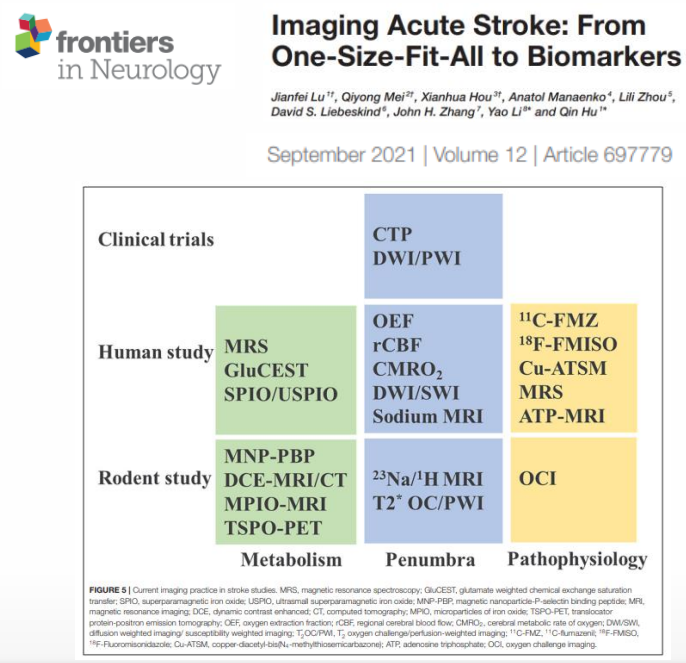
Emergency Imaging | Imaging Methods | Neuro | Professional Issues

Metabolic Imaging:

- APT (Amide Proton Transfer) imaging: based on pH changes
- Glucose driven research
- Oxygen driven research

<u>Better discrimination</u>: Core / Penumbra / Benign oligemia

<u>Research:</u> Rodent models, preliminary clinical



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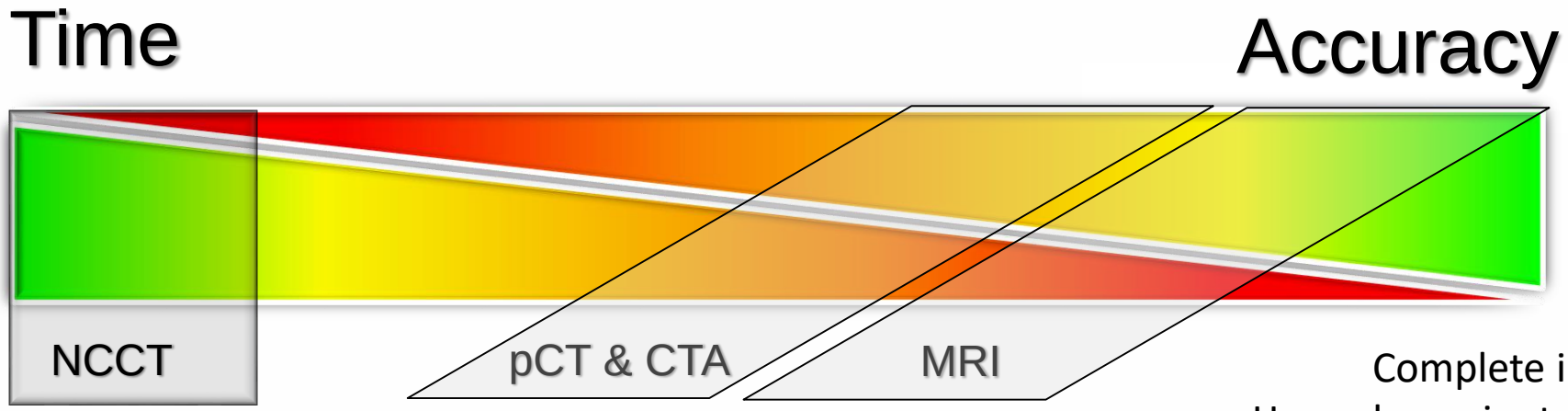
MRI: what's new

Statement 1: MRI
- is most accurate
- will become more accurate with metabolic imaging
- will become faster
- but practical issues will stay



Complete information
Hemodynamic stable patient
Practical issues

What to expect?

Questions we ask: Hemorrhage?
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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:

Bijoy K. Menon, MD
Christopher D. d'Esterre, PhD
Emmad M. Qazi, BSc
Mohammed Almekhlafi, MD[2]
Leszek Hahn, PhD
Andrew M. Demchuk, MD
Mayank Goyal, MD

Multiphase CT Angiography: A New Tool for the Imaging Triage of Patients with Acute Ischemic Stroke[1]

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

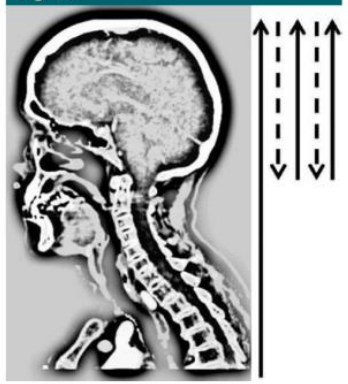
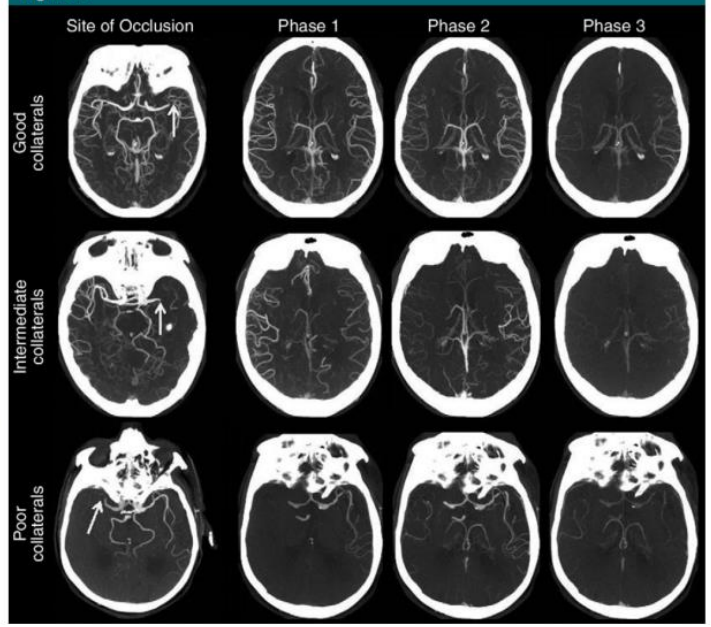


Figure 1: Multiphase CT angiography image, with each phase represented by an arrow. The first phase (long solid arrow) is conventional arch-to-vertex CT angiography. The next two phases (short solid arrows) are sequential skull base–to-vertex acquisitions performed in the midvenous and late venous phases.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

