KANSAS INITIATIVE FOR STROKE SURVIVAL

A PROJECT BY AND FOR KANSANS

Phone (913) 588-1554 • Fax (913) 945-8892

CT Perfusion Imaging

"First Tuesdays" Lecture Series

Introduction and Goal of “First Tuesdays”

- Sabreena Slavin MD – Vascular Neurologist and Neurohospitalist at KU School of Medicine
- Didactic lecture series as part of the Kansas Initiative for Stroke Survival
- Updates in Practice and FAQ’s on Acute Stroke Care
- 30 minutes for didactics and questions/discussion.

When do you need a CTP?

- Lsw 2 hours ago, NIHSS 2 for sensory loss and mild drift. CTA negative for LVO.
- Lsw 2 hours ago, NIHSS 15 for unilateral plegia, aphasia, gaze deviation. CTA positive for LVO.
- Lsw 12 hours ago, NIHSS 8 for weakness and aphasia. CTA negative for LVO.
- Lsw 12 hours ago, NIHSS 8 for weakness and aphasia. CTA positive for LVO.

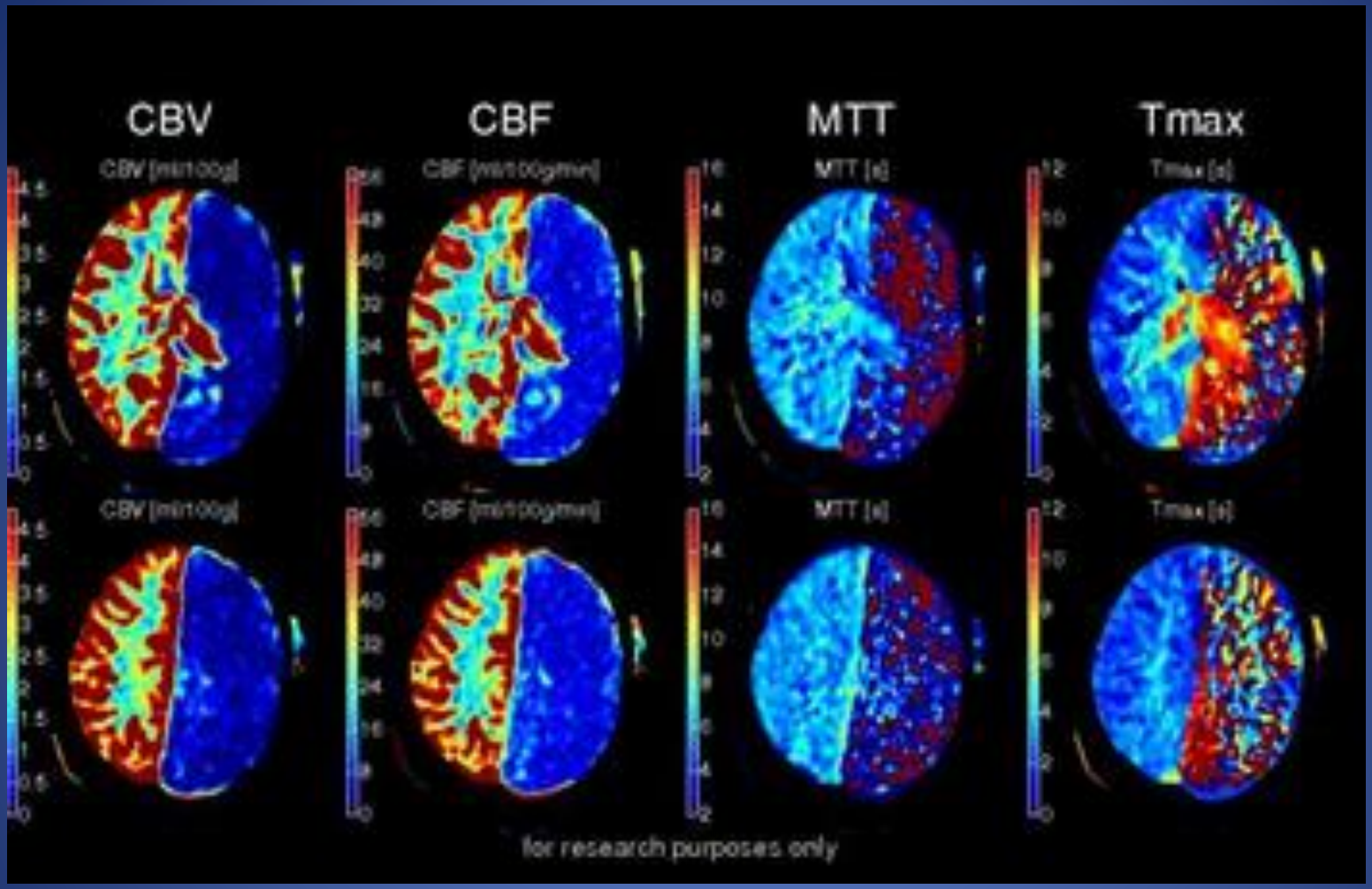
When do you need a CTP?

