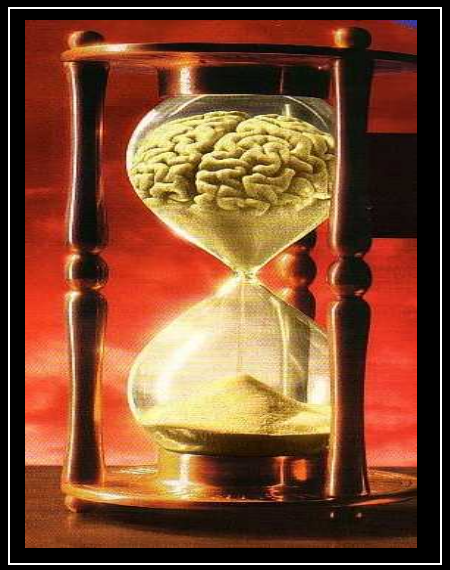
Acute Ischemic Stroke: Time vs Tissue



Greg Albers, MD
Coyote Foundation Professor of Neurology and Neurological Sciences
Stanford University School of Medicine
Director, Stanford Stroke Center
Stanford University Medical Center

Stroke Treatment in 2010

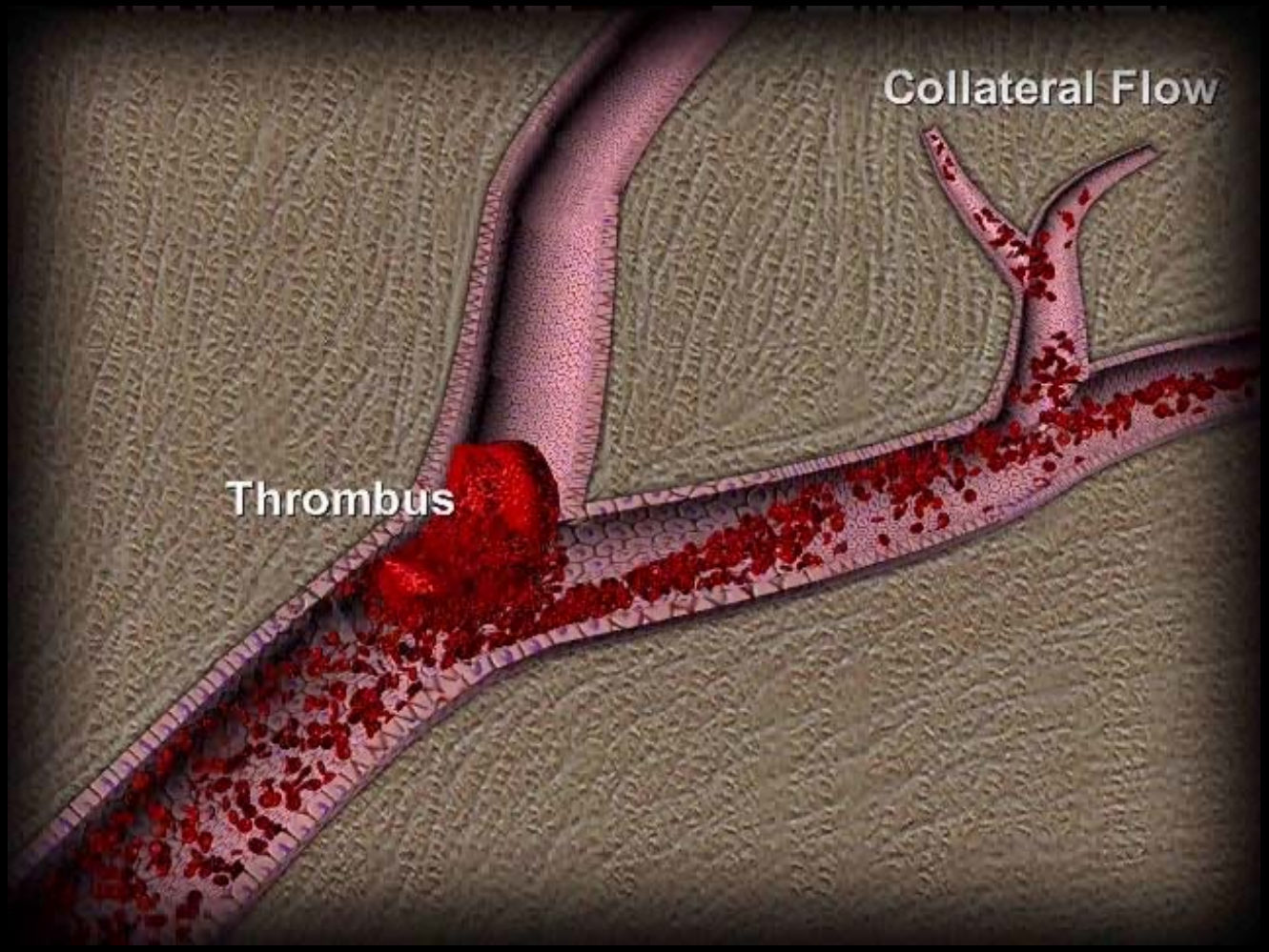
- Problem: very few stroke patients receive treatment (5%)

- Two treatments FDA approved:

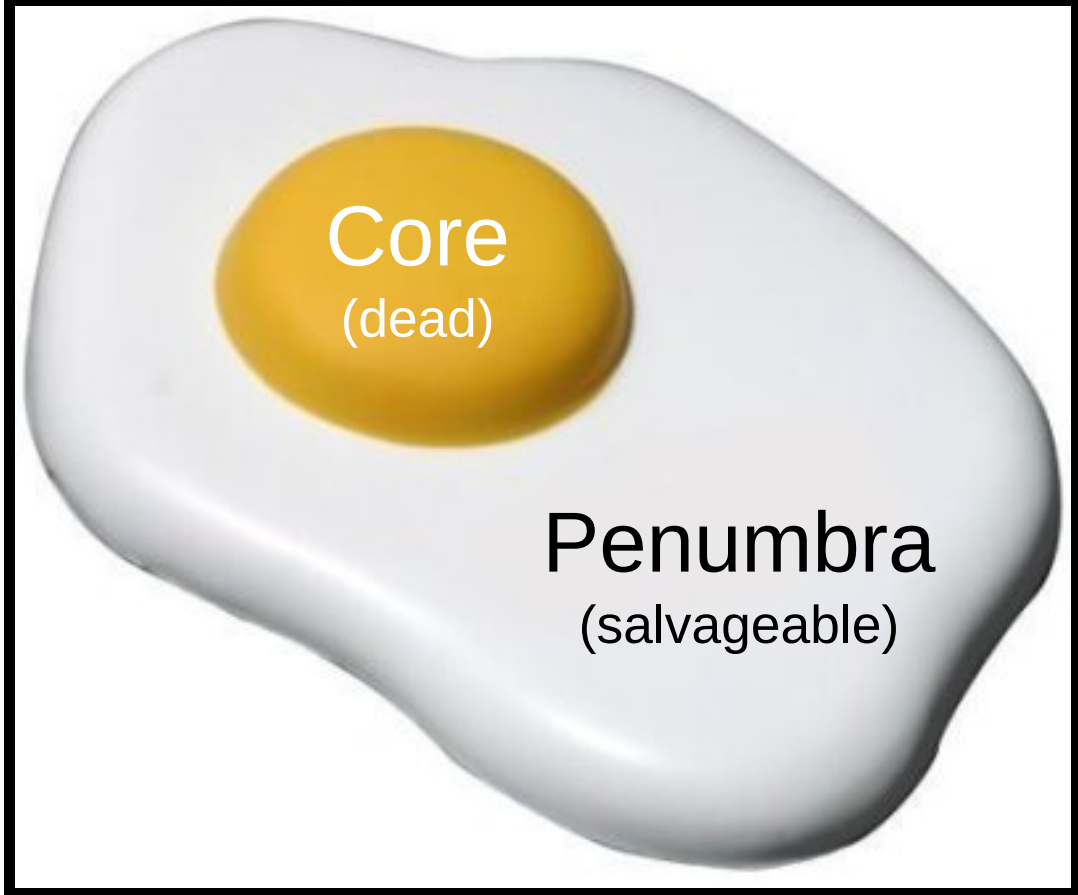
  Intravenous tPA – treatment must begin <3-4.5 hrs

  Mechanical devices; FDA approval but not clear who benefits and effective time window

Advances in Stroke Imaging:



The Mismatch Concept



- **Infarct Core (game over)**:

  Diffusion Weighted MRI (DWI)

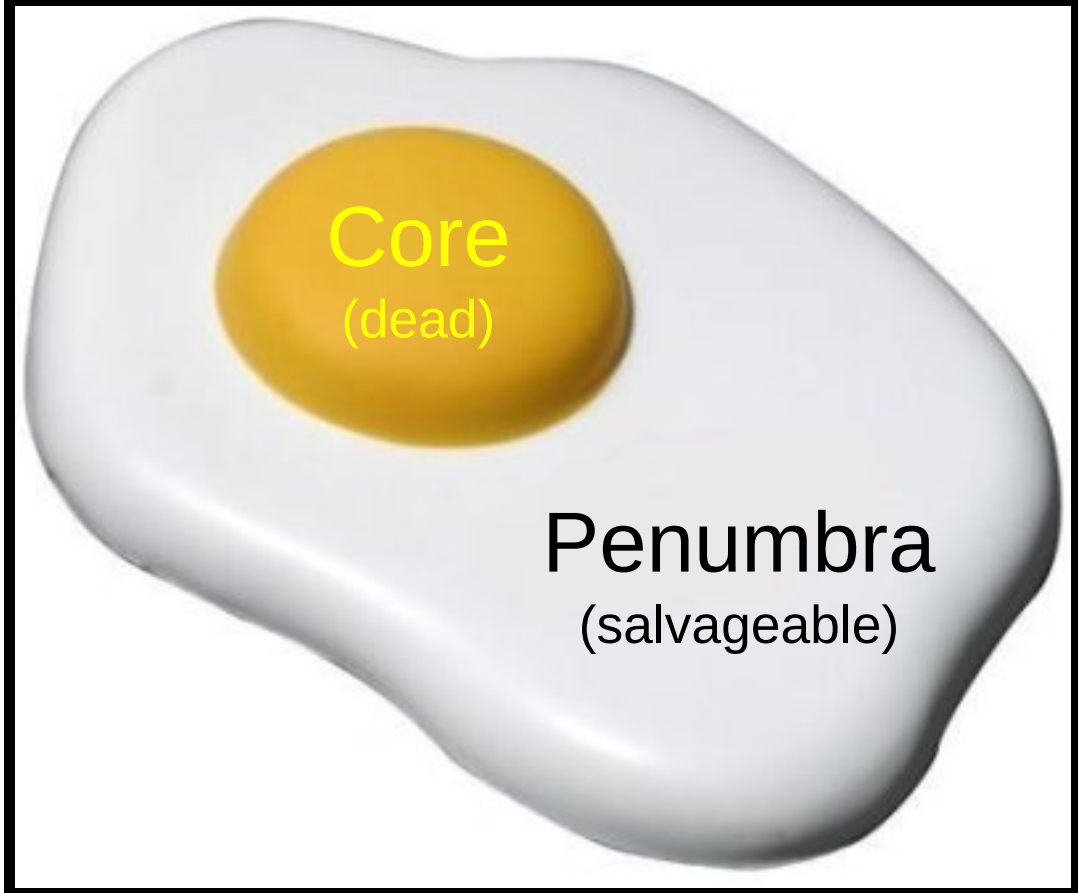
- **Penumbra or salvageable**:

  Perfusion Weighted MRI (PWI)

- **Mismatch ratio:**

  Penumbra/Core

The Mismatch Concept

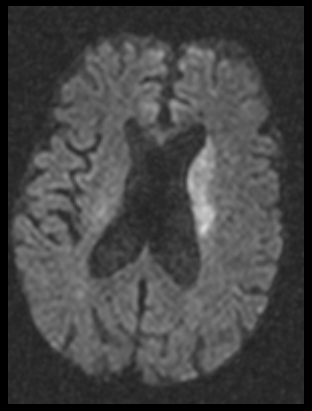


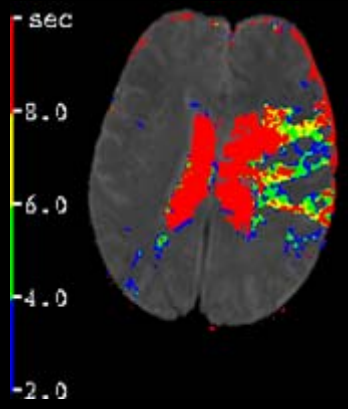
DEFUSE Study

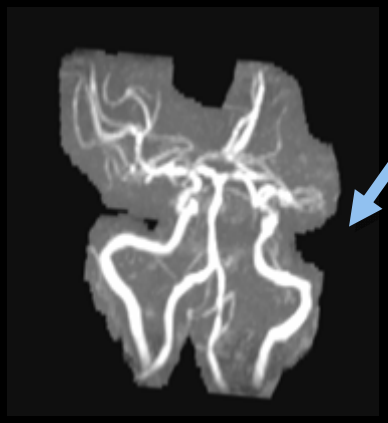
D*WI / PWI*
E*valuation*
F*or*
U*nderstanding*
S*troke*
E*volution*

Benefit of t-PA At 6 hrs in Mismatch Patients

6 hrs
Stroke score
16





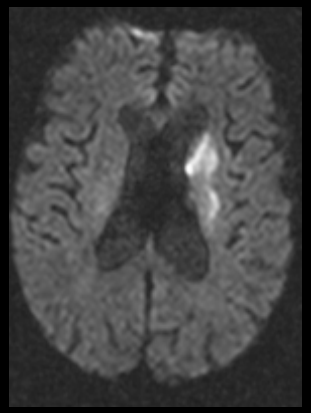


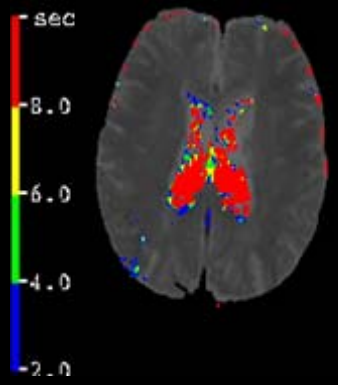
DWI: 3 cc

PWI: 95 cc

↓ Flow

4.5 hours
after t–PA
Stroke score
5





6 cc

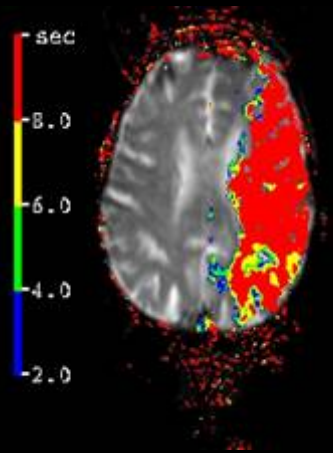
0 cc

Improved

The *Malignant Mismatch* – t-PA Harmful

Before t–PA

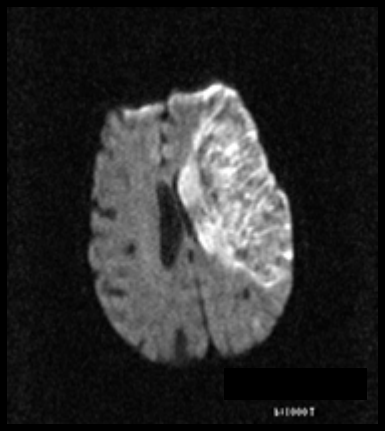
105 cc



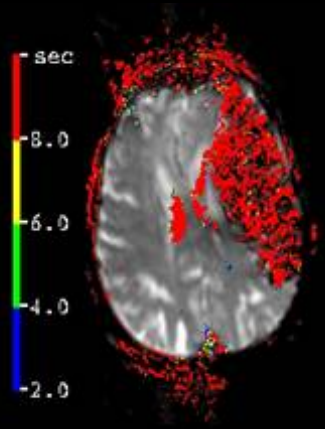
215 cc

vessel occlusion

4 hours after t–PA



> 100 cc



77 cc

vessel

Automated Image Processing Required: RAPID Software

Stroke MRI or CT

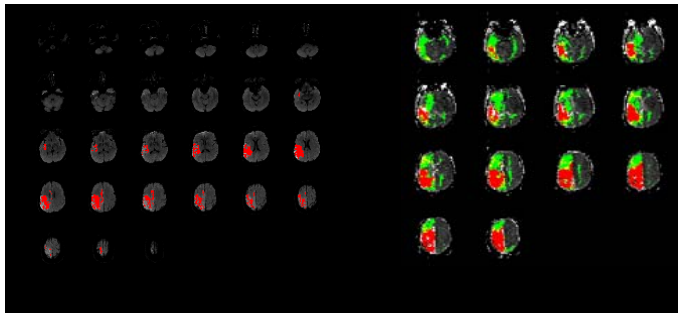
00:00
Completion of scan

MR tech pushes DWI & PWI to RAPID

00:30
image arrival

Image Analysis

04:30
RAPID image analysis complete



Auto-send

05:00
Images on PACS

DEFUSE 2 Protocol

MRI
baseline

Intra-arterial
Therapy

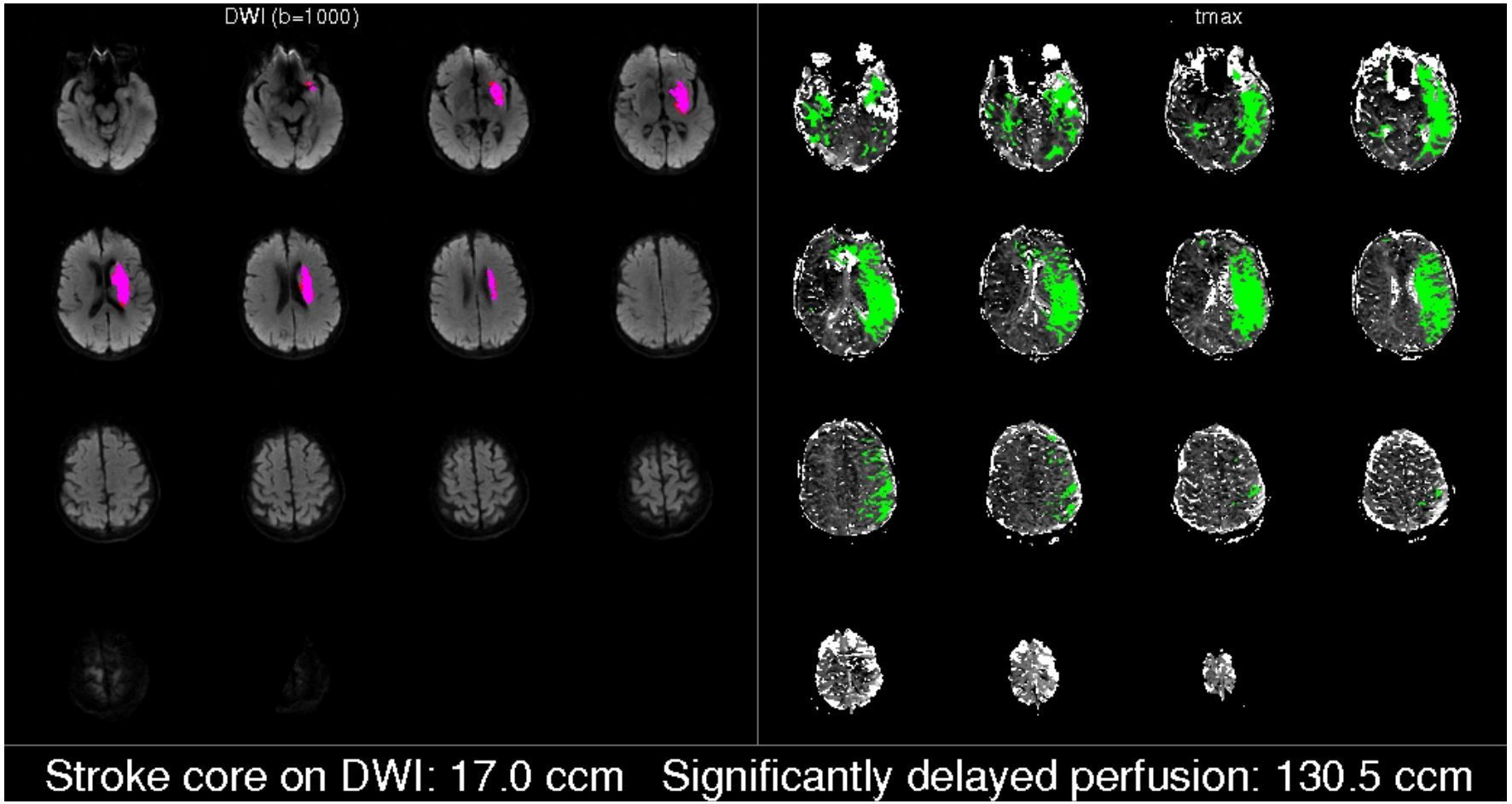
MRI
Post-procedure
(reperfusion)

