


How Can We Use Advanced Neuroimaging in the ED to Optimize Treatment Options for Acute Stroke Patients?

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Disclosure

- None related to the content of this presentation

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Session Objectives

- Acknowledge latest guidelines and systematic review related to advanced neuroimaging
- Review CTA/CTP concepts and supporting data
- Overview of latest MRI data

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Clinical Questions

- **What is the goal of initial neuroimaging for presumed acute stroke patients?**
- **How can CTP/CTA or MRI/MRA be utilized**
 - To optimize the use of IV tPA and the triage of ED stroke patients for advanced IR therapeutics?
 - To detect the site of the vascular occlusion, and CTP (DWI/PWI) the size of the ischemic penumbra and the infarct core?
 - To maximize the potential benefit and minimize risk when using IV tPA in ED stroke patients?

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Clinical Questions

- **What are perfusion scans, what do they demonstrate, and how are they interpreted?**
- **What software or technology is necessary for advanced neuroimaging?**
- **How can these capabilities be developed at my hospital?**
- **What usage of these advanced diagnostics is the standard of care in 2007?**

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Essential Imaging Questions

- **Is there hemorrhage?**
- **Are findings consistent with acute ischemic stroke?**
- **Can this imaging modality's results add to my risk/benefit analysis?**
 - Is there large vessel occlusion?
 - Is there "irreversibly" infarcted core?
 - Is there "salvageable" penumbra?
 - Are other findings present that should be considered
 - Microbleeds
 - Leukoaraiosis

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2007 Imaging Guidelines

AHA/ASA Guideline


Guidelines for the Early Management of Adults With Ischemic Stroke

A Guideline From the American Heart Association/
 American Stroke Association Stroke Council, Clinical Cardiology Council, Cardiovascular Radiology and Intervention Council, and the Atherosclerotic Peripheral Vascular Disease and Quality of Care Outcomes in Research Interdisciplinary Working Groups

The American Academy of Neurology affirms the value of this guideline as an educational tool for neurologists.

Harold P. Adams, Jr, MD, FAHA, Chair; Gregory del Zoppo, MD, FAHA, Vice Chair; Mark J. Alberts, MD, FAHA; Deepak L. Bhatt, MD; Lawrence Brass, MD, FAHA†; Anthony Furlan, MD, FAHA; Robert L. Grubb, MD, FAHA; Randall T. Higashida, MD, FAHA; Edward C. Jauch, MD, FAHA; Chelsea Kidwell, MD, FAHA; Patrick D. Lyden, MD; Lewis B. Morgenstern, MD, FAHA; Adrian I. Qureshi, MD, FAHA; Robert H. Rosenwasser, MD, FAHA; Phillip A. Scott, MD, FAHA; Eelco F.M. Wijdicks, MD, FAHA

Adams HP et al. *Stroke* 2007;38:1655-1711.

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Systematic Review of DWI/PWI Mismatch and Thrombolysis in Acute Stroke

Magnetic resonance perfusion diffusion mismatch and thrombolysis in acute ischaemic stroke: a systematic review of the evidence to date

I Kane, P Sandercock, J Wardlaw


See Editorial Commentary, p 443 J Neurol Neurosurg Psychiatry 2007;78:485-490. doi: 10.1136/jnnp.2006.100347

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Background: The mismatch between perfusion and diffusion lesions on magnetic resonance perfusion-weighted imaging (PWI)/diffusion-weighted imaging (DWI) may help identify patients for thrombolysis. Evidence underlying this hypothesis was assessed.
Methods: All papers describing magnetic resonance PWI/DWI findings in patients with acute ischaemic stroke, and their functional and/or radiological outcome at 1 month, with or without thrombolysis were systematically reviewed.
Results: 11 papers fulfilled the inclusion criteria. Among these, there were 5 different mismatch definitions and at least 7 different PWI methods. Only 3 papers including 61 patients with and 18 without mismatch provided data on mismatch, outcome and influence of thrombolysis. Mismatch (v no mismatch) without thrombolysis was associated with a non-significant twofold increase in the odds of infarct expansion (odds ratio (OR) 2.2; 95% confidence interval (CI) 0.24 to 14.1), which did not change with thrombolysis (OR 2.0; 95% CI 0.37 to 10.9). Half of the patients without mismatch also had infarct growth (with or without thrombolysis). No data were available on functional outcome.
Conclusions: Standardised definitions of mismatch and perfusion are needed. Infarct growth may occur even in the absence of mismatch. Currently, data available on mismatch are too limited to guide thrombolysis in routine practice. More data are needed from studies including patients with and without mismatch, and randomised treatment allocation, to determine the role of mismatch.

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From the 2007 Guidelines

“Several studies have suggested that perfusion CT may be able to differentiate thresholds of reversible and irreversible ischemia and thus identify the ischemic penumbra.^{114,115”}


Klotz E et al. *Eur J Radiol* 1999; 30: 170-184.
 Wintermark M et al. *Ann Neurol* 2002; 51: 417-432.