- When it will be > 6 hours from last seen well by the time the patient goes for thrombectomy
  - Looking for **mismatch** between ischemic core (area already damaged) and ischemic penumbra (area at risk of damage).
  - DAWN[1] and DEFUSE 3[2] trials showing significant benefit for patients 6-24 hours from last well if they have a mismatch

1. Nogueira et al, *NEJM* 2018; 2. Albers et al, *NEJM* 2018

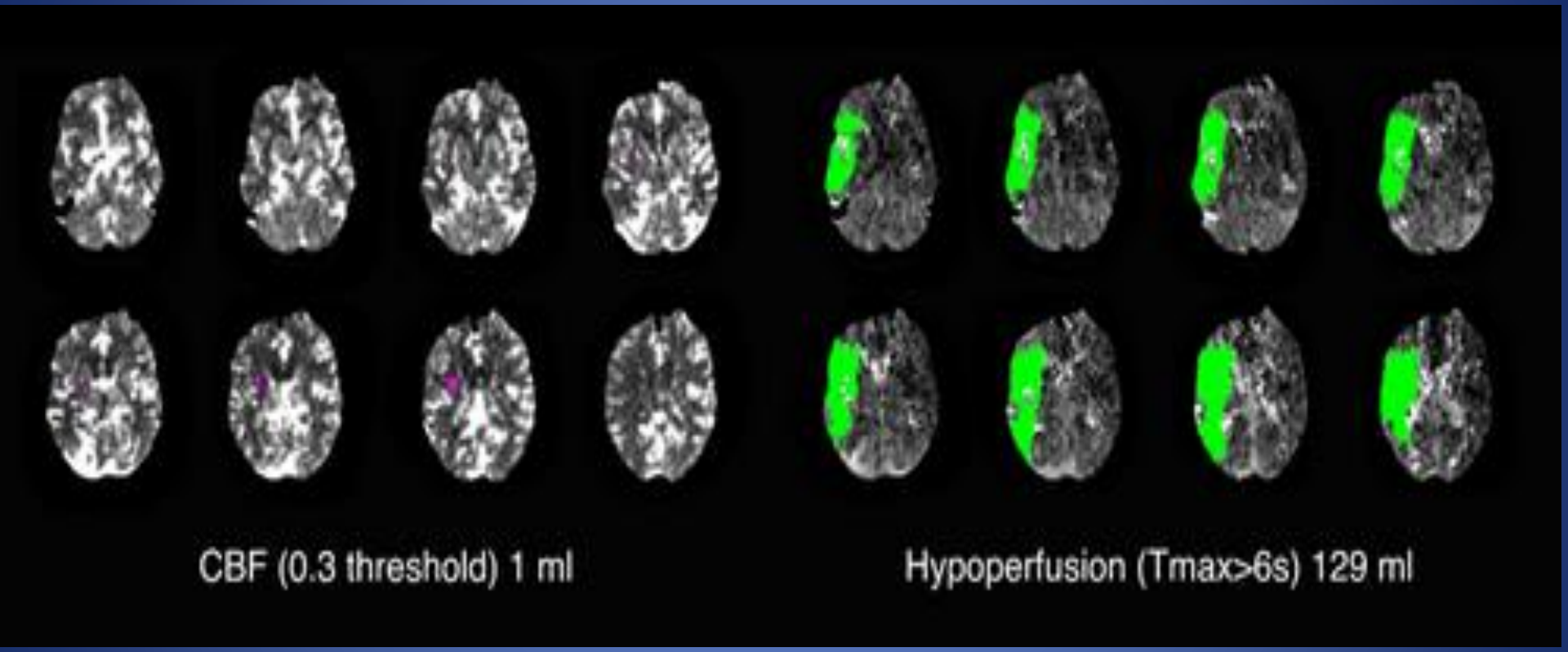
CTP

- CT perfusion (MRI perfusion can be used similarly) is used to find a **mismatch** between ischemic core (area already damaged) and ischemic penumbra (area at risk of damage).
- Measures of core: cerebral blood volume, cerebral blood flow
- Measures of penumbra: mean transit time (ratio cerebral blood flow/cerebral blood volume), time to peak, time to drain, and T_{max} (measures of contrast arrival time to tissue).