MRI
Day 5
(infarct volume)

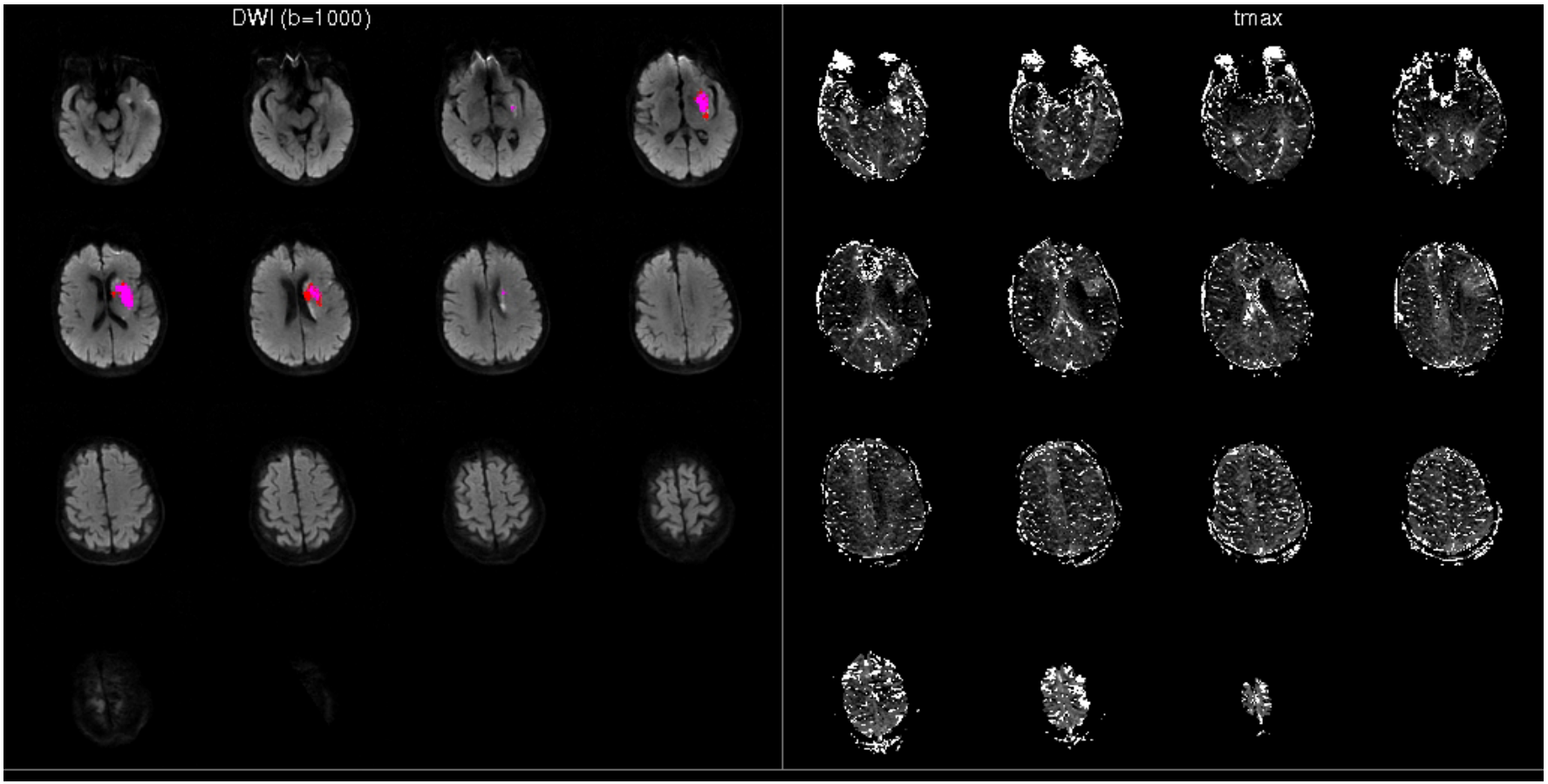
Favorable clinical response:

- NIHSS score of 0-1 at day 30 or improvement of NIHSS score by ≥8 points between baseline and day 30

88-Year-Old Female - IV t-PA Not Effective



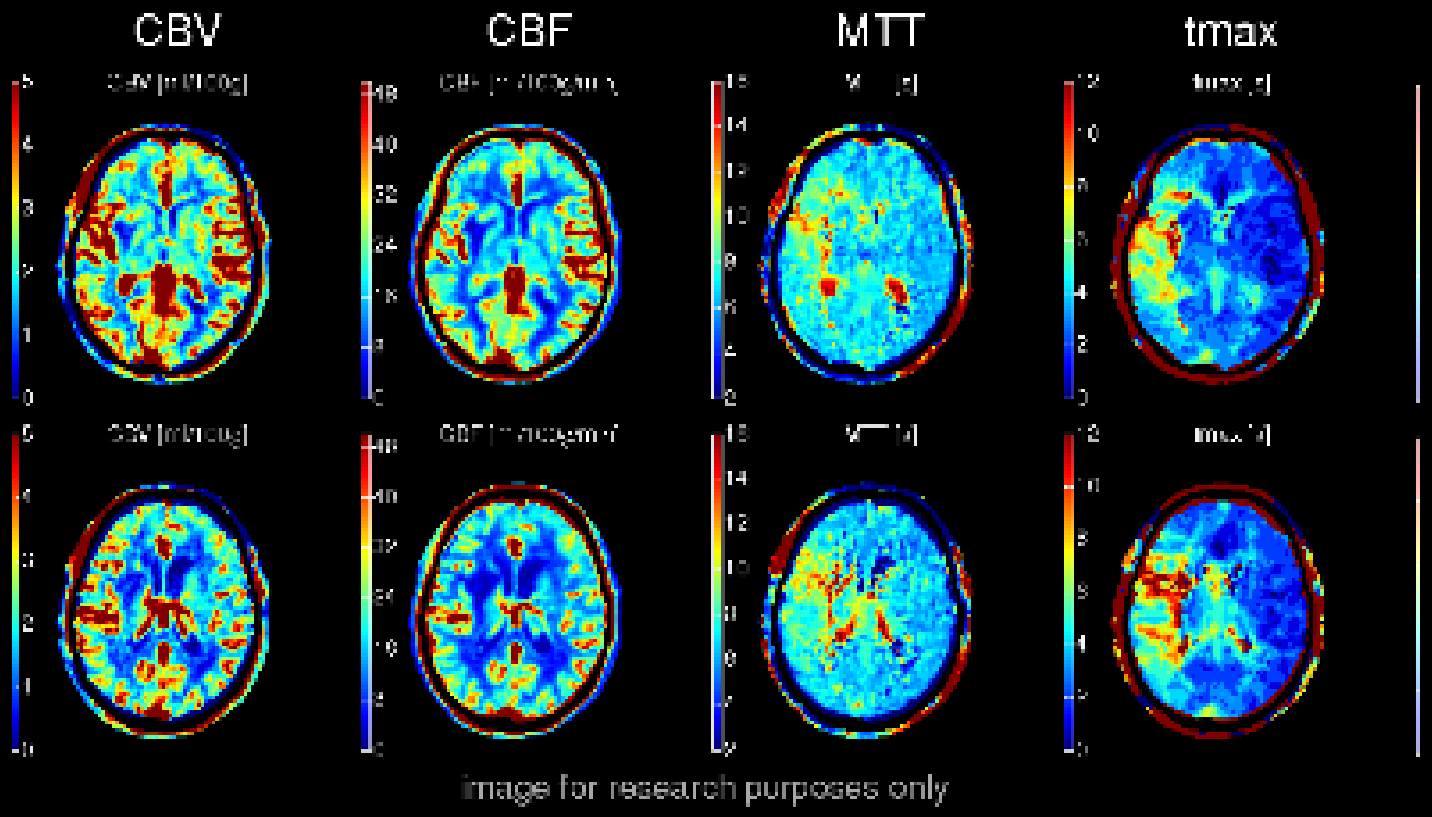
After Mechanical Clot Removal



Complete neurologic recovery at 24 hrs

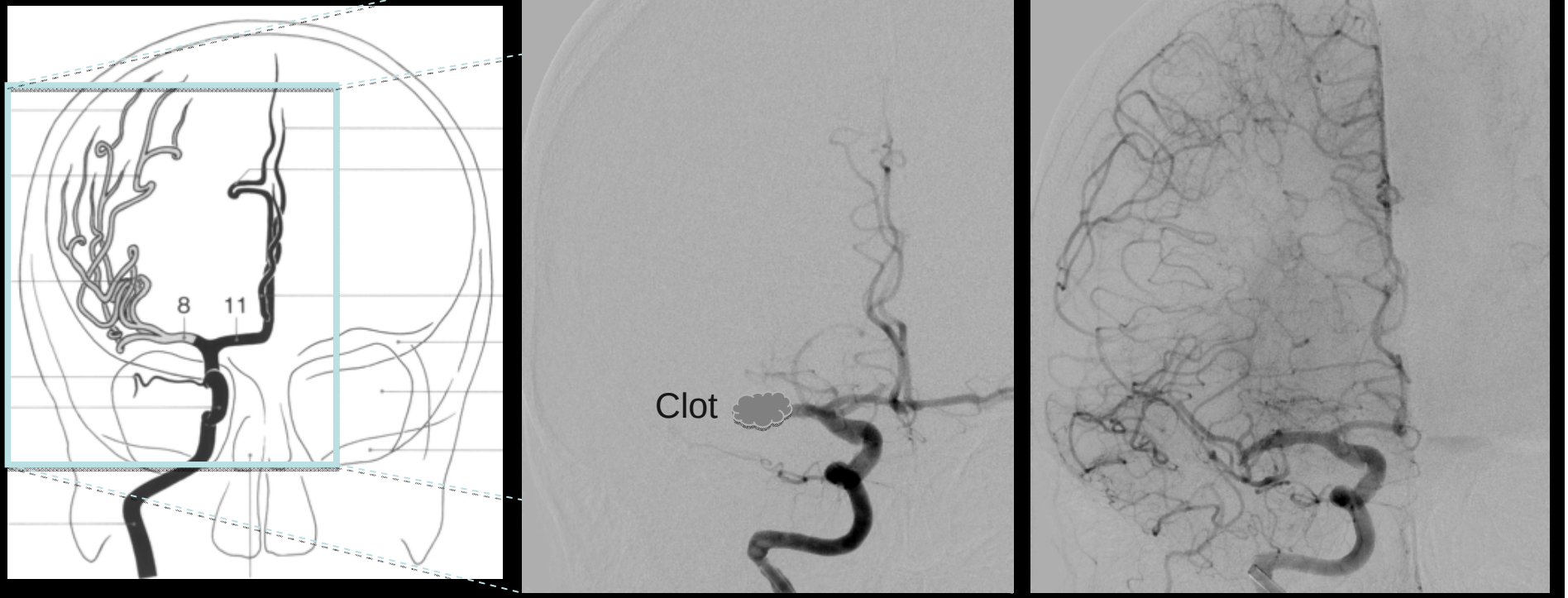
Use of Imaging to Monitor Stroke Therapies