or therapy; and *(f)* any terminal illness

Figure 2



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

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

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*

AJNR Am J Neuroradiol 43:1424–30 Oct 2022

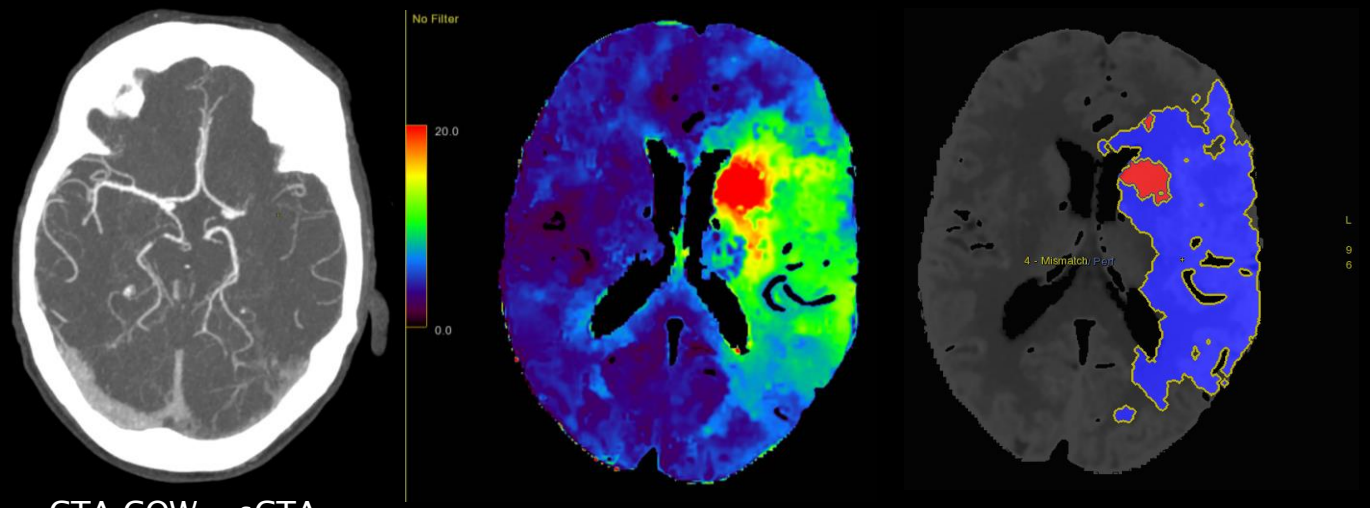
ORIGINAL RESEARCH
ADULT BRAIN

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

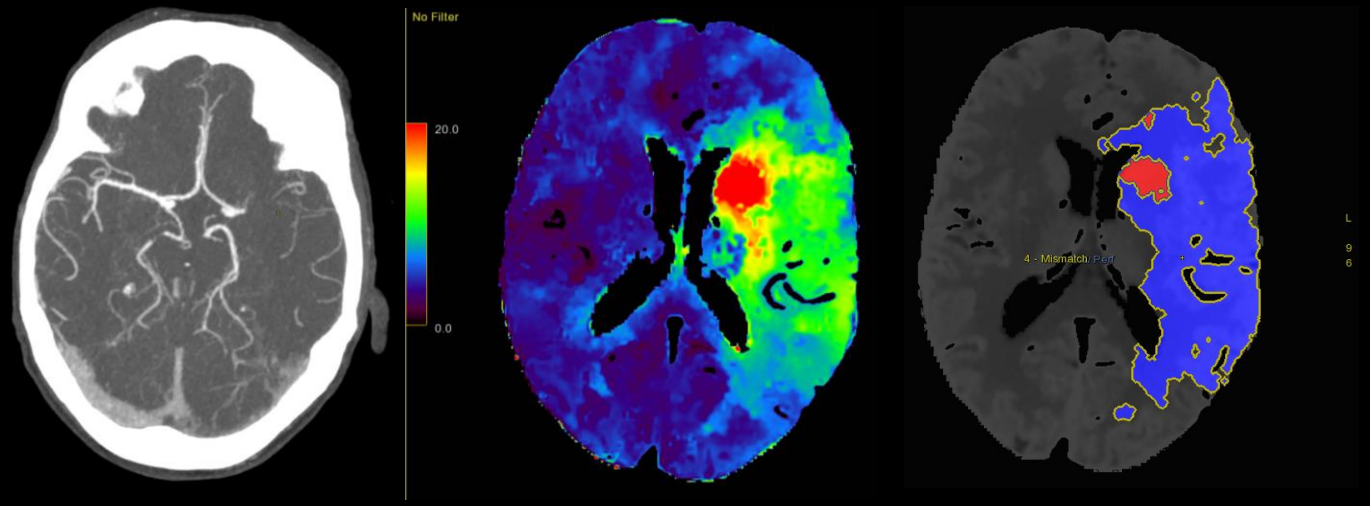
Technique: single-phase vs multi-phase CTA