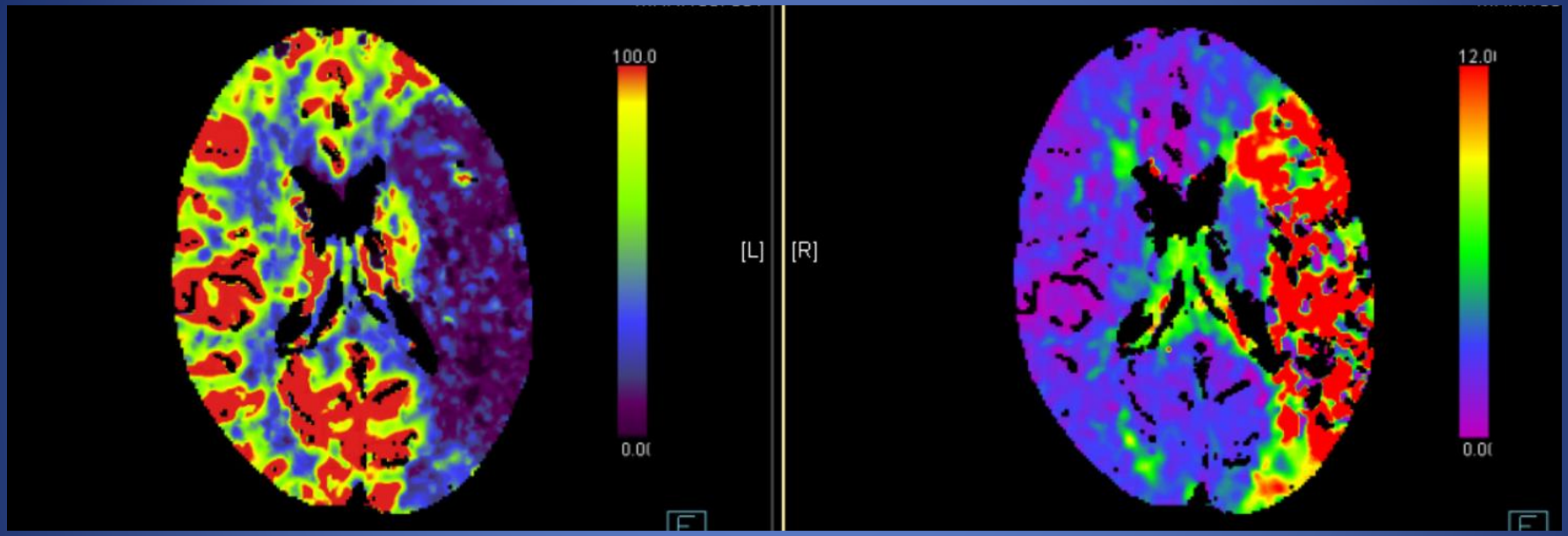


Case courtesy of RMH Core Conditions, Radiopaedia.org, rID: 28678