79 yo female, left side paralysis



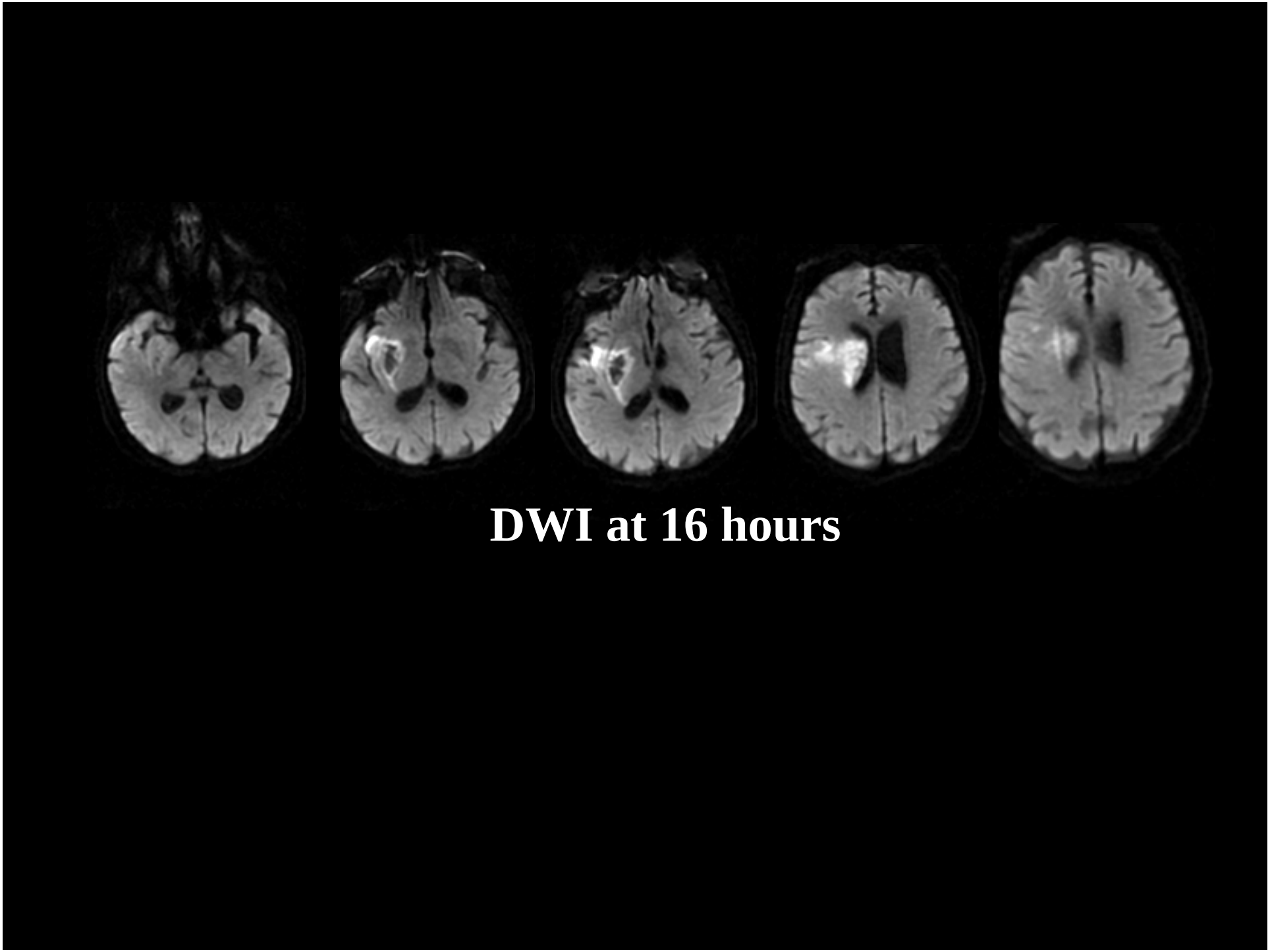
CT Perfusion at 6.5 hours

Blocked Artery Open at 8 Hours

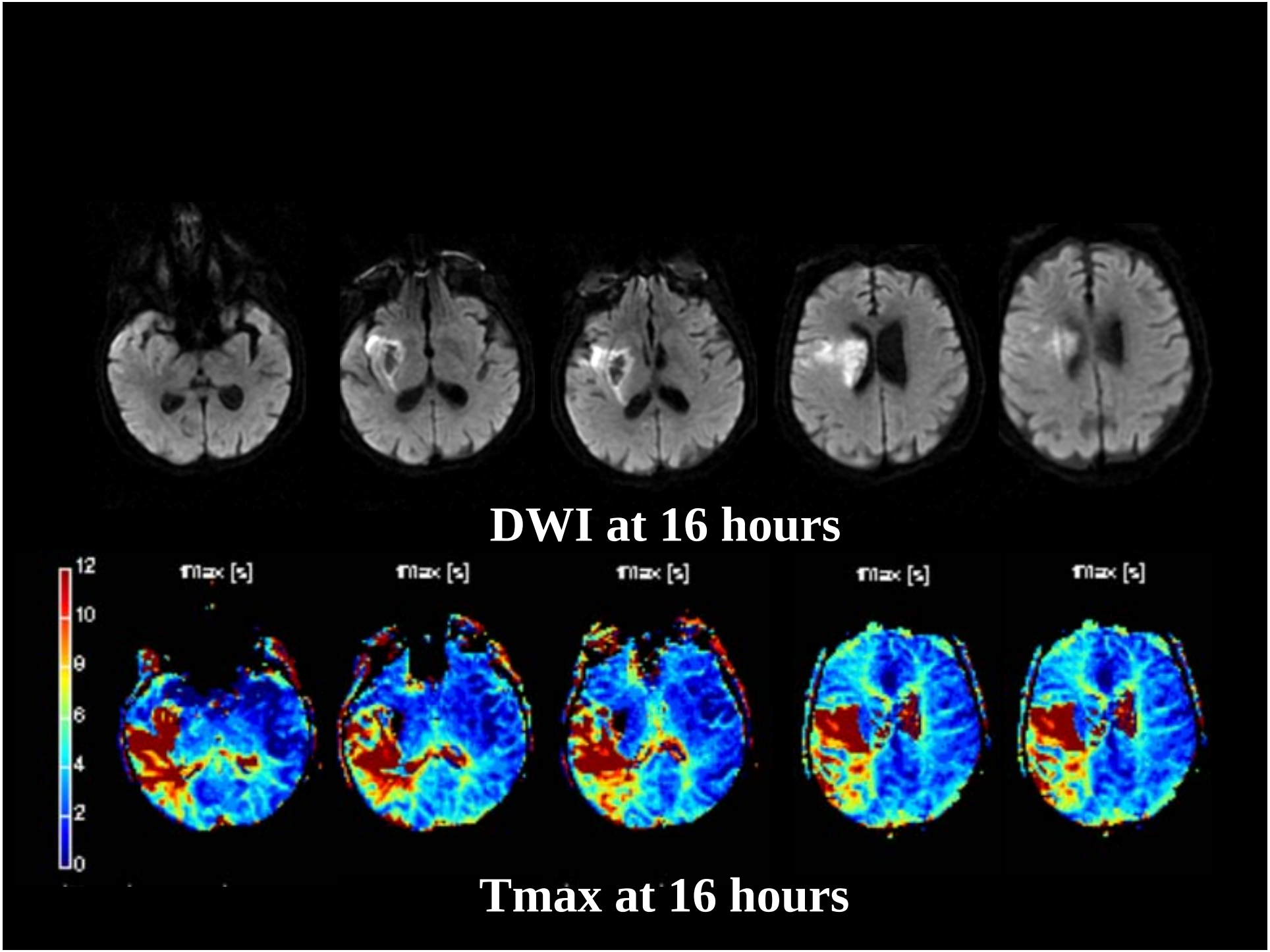


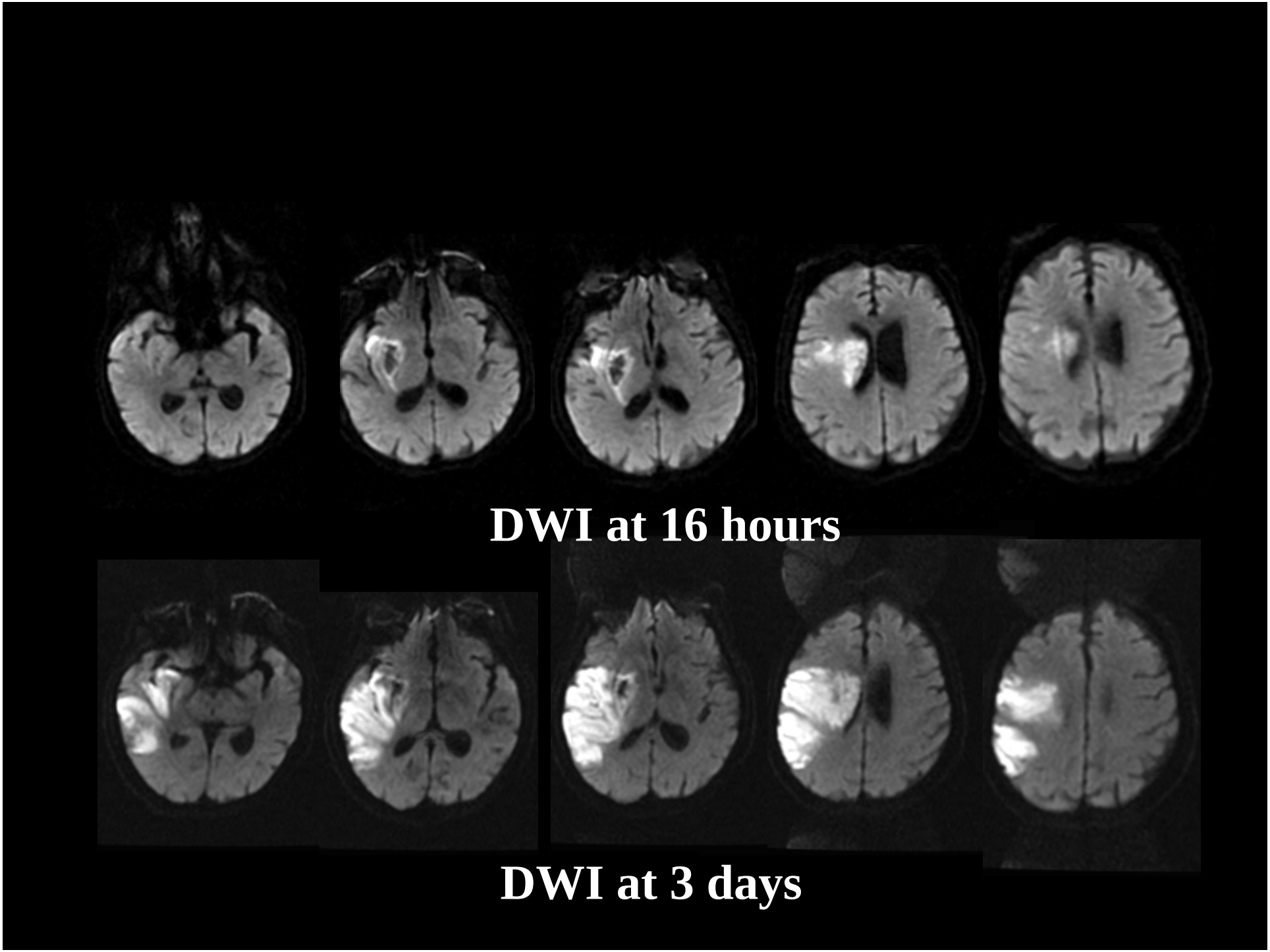
Blocked Artery Open at 8 Hours

Angiogram pre and post mechanical device

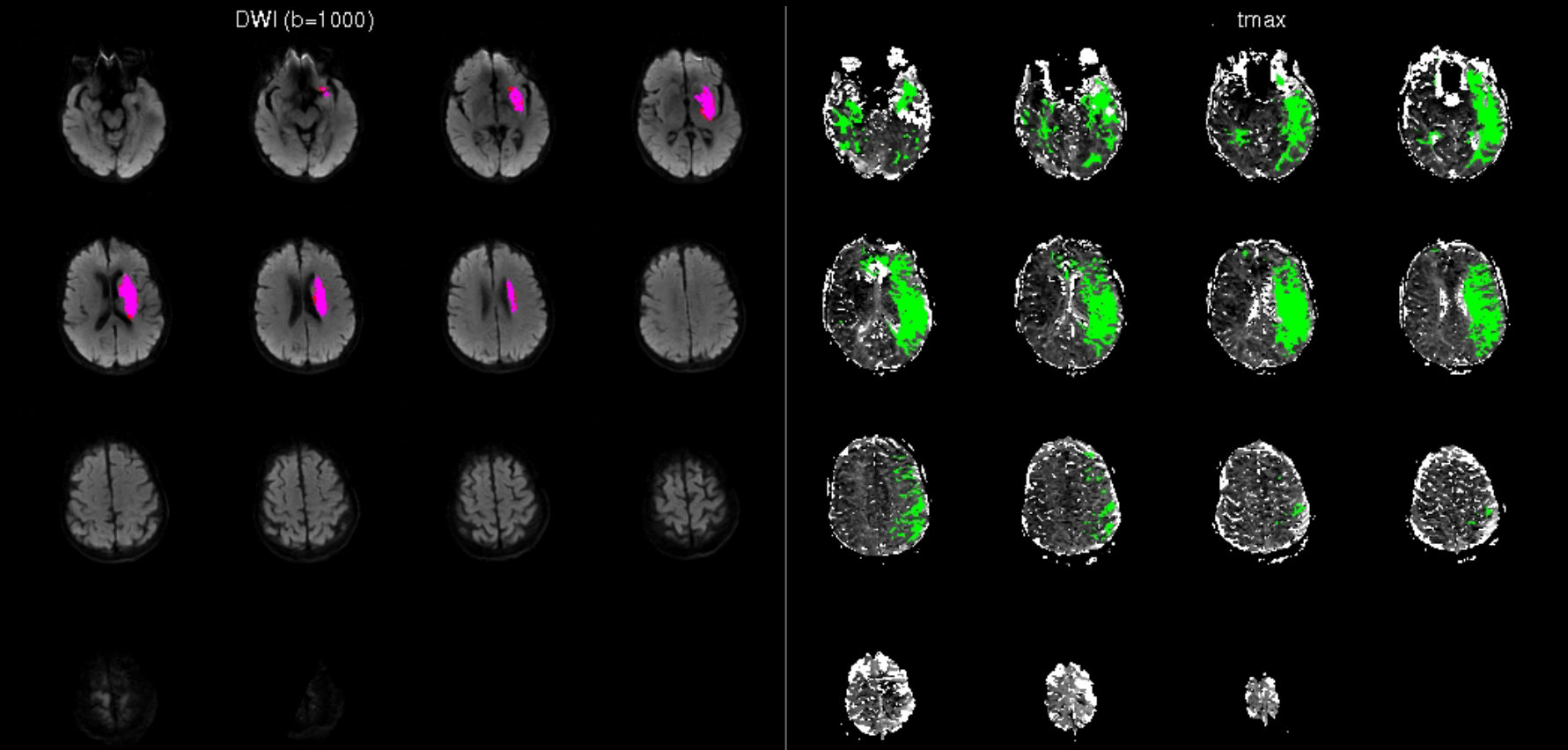


DWI at 16 hours


DWI at 16 hours
Tmax [s]
12
10
8
6
4
2
0
Tmax at 16 hours