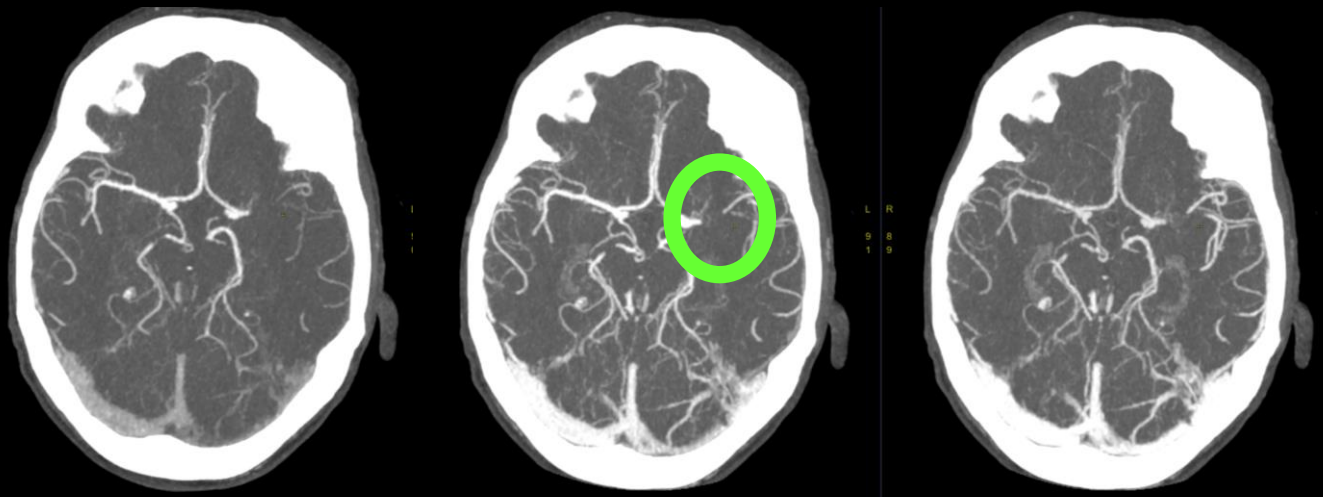


CTA COW = sCTA

Collateral imaging

Technique: single-phase vs multi-phase CTA

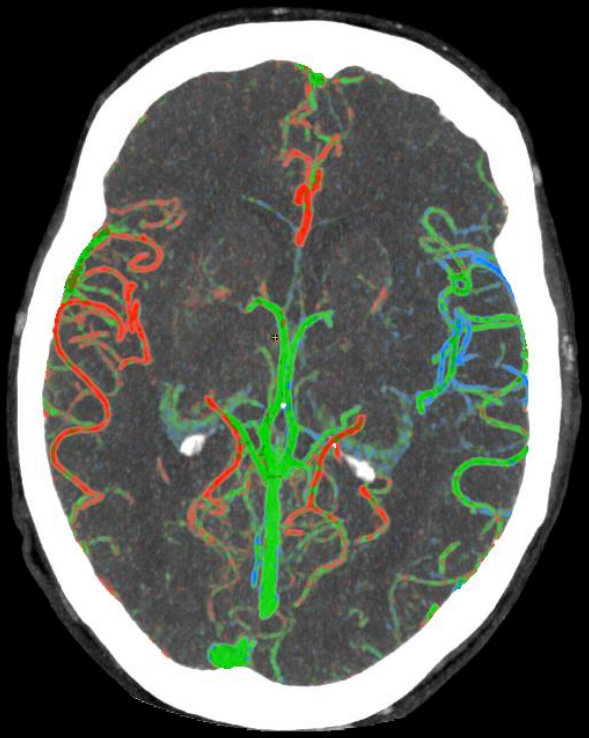


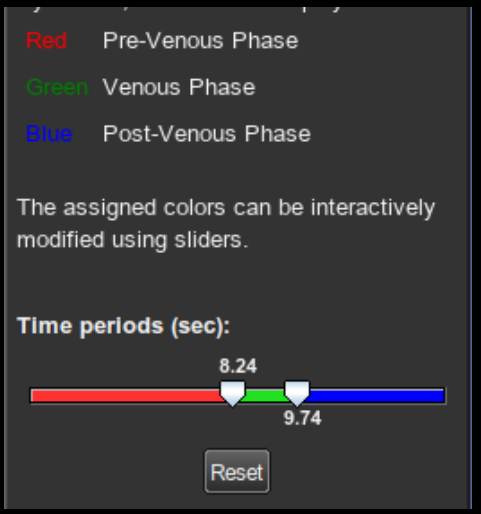


Phase 1 mCTA

Phase 2mCTA

Phase 3 mCTA





Difference =

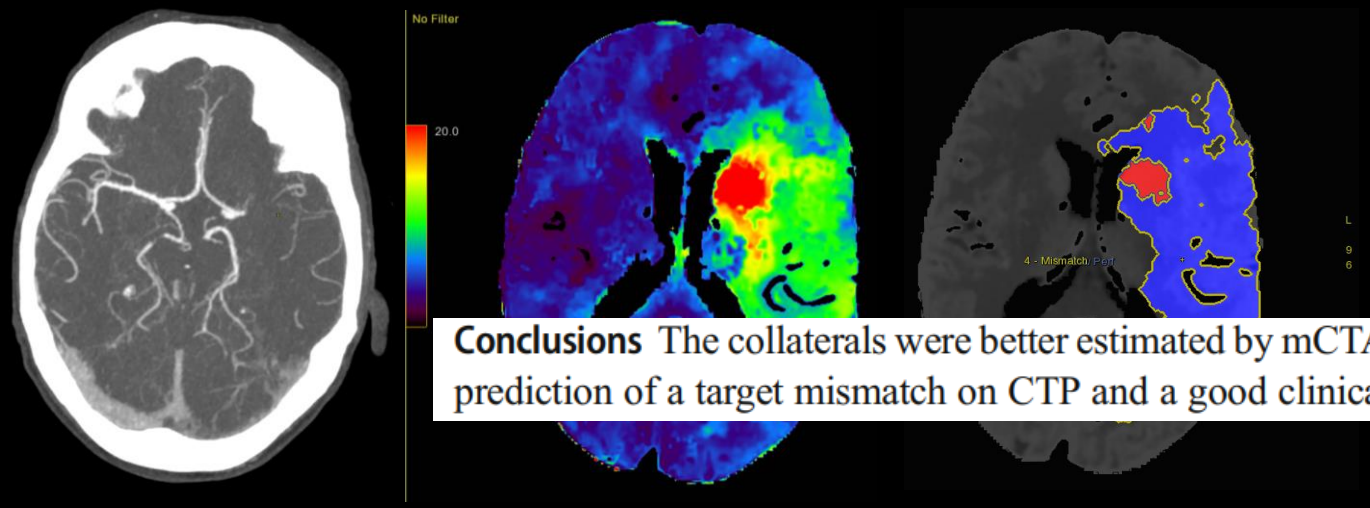
Temporal information

+

Cloth lenght

Collateral imaging

Technique: single-phase vs multi-phase CTA



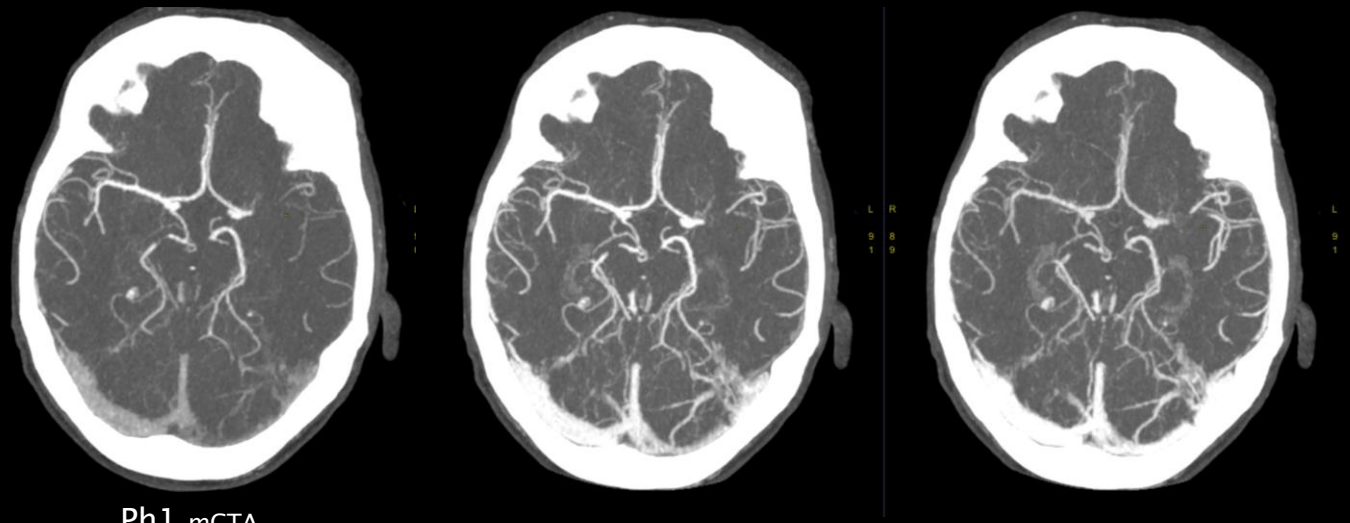
European Radiology (2019) 29:4922–4929
https://doi.org/10.1007/s00330-019-06027-9

NEURO

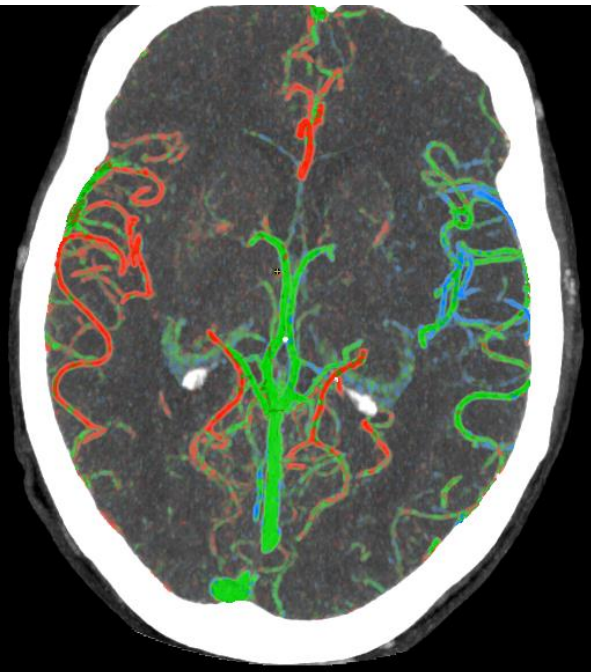
Comparison of CT angiography collaterals for predicting target perfusion profile and clinical outcome in patients with acute ischemic stroke

Shan-shan Lu[1] · Xuan Zhang[1] · Xiao-quan Xu[1] · Yue-zhou Cao[2] · Lin bo Zhao[2] · Qiang-hui Liu[3] · Fei-yun Wu[1] · Sheng Liu[2] · Hai-bin Shi[2]

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.



