Acute Ischemic Stroke: Time vs Tissue

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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:

Collateral Flow

Thrombus
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

Core (dead)

Penumbra (salvageable)
DEFUSE Study

DWI / PWI Evaluation For Understanding Stroke Evolution
Benefit of t-PA At 6 hrs in Mismatch Patients

6 hrs Stroke score 16

4.5 hours after t–PA Stroke score 5

DWI: 3 cc

PWI: 95 cc

↓ Flow

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

00:30 MR tech pushes DWI & PWI to RAPID

04:30 RAPID image analysis complete

05:00 Images on PACS

Image Analysis

Auto-send
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

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

No blood flow to parts of brain
Restored blood flow

Clot
Blocked Artery Open at 8 Hours

Angiogram pre and post mechanical device

No blood flow to parts of brain

Restored blood flow

Clot
DWI at 16 hours
DWI at 16 hours

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 $t_{max} > 6.0\text{s}$: 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
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

PWI lesion for $t_{\text{max}} > 6.0\text{s} = 89.9 \text{ccm}$

$\text{DWI lesion (SD} > 2.20) = 9.3 \text{ccm, mismatch ratio: 9.7}$

$\text{DWI lesion (ADC} < 615) = 3.4 \text{ccm, mismatch ratio: 26.4}$
Carotid artery open at 4 hours
Follow-up MRI 4 hours later (8 after onset). Full recovery.

PWI lesion for $t_{max} > 6.0s = 0.0$ ccm

$DWI$ lesion ($SD > 2.20$) = 0.0 ccm, mismatch ratio: none

$DWI$ lesion ($ADC < 615$) = 0.0 ccm, mismatch ratio: none
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