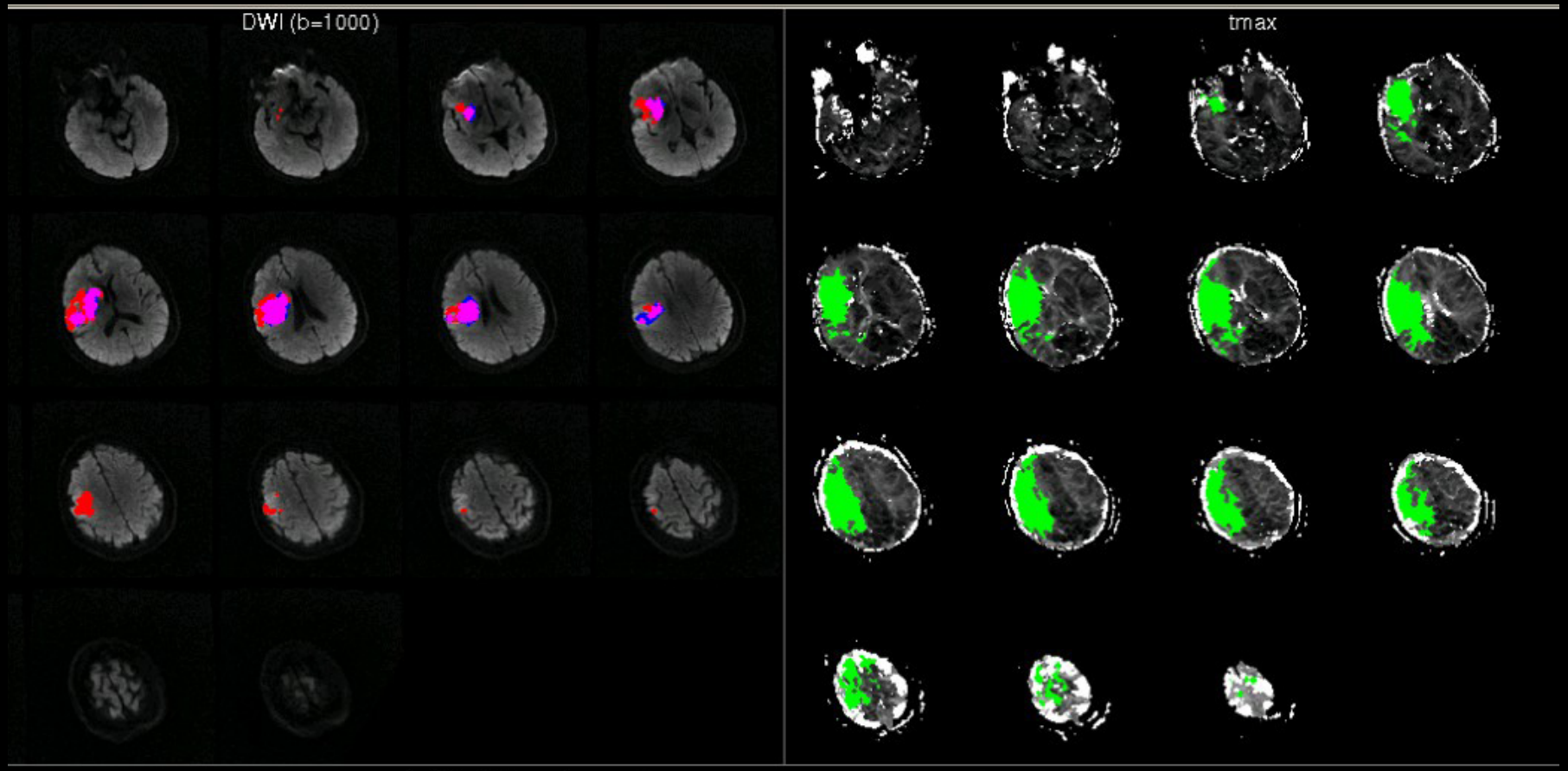

DWI at 16 hours
DWI at 3 days

88-Year-Old Female - IV t-PA Not Effective



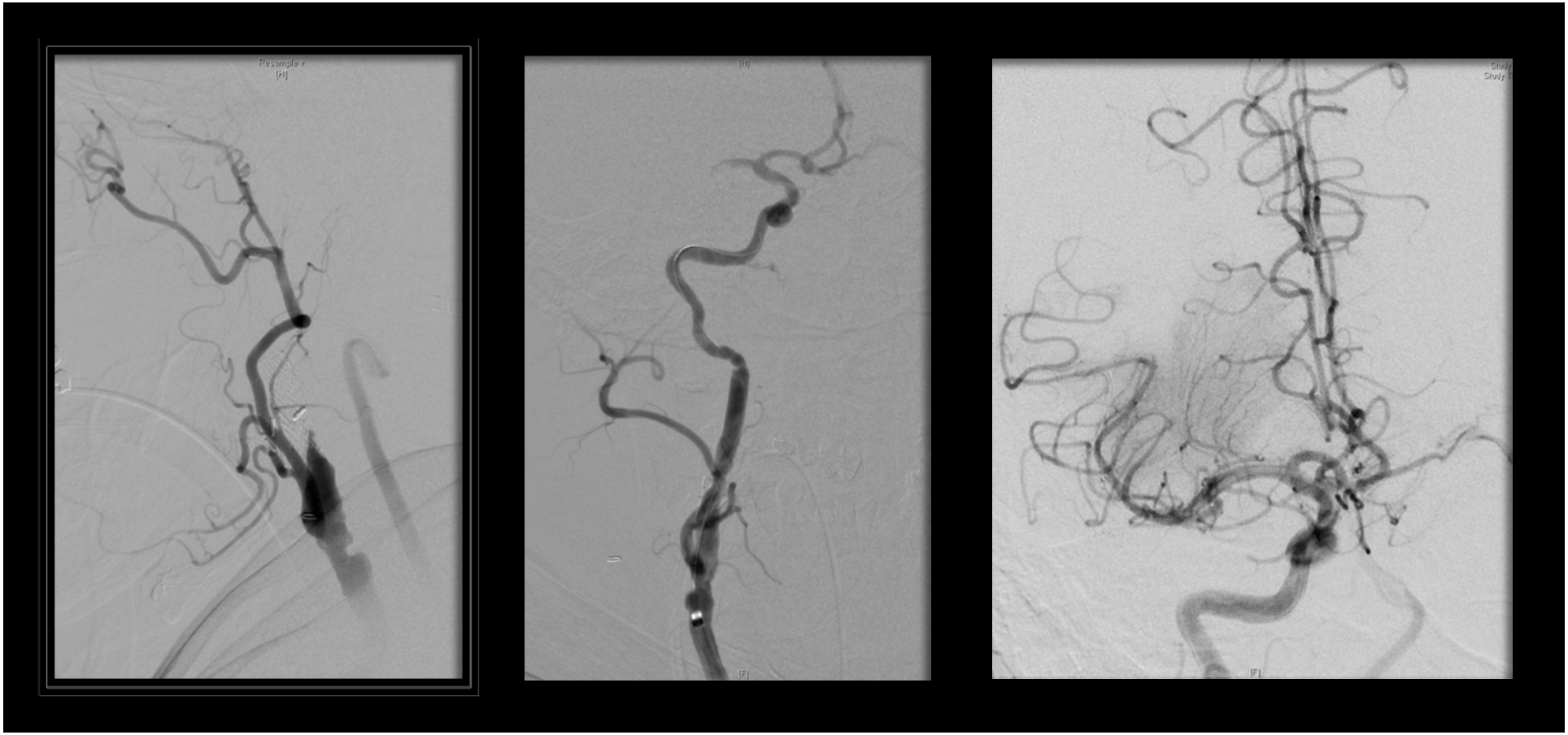
Stroke core on DWI: 17.0 ccm Significantly delayed perfusion: 130.5 ccm

61-Yr-Old, 7 hrs After Left Side Paralysis

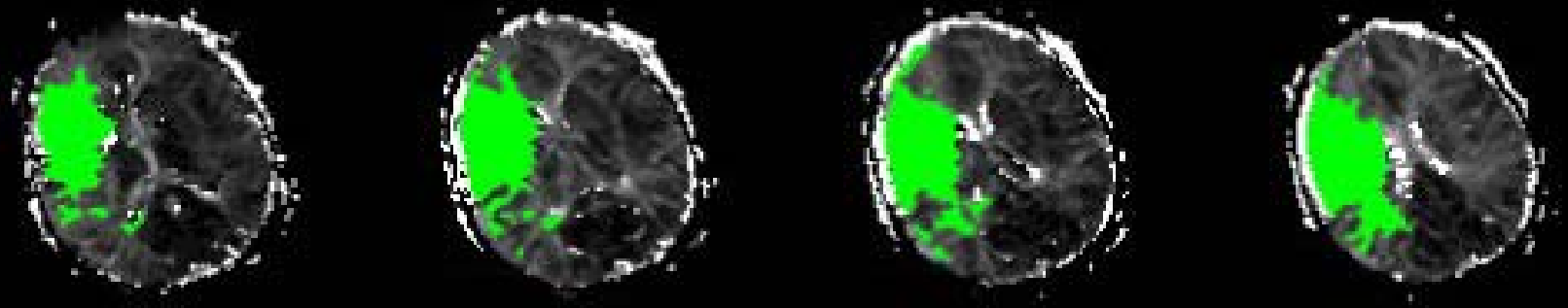


PWI lesion for tmax > 6.0s: 152.7 ccm
DWI lesion (total): 40.6 ccm, mismatch ratio: 3.8