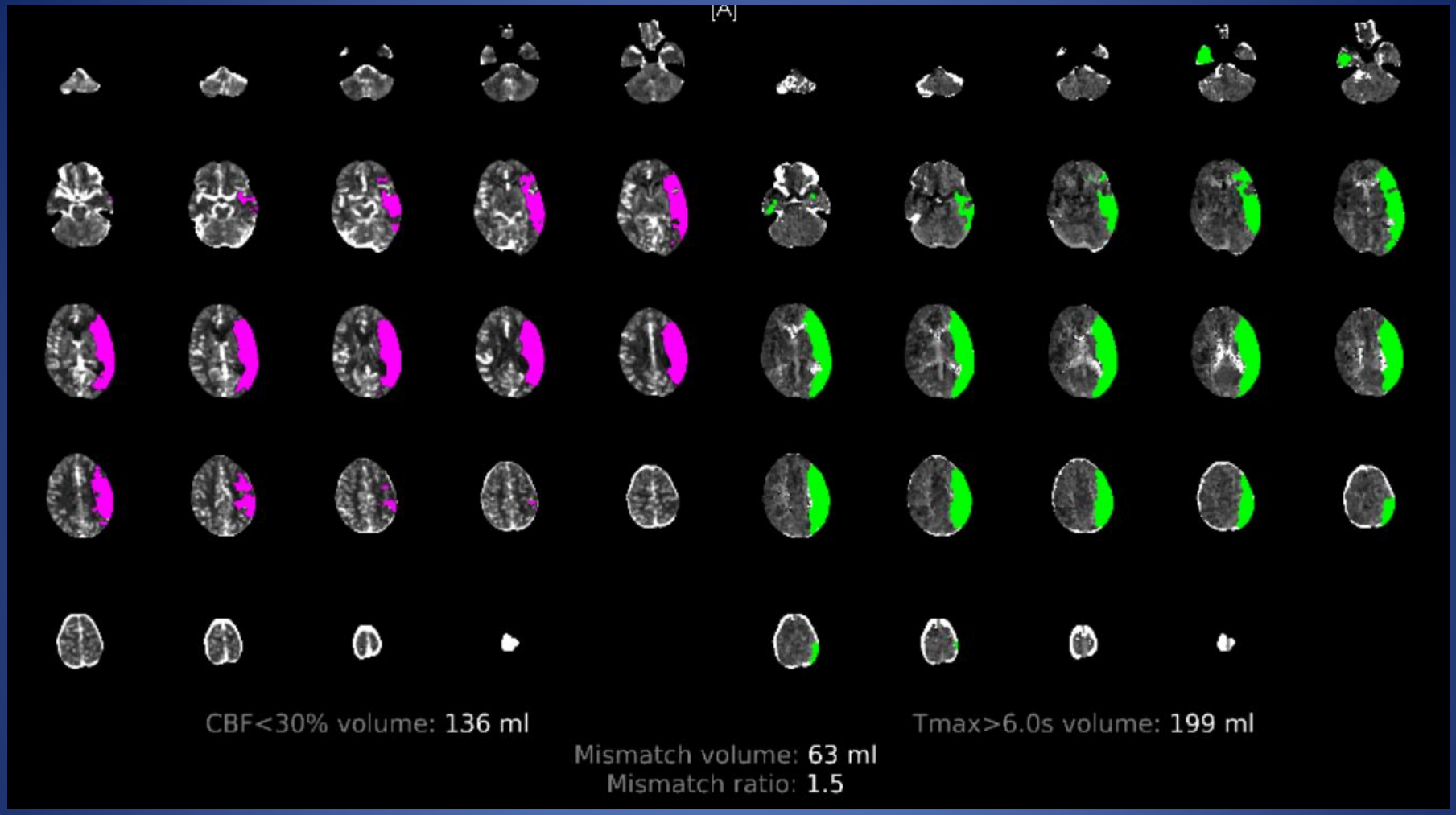
RAPID software to analyze core and penumbra:

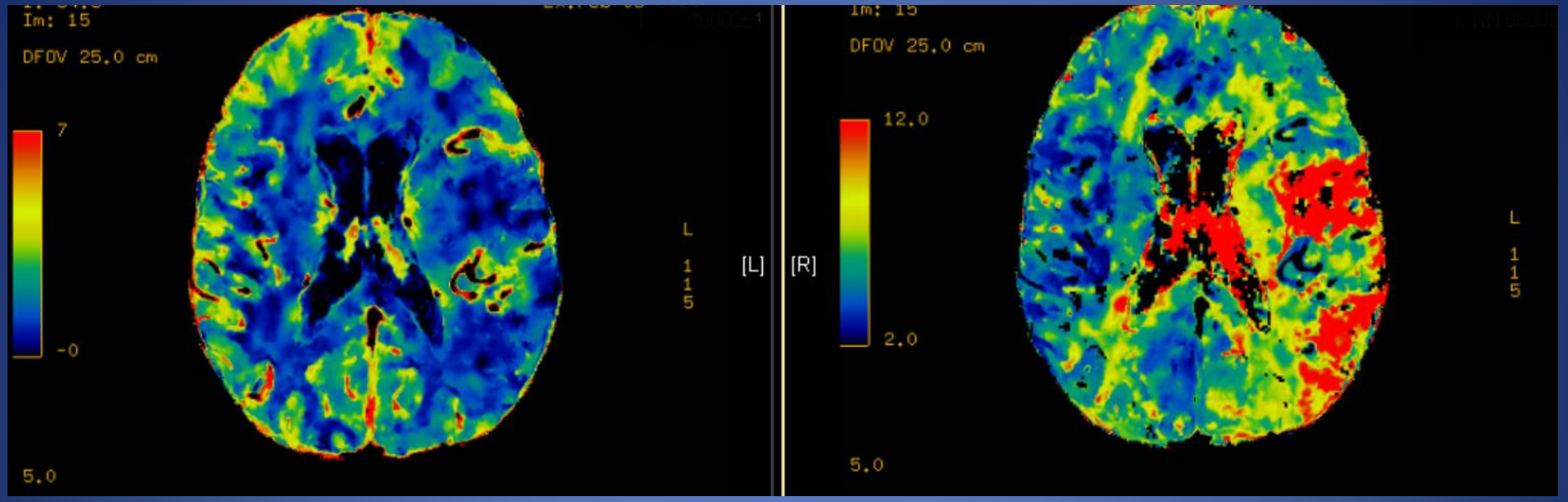


iSchemaView RAPID: www.irapid.com

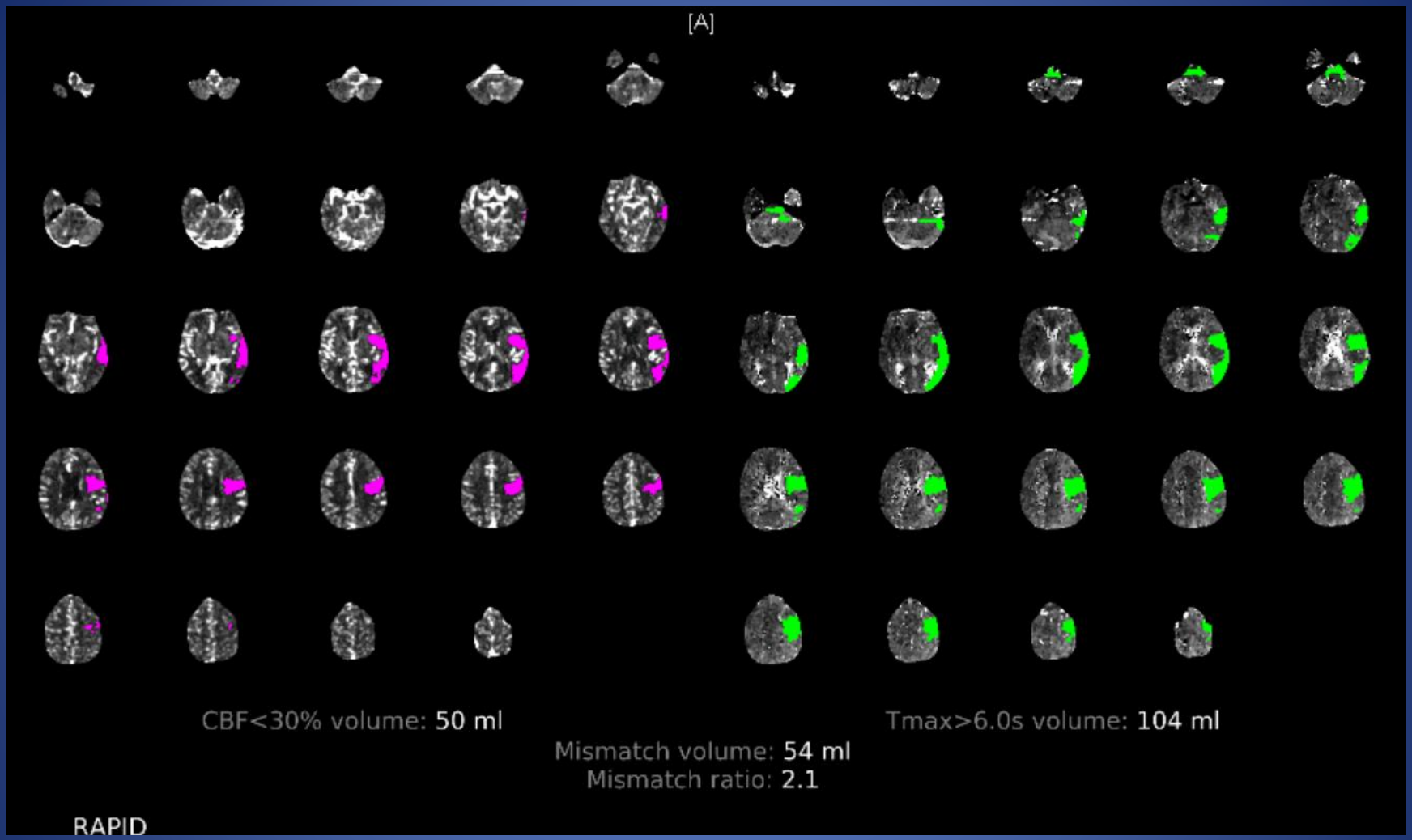


CBV **Tmax**


[A]
CBF<30% volume: 136 ml
Tmax>6.0s volume: 199 ml
Mismatch volume: 63 ml
Mismatch ratio: 1.5



CBV **Tmax**


[A]
CBF<30% volume: 50 ml
Tmax>6.0s volume: 104 ml
Mismatch volume: 54 ml
Mismatch ratio: 2.1
RAPID

DAWN Trial

- Enrolled patients 6 to 24 hours after last known well with prestroke mRS 0-1 and with ICA or M1 occlusion.
- Imaging inclusion criteria: *clinical-core mismatch*
- If age greater than 80, needed NIHSS ≥ 10 and core volume ≤ 20 mL
- If less than 80 and NIHSS ≥ 10, needed core volume ≤ 30 mL
- If less than 80 and NIHSS ≥ 20, needed core volume 31 to 50 mL
- Randomized 1:1 to EVT vs standard medical care

Nogueira et al, *NEJM,* 2018

Results of DAWN Trial

Outcome	Thrombectomy Group (N=107)	Control Group (N=99)	Absolute Difference (95% CI)†	Adjusted Difference (95% Credible Interval)‡	Posterior Probability of Superiority
Primary end points					