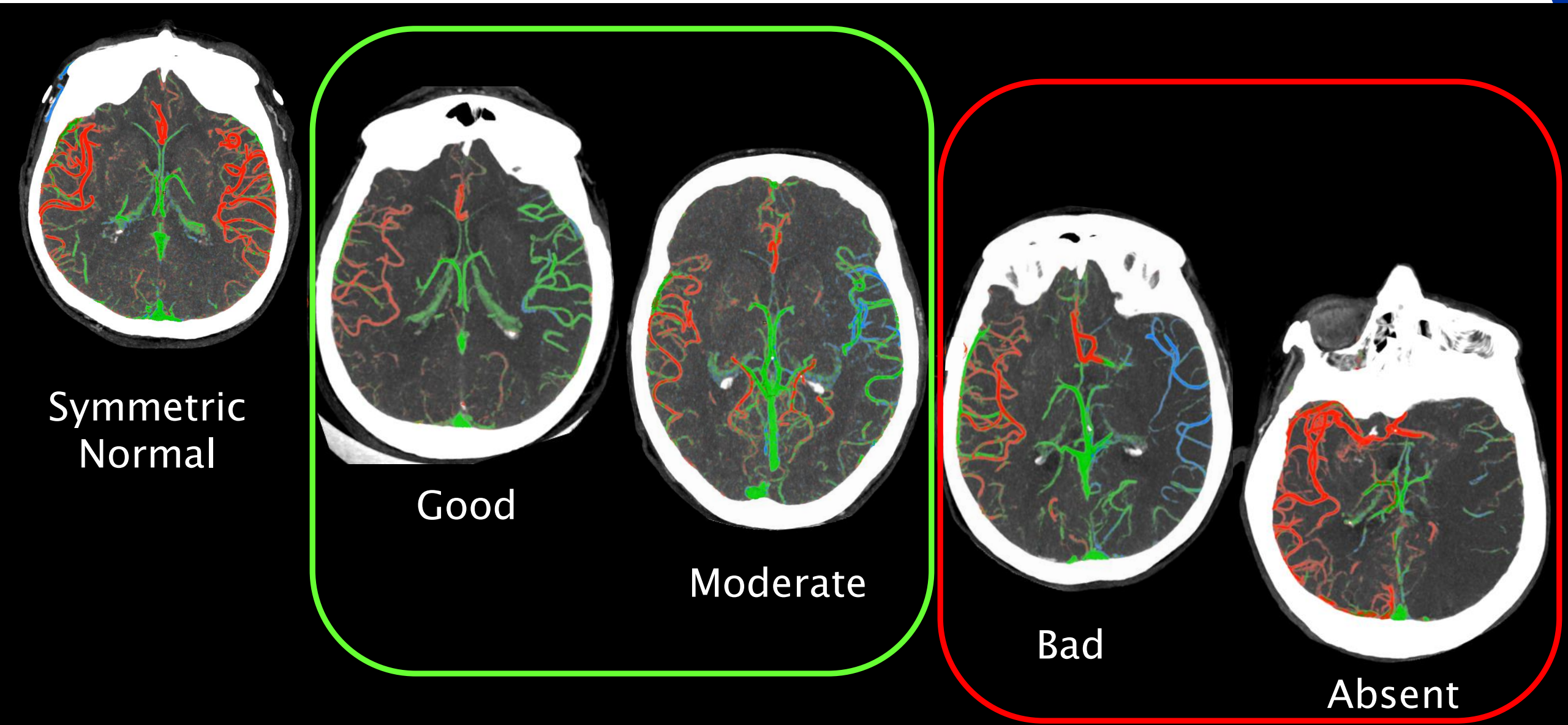
Ph1 mCTA



Difference =

Temporal information + Cloth lenght

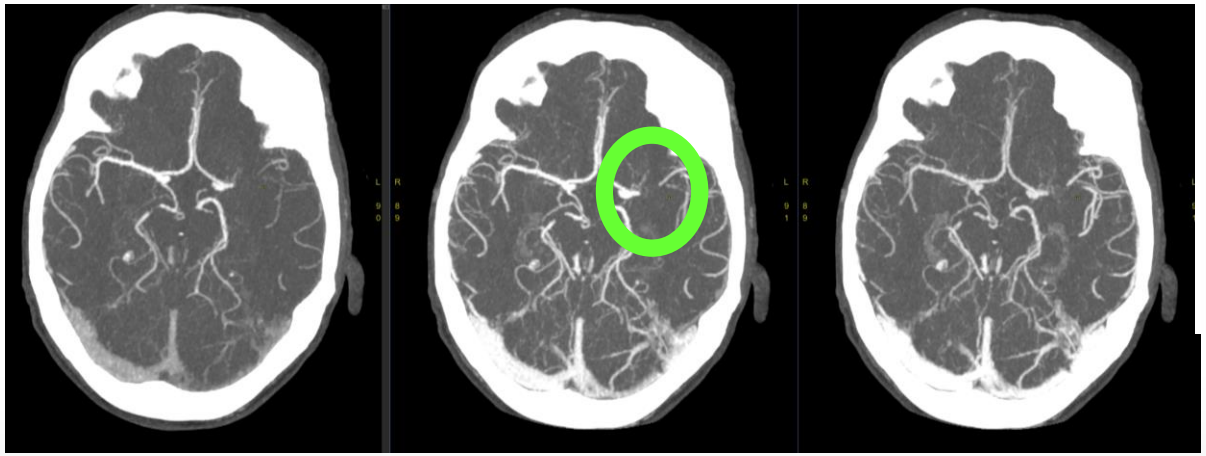
Collateral imaging



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



Clinical Neurology and Neurosurgery 222 (2022) 107421

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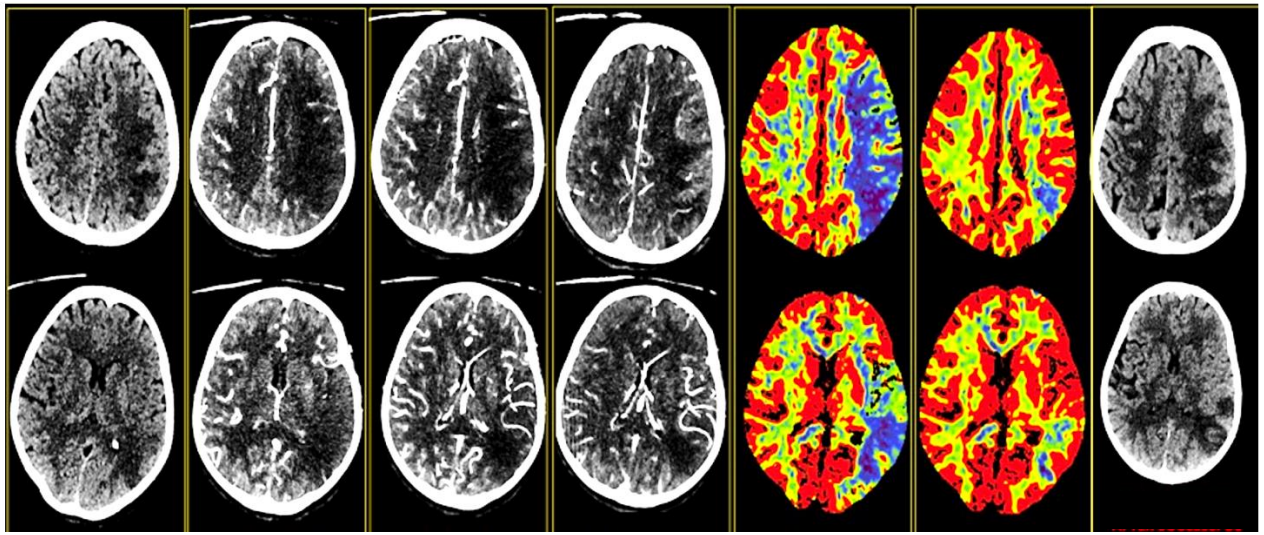