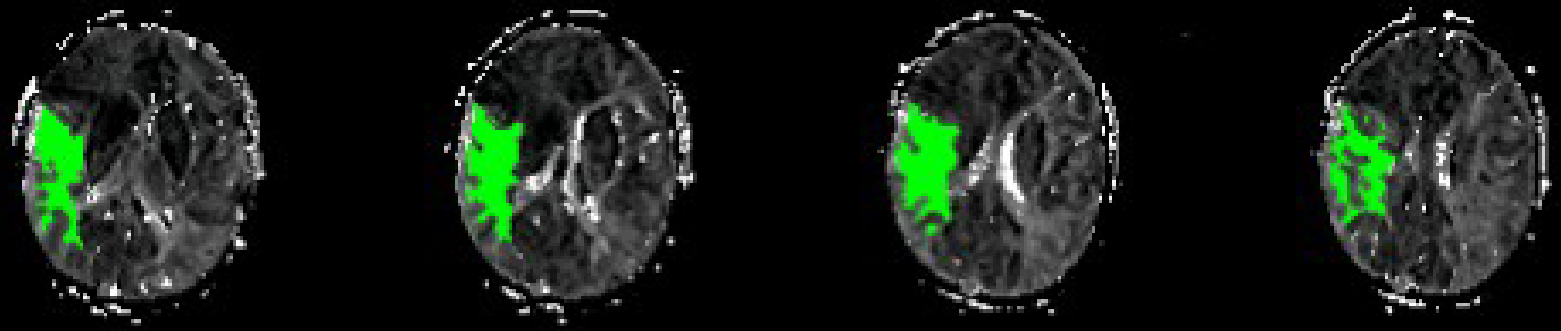
Recanalization at 6 hours after onset



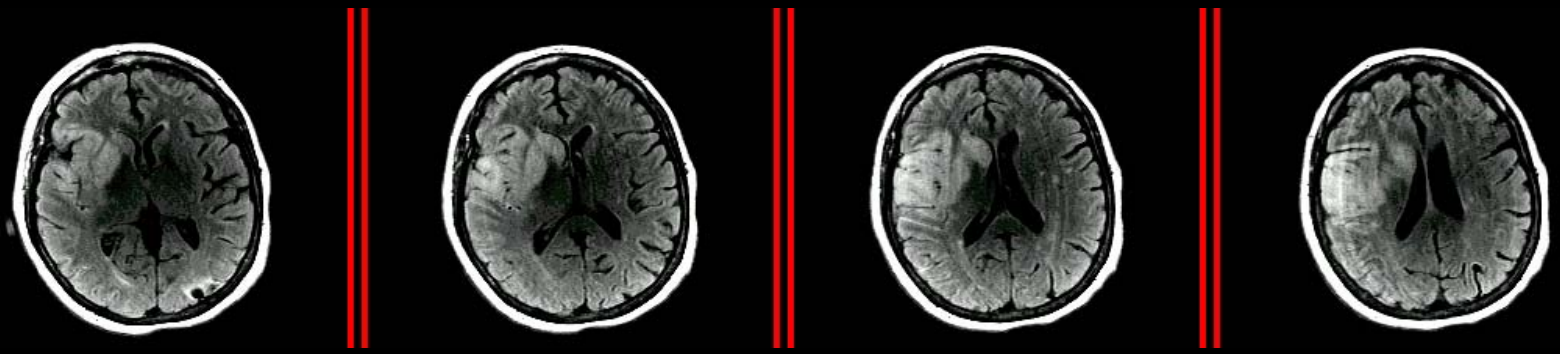
Baseline PWI lesion=153 cc



Early follow-up PWI lesion=45 cc

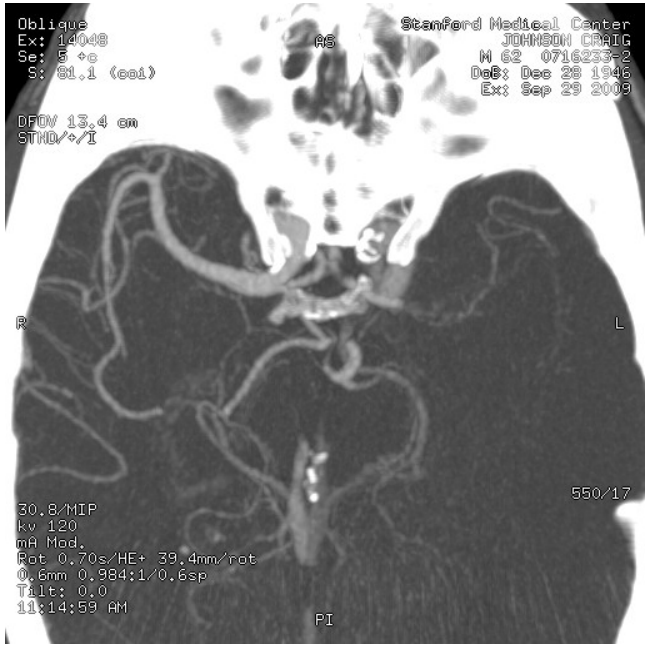


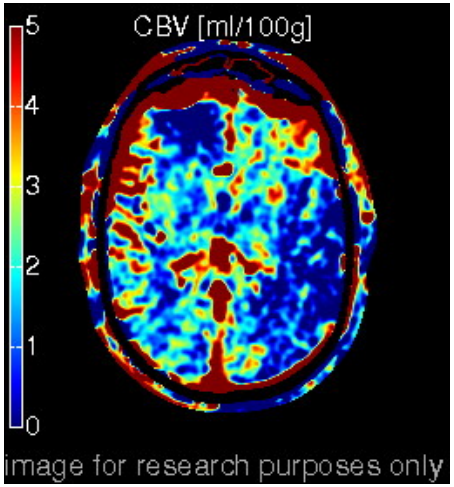
Final stroke size= 45 cc

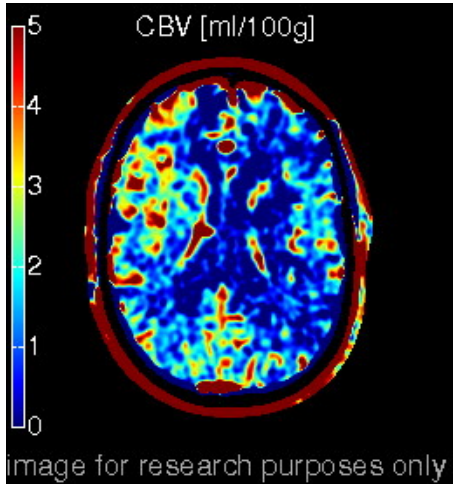


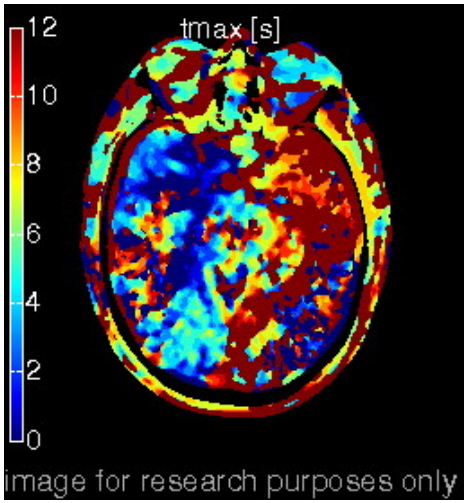
Tissue vs. Time

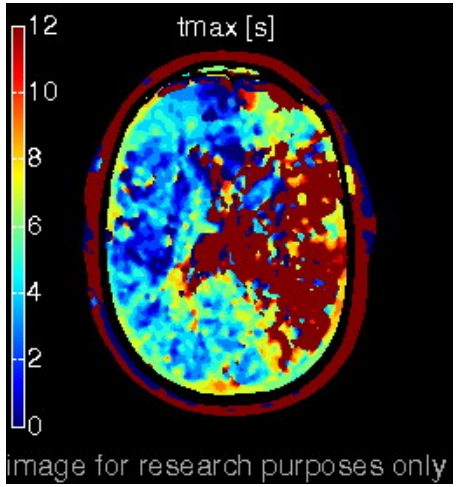
62 yo male 2.5 hrs after symptom onset- CT PERFUSION