Score on utility-weighted modified Rankin scale at 90 days§	5.5±3.8	3.4±3.1	2.1 (1.2–3.1)	2.0 (1.1–3.0)	>0.999
Functional independence at 90 days — no. (%)¶	52 (49)	13 (13)	36 (24–47)	33 (21–44)	>0.999
				Risk Ratio (95% CI)	P Value
Secondary end points					
Early response — no. (%)‖	51 (48)	19 (19)	29 (16–41)	3 (2–4)	<0.001**
Recanalization at 24 hr — no. (%)††	82 (77)	39 (39)	40 (27–52)	2 (2–4)	<0.001**
Change from baseline in infarct volume at 24 hr — ml††					0.003‡‡
Median	1	13			
Interquartile range	0–28	0–42			
Infarct volume at 24 hour — ml††					<0.001‡‡
Median	8	22			
Interquartile range	0–48	8–68			
Grade of 2b or 3 on mTICI scale — no. (%)§§	90 (84)	NA			

Nogueira et al, *NEJM,* 2018

DEFUSE 3 Trial

- Enrolled patients **6 to 16 hours** post last known well with prestroke **mRS 0-2** and with ICA or M1 occlusion. **Max age 85, NIHSS ≥ 6.** This included a broader population than DAWN.
- Imaging inclusion criteria: *perfusion-core mismatch*
- **Core < 70 mL, mismatch ratio > 1.8 and mismatch volume ≥ 15 mL**
- Randomized 1:1 to EVT vs standard medical care.