NCCT | Ph1 mCTA | Ph2 mCTA | Ph3 mCTA | CBF | CBV | Post-IR TICI 3

Collateral imaging

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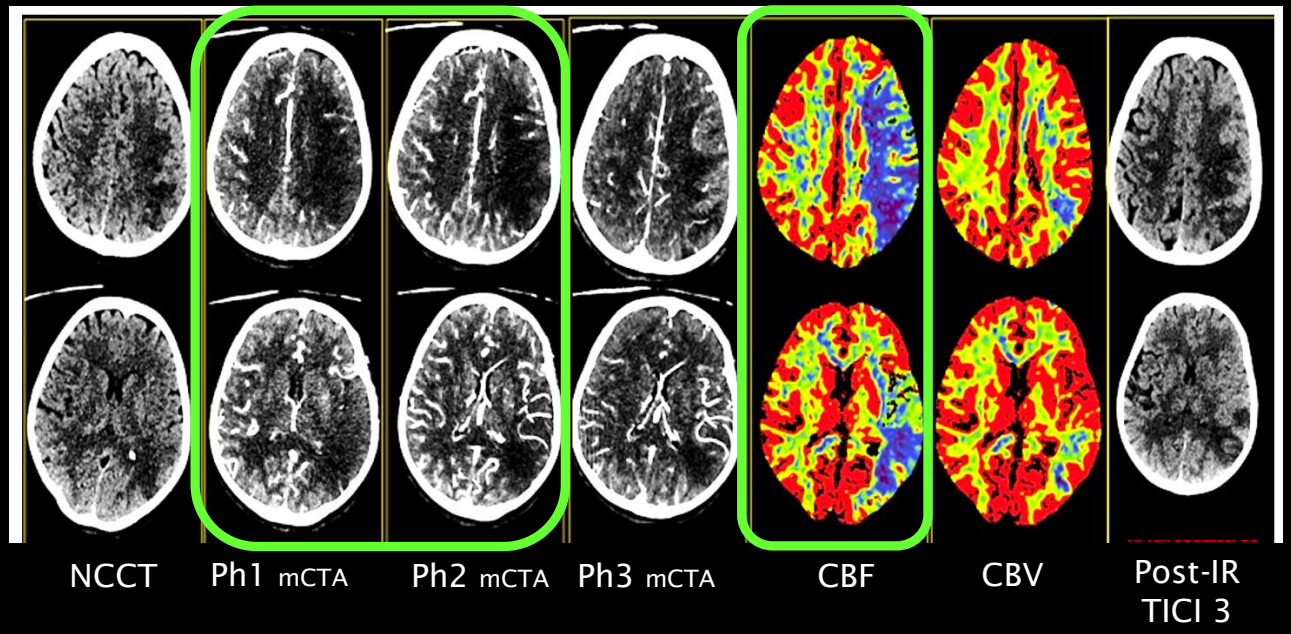

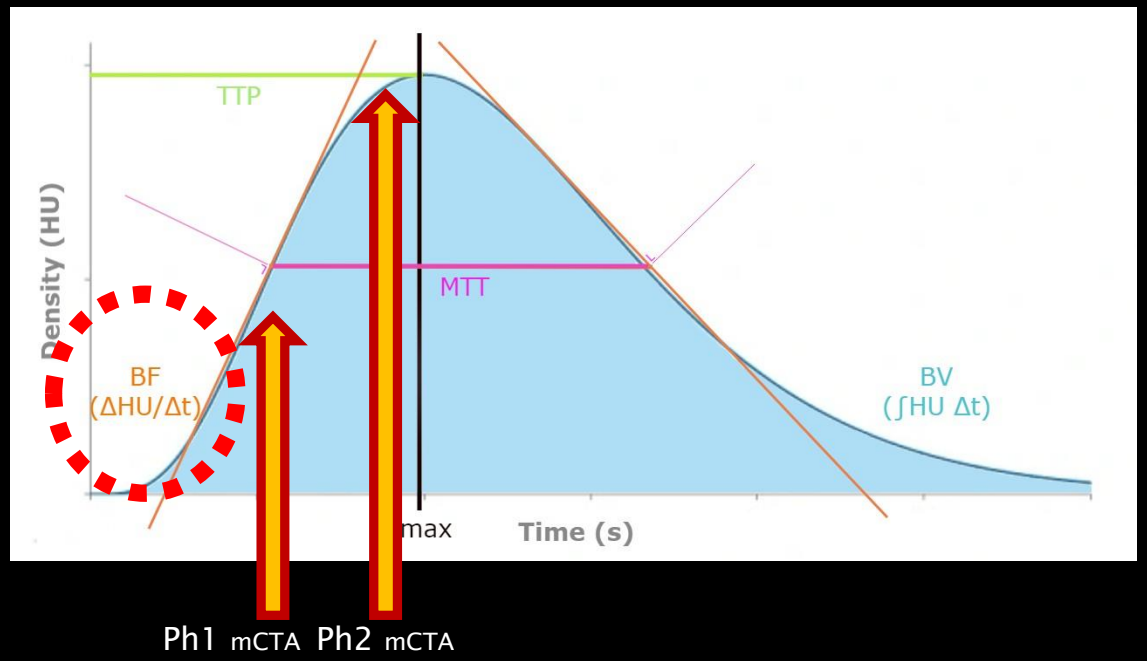

Collateral imaging

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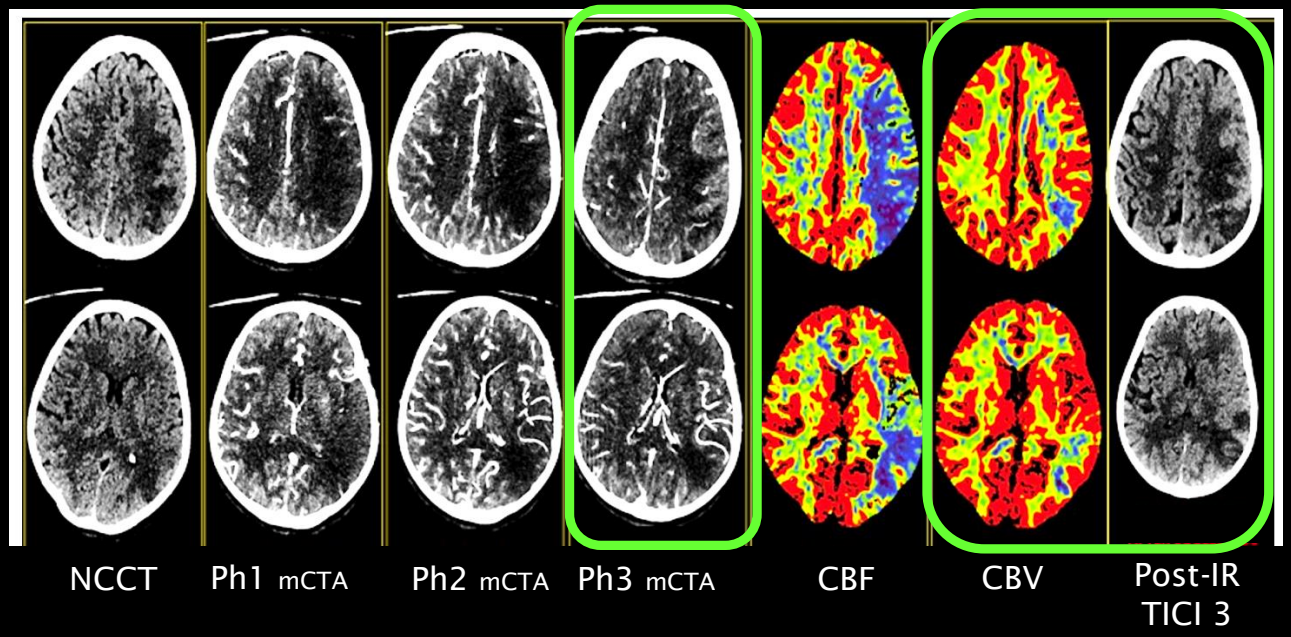