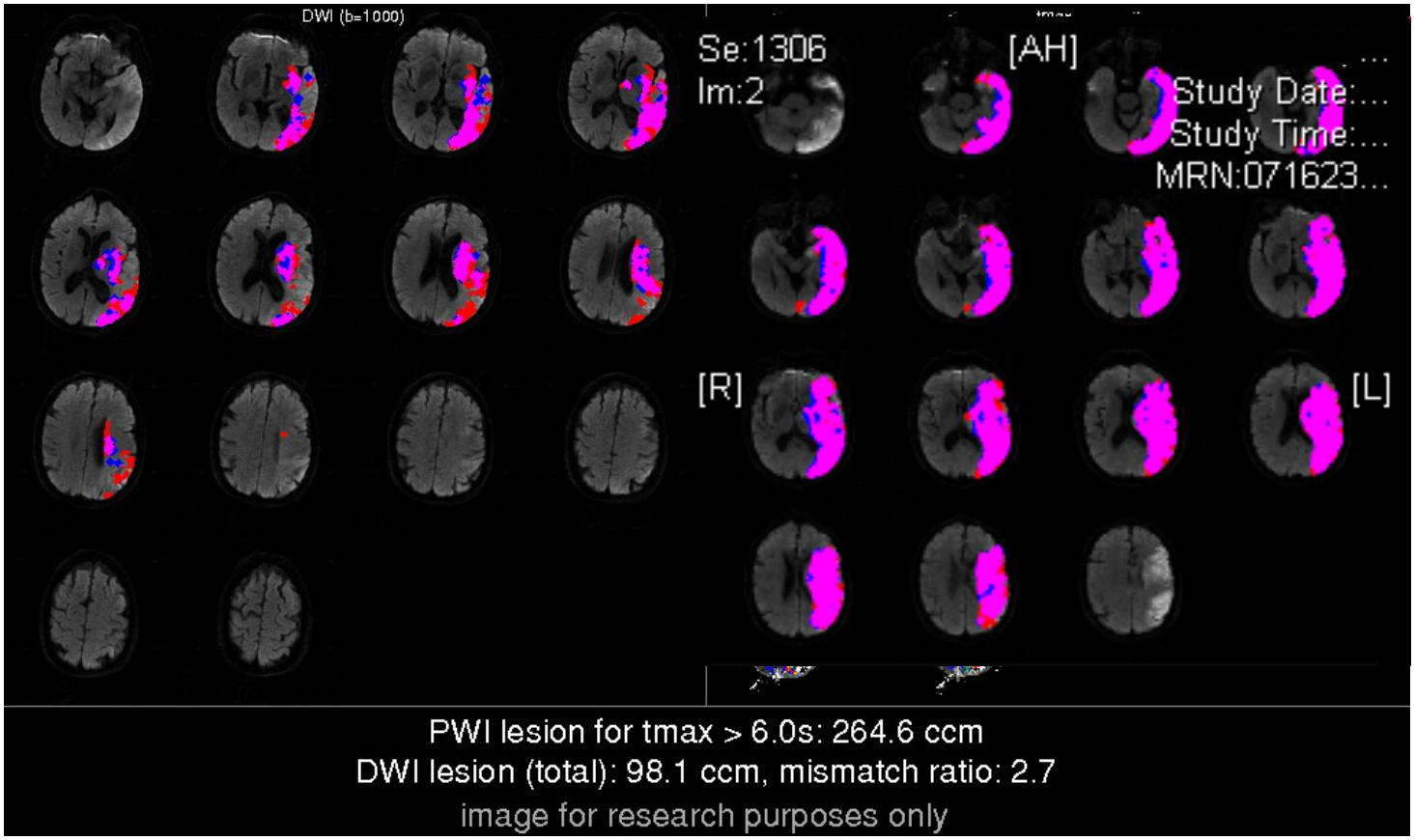




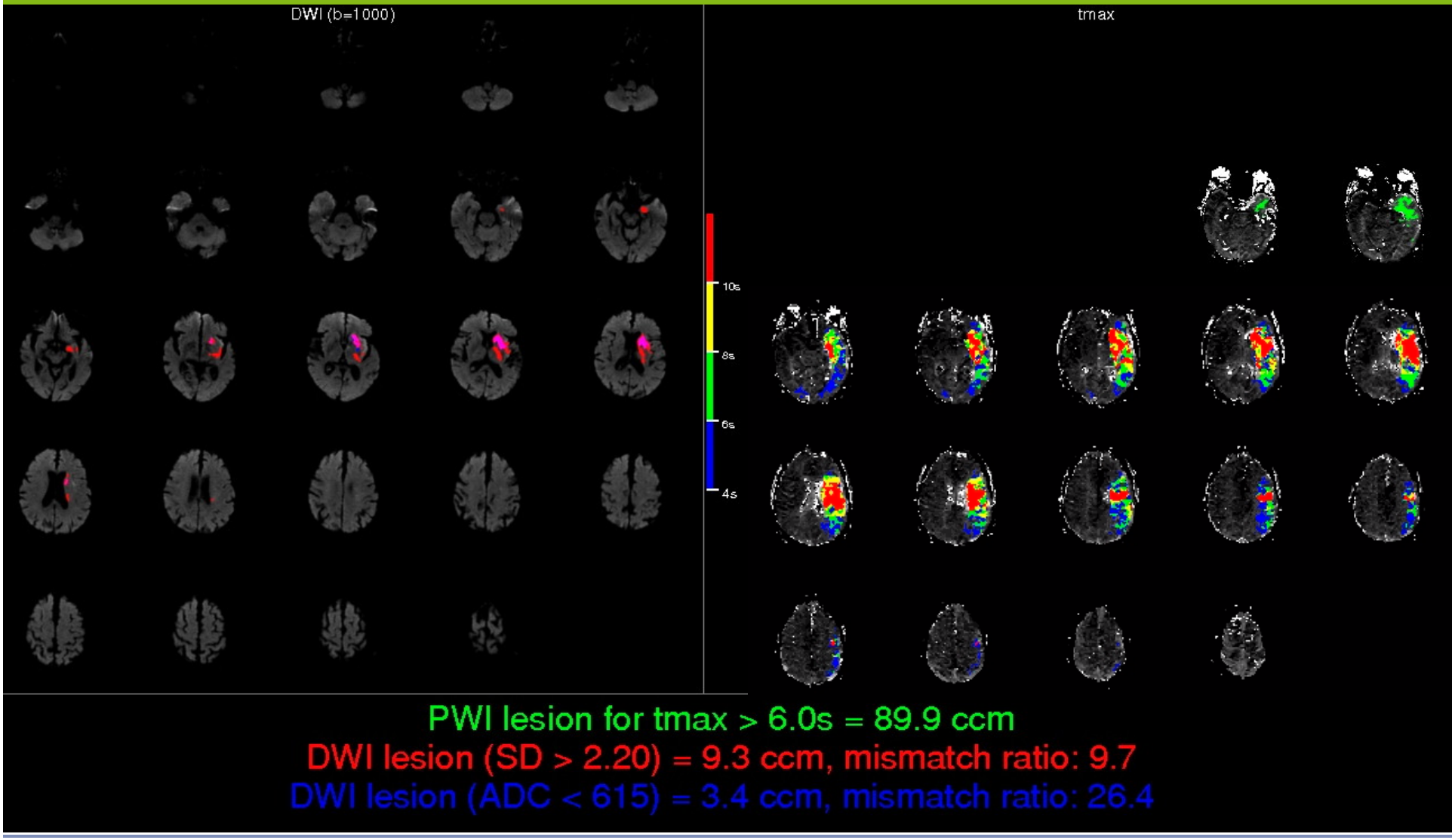




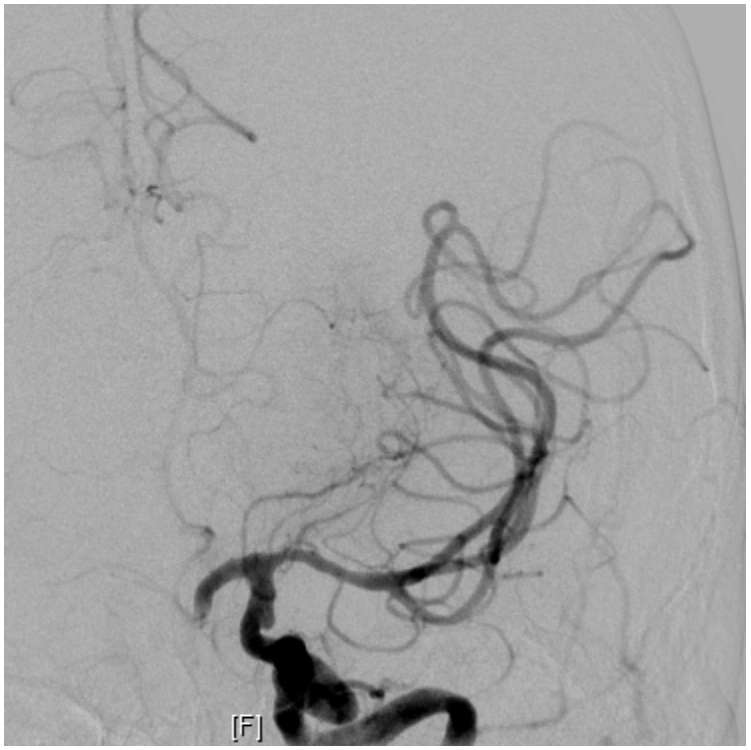



DWI (b=1000)
Se:1306
Im:2
[AH]
Study Date:...
Study Time:...
MRN:071623...
[R]
[L]
PWI lesion for tmax > 6.0s: 264.6 ccm
DWI lesion (total): 98.1 ccm, mismatch ratio: 2.7
image for research purposes only

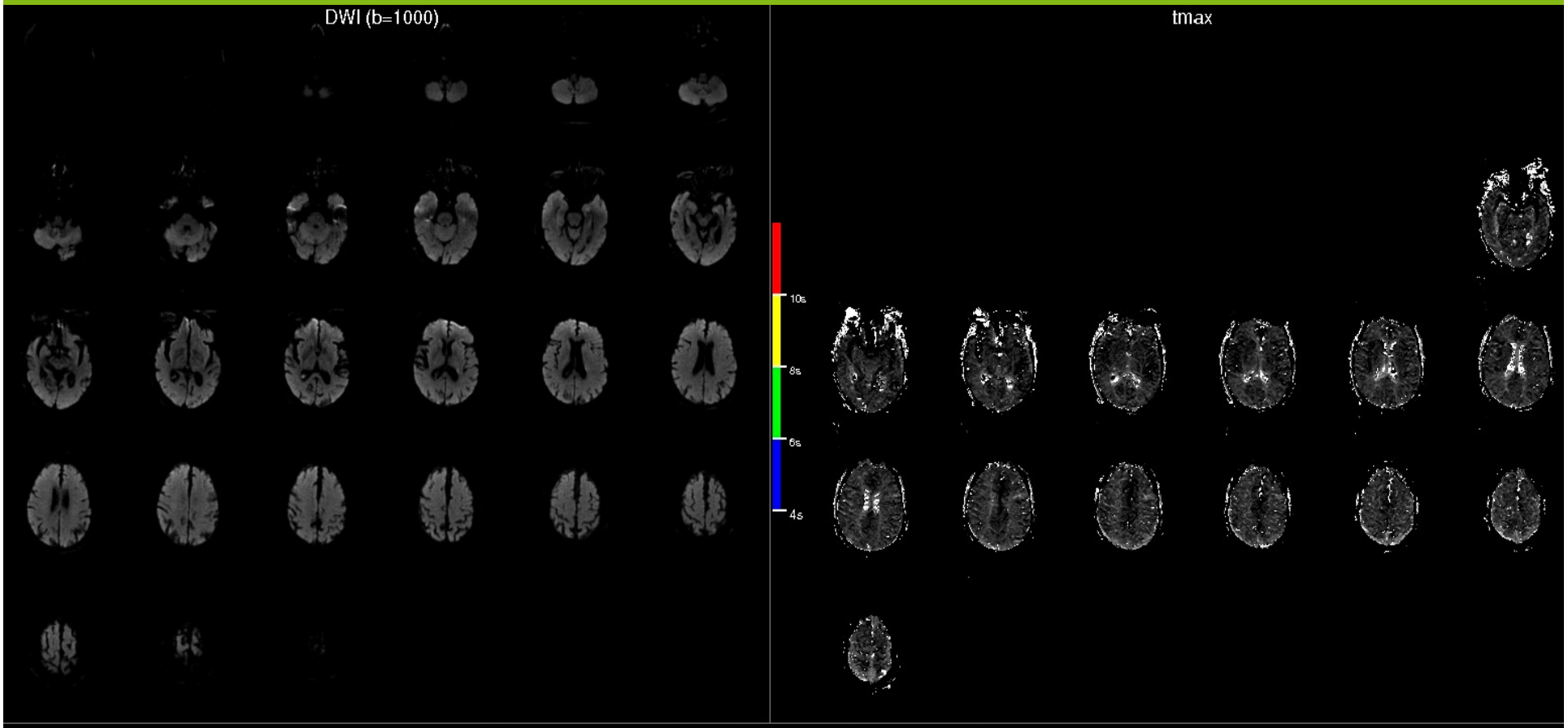
82 yo female, iv tpa not effective, severe stroke symptoms



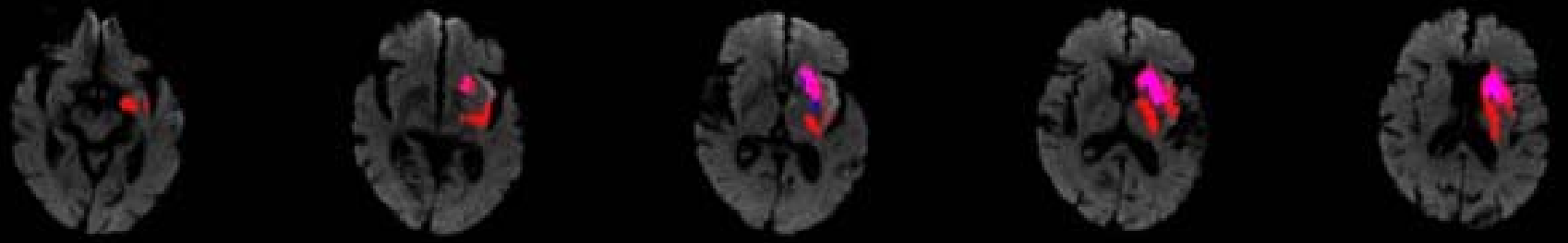
Carotid artery open at 4 hours



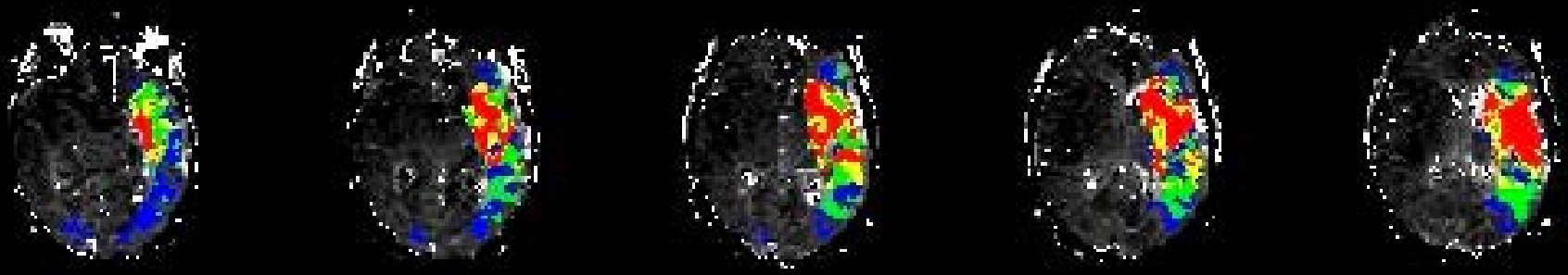
Follow-up MRI 4 hours later (8 after onset). Full recovery



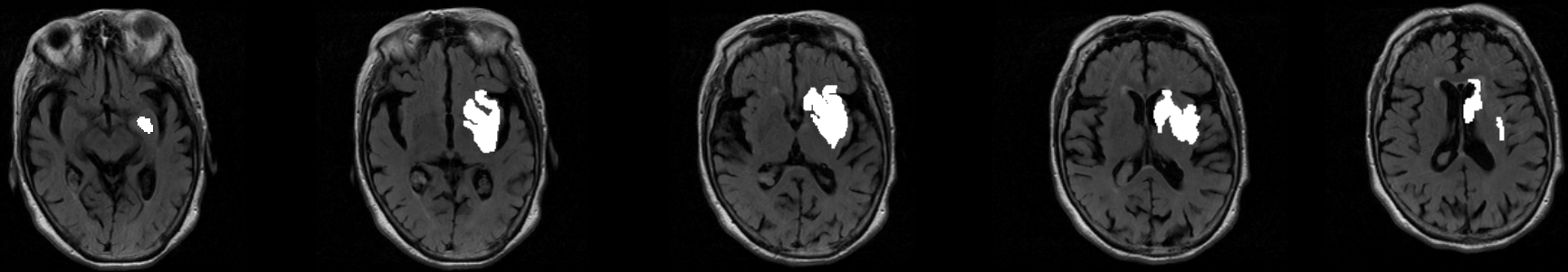
Baseline DWI lesion= 10 cc; NIH 22



Baseline PWI lesion



Day 3: Flair lesion = 11 cc; NIH 0



How to Increase the Effectiveness of Stroke Treatment:

- Use advanced imaging to triage and monitor therapy
- Don’t treat patients with severe irreversible damage
- Treat patients with salvageable tissue even if they arrive late
- Use intravenous tPA for small clots; mechanical devices for large clots

DEFUSE 2 Coordinating Center

M. Lansberg

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M. Straka

M. Marks

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M. Mlynash

J.M. Olivot

A. Purushotham

M. Moseley