Albers et al, *NEJM,* 2018

DEFUSE 3 Trial Results

Outcome	Endovascular Therapy (N=92)*	Medical Therapy (N=90)	Odds Ratio or Risk Ratio (95% CI)†	P Value
Primary efficacy outcome: median score on modified Rankin scale at 90 days (IQR)‡	3 (1–4)	4 (3–6)	2.77 (1.63–4.70)§	<0.001
Secondary efficacy outcome: functional independence at 90 days — no. (%)¶	41 (45)	15 (17)	2.67 (1.60–4.48)	<0.001
Safety outcomes — no. (%)				
Death at 90 days	13 (14)	23 (26)	0.55 (0.30–1.02)	0.05
Symptomatic intracranial hemorrhage‖	6 (7)	4 (4)	1.47 (0.40–6.55)	0.75
Early neurologic deterioration	8 (9)	11 (12)	0.71 (0.30–1.69)	0.44
Parenchymal hematoma type 2	8 (9)	3 (3)	2.61 (0.73–14.69)	0.21
Imaging outcomes**				
Median infarct volume at 24 hr (IQR) — ml	35 (18–82)	41 (25–106)	—	0.19
Median infarct growth at 24 hr (IQR) — ml	23 (10–75)	33 (18–75)	—	0.08
Reperfusion >90% at 24 hr — no./total no. (%)	59/75 (79)	12/67 (18)	4.39 (2.60–7.43)	<0.001
Complete recanalization at 24 hr — no./total no. (%)	65/83 (78)	14/77 (18)	4.31 (2.65–7.01)	<0.001
TICI score of 2b or 3 — no./total no. (%)	69/91 (76)	—	—	

Albers et al, *NEJM,* 2018

From the 2018 Guidelines for Management of Acute Ischemic Stroke

- New recommendations, class I, level A:
  - "In selected patients with AIS within **6 to 24 hours of last known normal** who have LVO in the anterior circulation, obtaining **CTP, DW-MRI, or MRI perfusion** is recommended to aid in patient selection for **mechanical thrombectomy**, but only when imaging and other eligibility criteria from RCTs showing benefit are being strictly applied in selecting patients for mechanical thrombectomy."

Based on DAWN and DEFUSE 3 trials
Powers et al, *Stroke,* 2018

Larger core on CTP?

- ANGEL-ASPECT study: CTP criteria of core 70-100 mL. Improved mRS for EVT vs medical therapy had OR 1.37 (95% CI 1.11-1.69). There was more symptomatic hemorrhage in EVT group (6.1% vs 2.7%).
- SELECT 2: CTP criteria of core > 50 mL (average core enrolled was 80 mL). Improved mRS for EVT vs medical therapy had OR of 1.51 (95% CI 1.20-1.89). No difference in symptomatic hemorrhage or mortality.

1. Huo et al, *NEJM* 2023. 2. Sarraj et al, *NEJM* 2023

When do you NOT need CTP

- Before decision to give tNK/tPA
  - Smaller strokes may not have any core or penumbra at all on CTP
- No LVO or not intervention candidate
- Has an LVO but last well within 6 hours by the time they receive intervention
  - ASPECTS on CT w/o contrast is sufficient
- Caveat: If higher suspicion of LVO but not yet read on imaging, can obtain CTP with CTA to save time.

Conclusions

- CT for all suspected stroke and early CTA for all patients with suspected LVO
- CTP for patients > 6 hours from last well to assess for mismatch which is the **difference between core and penumbra.**
  - Larger core → more irreversible damage → worse
  - Larger area of mismatch → more potentially reversible damage → better candidate for EVT
- Remember to cloud imaging asap. RAPID AI app has also been helpful.

Questions?

- Call for help anytime!
- KU BAT phone: 913-588-3727
- http://www.kissnetwork.us/
- sslavin2@kumc.edu