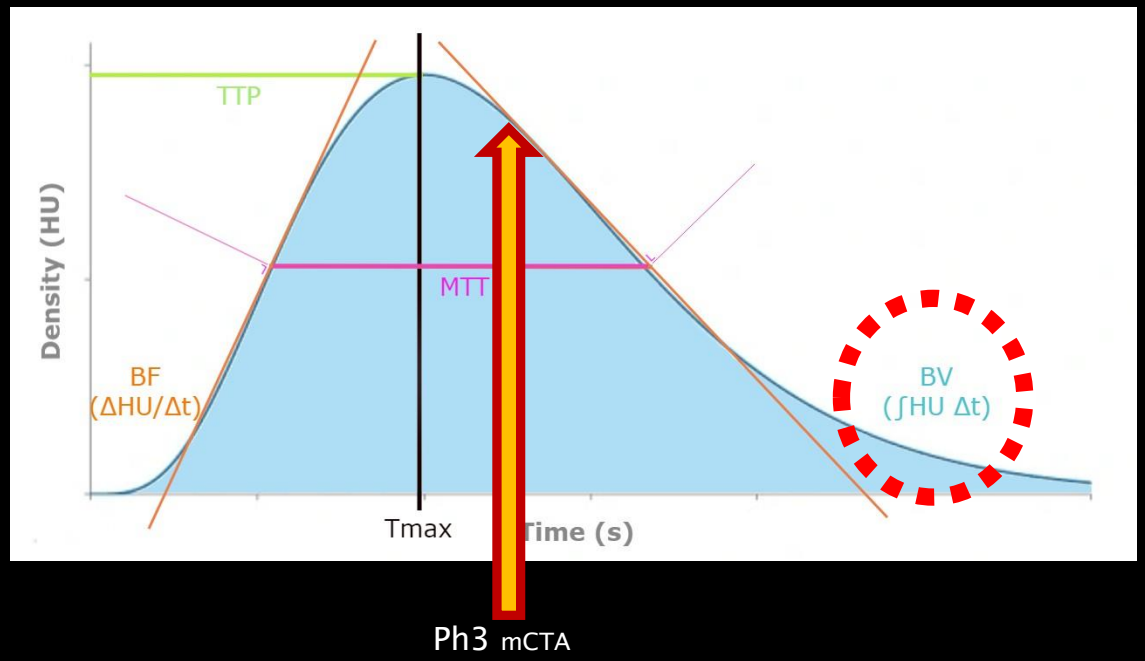

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Non Contrast CT

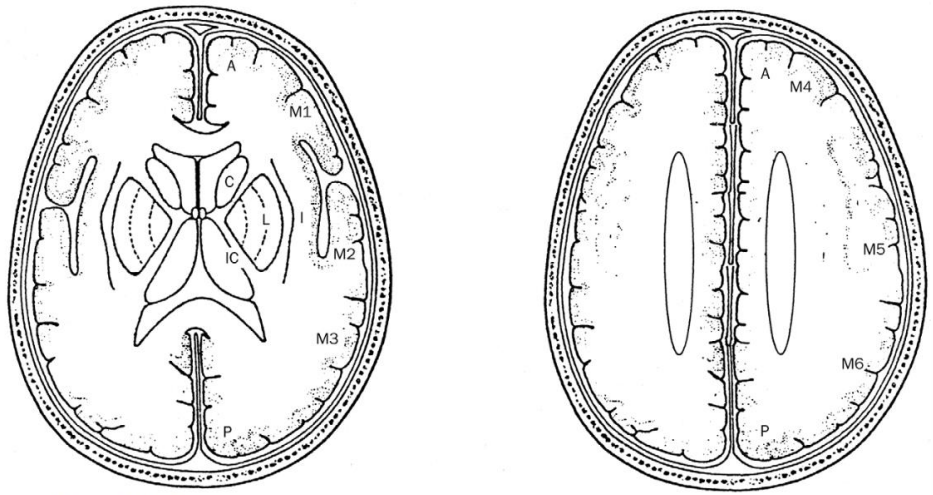


Figure 1: **ASPECTS study form**
A=anterior circulation; P=posterior circulation; C=caudate; L=lentiform; IC=internal capsule; I=insular ribbon; MCA=middle cerebral artery; M1=anterior MCA cortex; M2=MCA cortex lateral to insular ribbon; M3=posterior MCA cortex; M4, M5, and M6 are anterior, lateral, 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).

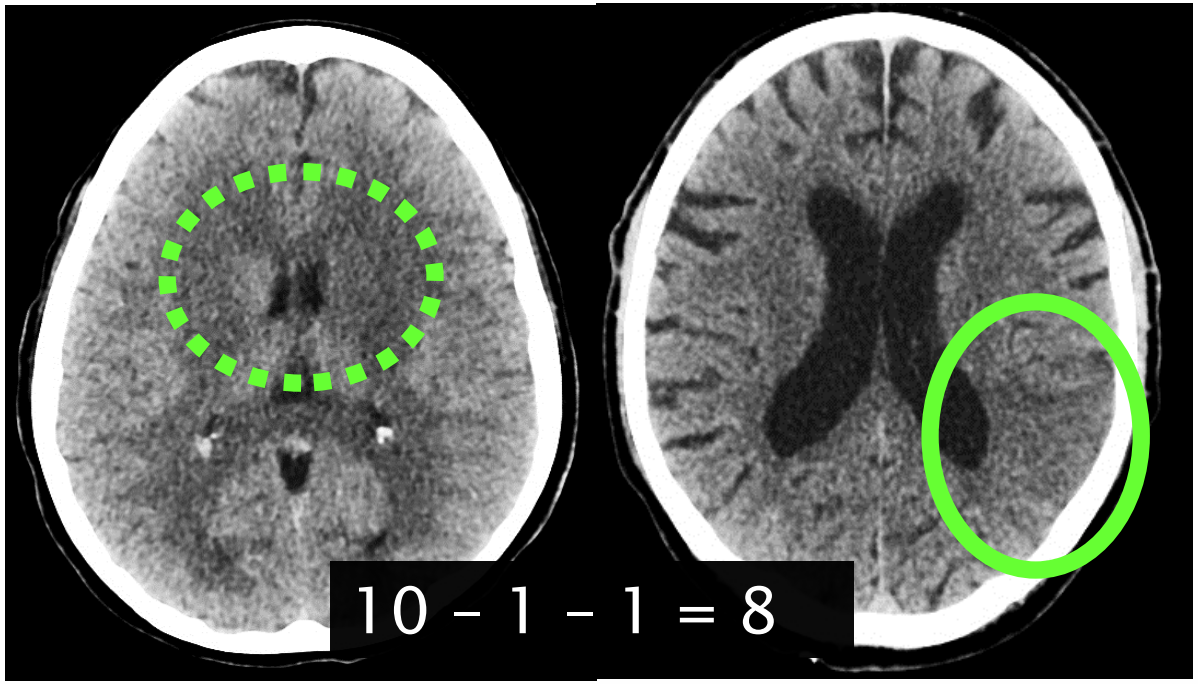
THE LANCET

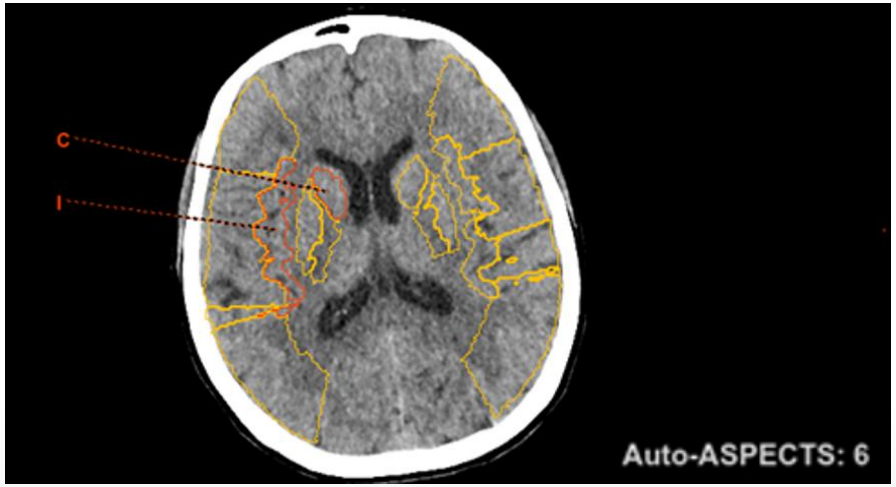
ARTICLES | VOLUME 355, ISSUE 9216, P1670-1674, MAY 13, 2000

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





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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

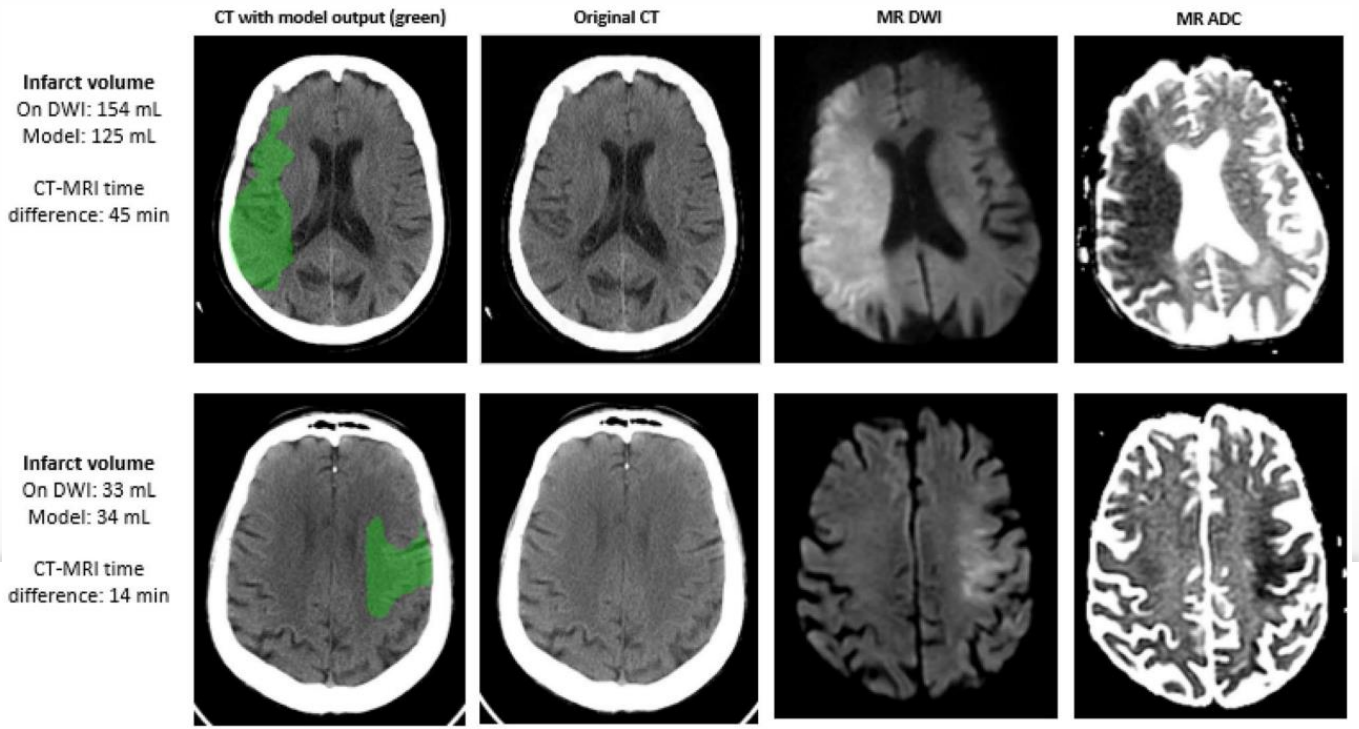
Philip Hoelter[1] · Iris Muehlen[1] · Philipp Goelitz[1] · Vanessa Beuscher[2] · Stefan Schwab[2] · Arnd Doerfler[1]

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.

Scientific Reports | (2023) 13:189 | https://doi.org/10.1038/s41598-023-27496-5 nature portfolio

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. Comeau[1], James M. Hillis[1,5], Christopher P. Bridge[1,2], John K. Chin[1], Jayashri Pawar[1], Ali Pourvaziri[1,2], Ivana Sesic[1], Elshaimaa Sharaf[1], Jinjin Cao[1,2], Flavia T. C. Noro[1], Walter F. Wiggins[1,4], M. Travis Caton[1,4], Felipe Kitamura[3], Keith J. Dreyer[1,2], John F. Kalafut[6], Katherine P. Andriole[1,4], Stuart R. Pomerantz[1,2], Ramon G. Gonzalez[1,2] & Michael H. Lev[1,2]



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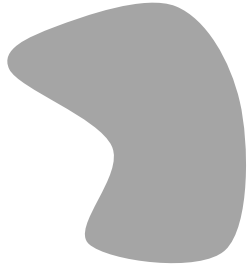


Medical Imaging

About Search Tags

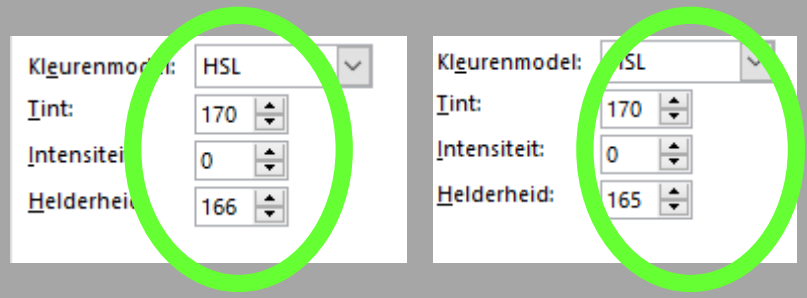
A Matter of Grayscale: Understanding Dicom Windows

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



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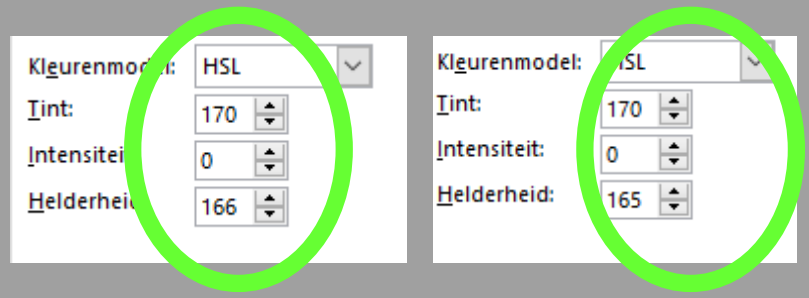
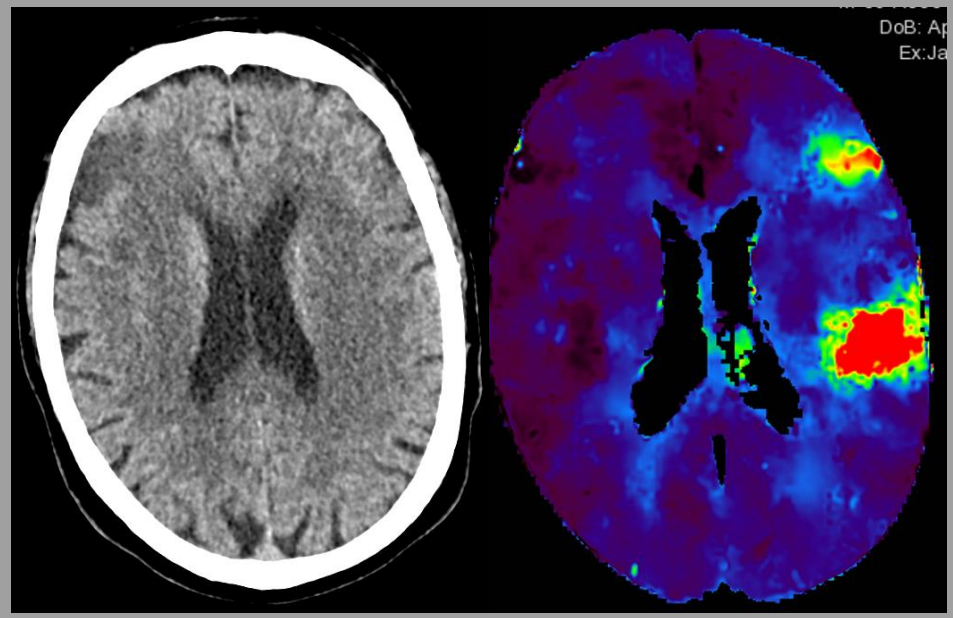
This is why Radiologist have to Window / Level





But Deep Learning can detect these differences

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We should rethink the use of CTP

Nevertheless we made CTperfusion more performant, with Automated tools:

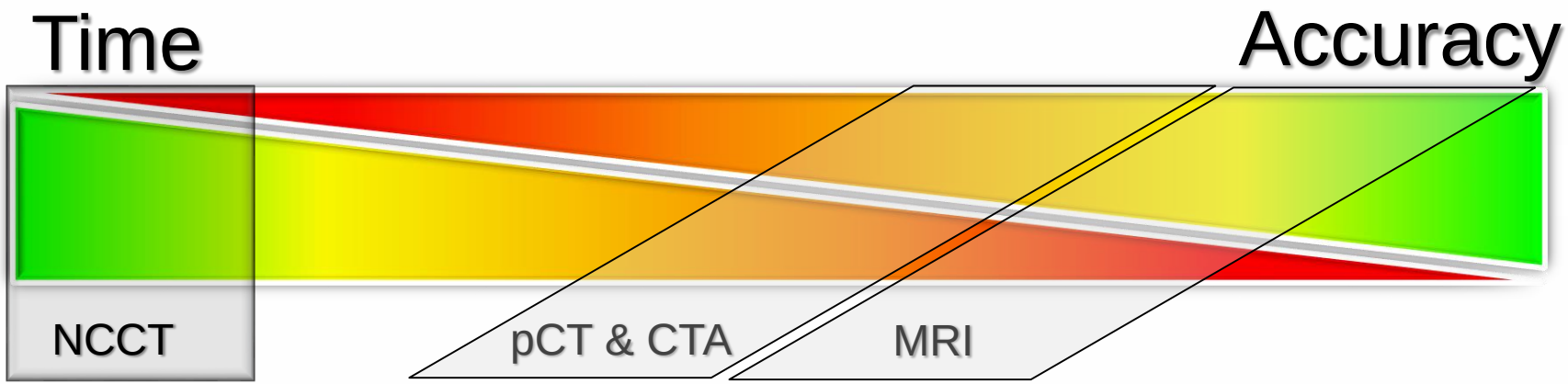
- High radiation dose
- Extra contrast load
- High risk for Movement / Registration Artefacts
- Suboptimal Bolus injection / Cardiac failure / Low Blood pressure
- Suboptimal Arterial input / Venous output detection
- Truncation artefacts
- No standardization of post processing algoritms / thresholding 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

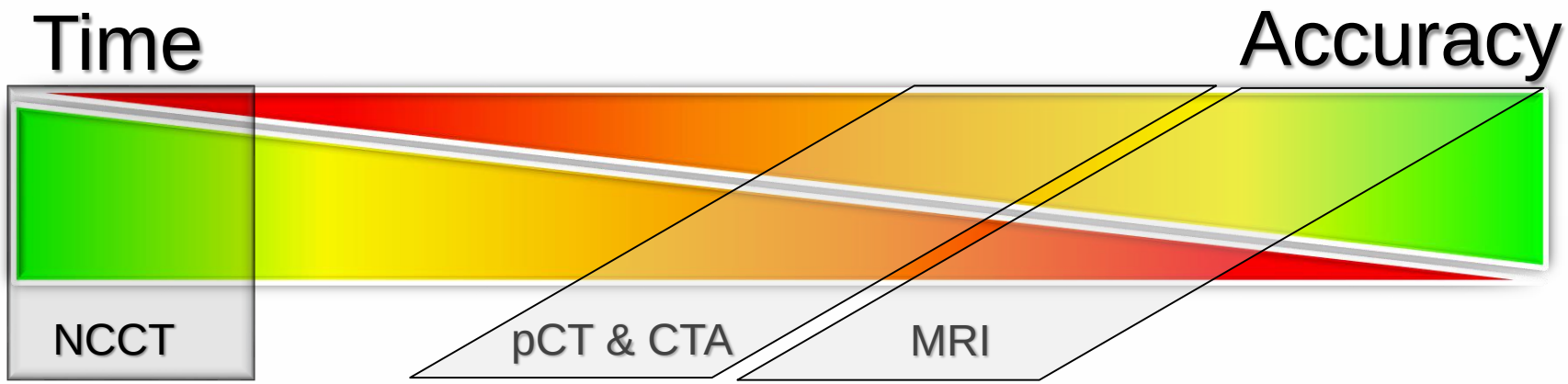


Future perspectives for Radiologic Stroke Work Up:

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

Deep Learning > Improved Core estimation

mCTA estimate the Core and Penumbra Volumes + Collateral evaluation



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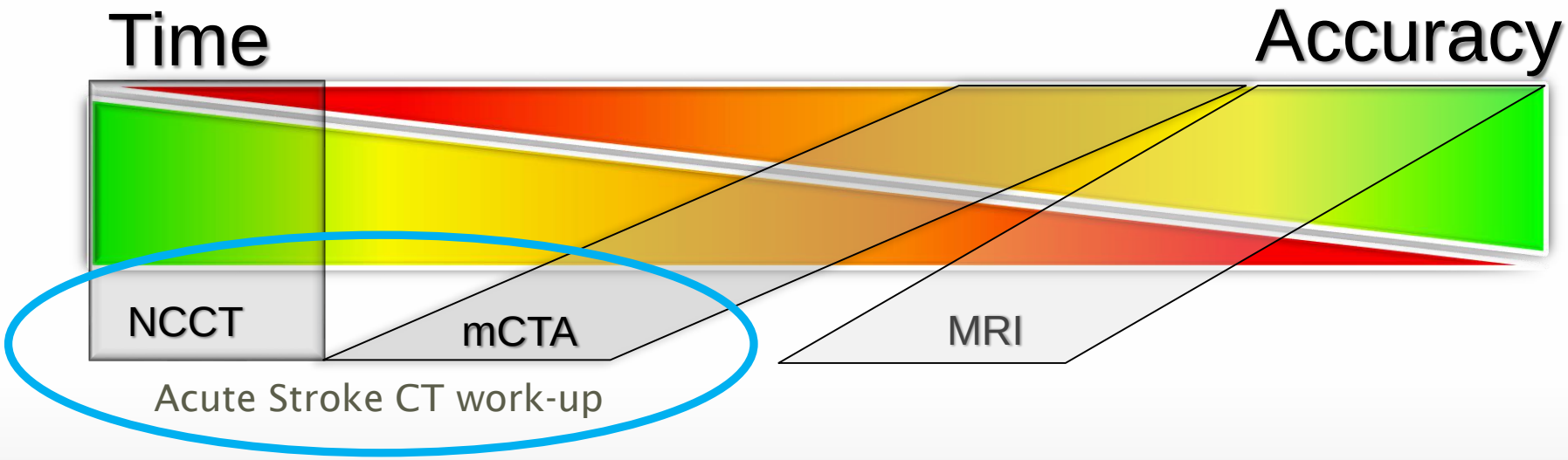

Thank you for your attention

koenraad.nieboer@uzbrussel.be

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