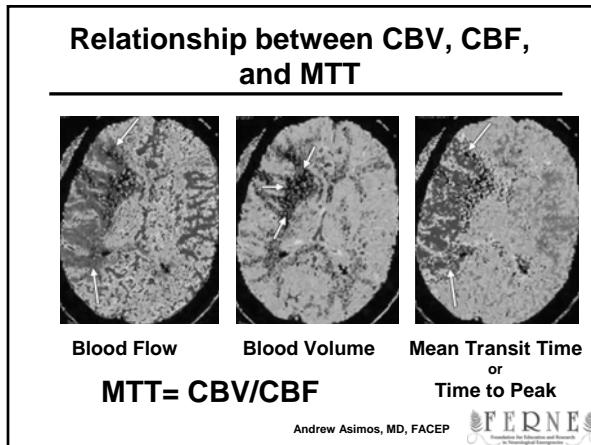
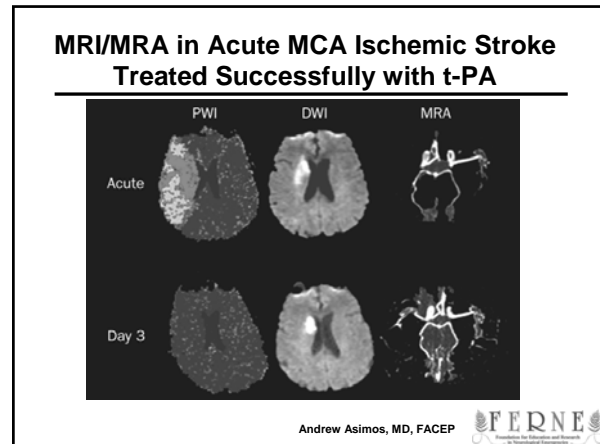
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Advanced CT Imaging for Acute Stroke: CTP versus MRI

| | Parameters | Definition of Penumbra | Advantages | Limitations |
|---------------------|-------------------------|---|--|--|
| CT Perfusion | CBF, CBV, MTT, TTP | MTT threshold at 145% | -Combined with plain CT -Available -Fast | -Limited brain coverage -Poorly sensitive to posterior circulation -Iodinated contrast |
| DWI-PWI MRI | CBF, CBV, MTT, TTP, ADC | Relative TTP (or MTT) delay >45s and normal DWI | -Sensitive -No radiation | -Limited availability -Patient cooperation required -Frequent contraindications |


Muir KW et al. Lancet Neurology 2006; 5:755-768

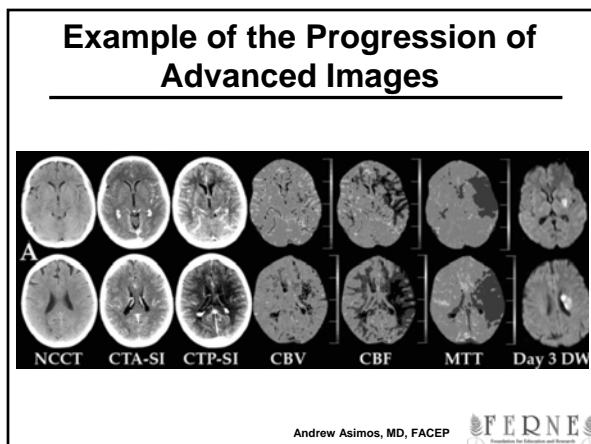
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Changes in Cerebral Vascular Physiology with Worsening Circulatory Impairment

| | CBF | CBV | MTT |
|------------------------------|-----|-----|-----|
| Salvageable Penumbra | ↓ | ↔ ↑ | ↑ |
| Irretrievable Infarct | ↓ ↓ | ↓ | ↑ ↑ |


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- ### Are CTP Techniques Ready for Prime Time?
- CTP more accurate than unenhanced CT for detecting stroke and determining the extent of stroke
 - Possible to distinguish penumbra from infarcted tissue
 - Correlation between PCT/CTA and MRI is excellent
 - Already used in DIAS and DEDAS
- Wintermark M et al. Am J Neuroradiol 2005;26(1):104-12.
 Wintermark M et al. Stroke 2006;37:979-985.
 Wintermark M et al. Neurology 2007;68(3):694-697.
- Andrew Asimos, MD, FACEP 


Important Remaining CTP Questions

- What is the interrater reliability of visual estimation of lesion volumes?
 - Is that variability clinically important?
- Can computerization automate measurement of absolute perfusion thresholds and lesion volume in a clinically meaningful way?
- Will the current perfusion thresholds for penumbra and infarct be maintained with rigorous future testing?

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DEFUSE Study

- Prospective pilot study (n=74)
- Patients treated with IV tPA 3-6 hours after symptom onset
- Goal to identify MRI patterns that predict the clinical response to early reperfusion

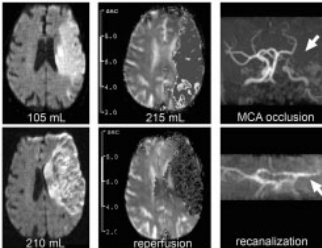
Albers GW et al. *Ann Neurol* 2006;60(5):508-17. Andrew Asimos, MD, FACEP 

Malignant Mismatch Pattern

Malignant Profile


4 hr 36 min after stroke onset: NIHSS 26

4 hrs after tPA bolus: NIHSS 27



105 mL 215 mL MCA occlusion


210 mL reperfusion recanalization

Albers GW et al. *Ann Neurol* 2006;60(5):508-17. Andrew Asimos, MD, FACEP 

Proposed Imaging Algorithm


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    graph TD
      A[ACUTE STROKE  
0-6 hours of onset] --> B[NECT/Conventional MRI+DWI]
      B --> C[Hemorrhage]
      B --> D[No hemorrhage]
      C --> E[No therapy]
      D --> F[0-3 hours of onset]
      D --> G[3-6 hours of onset]
      F --> H[IV thrombolytics]
      G --> I[CTA+CTP/MRA+PWI]
      I --> J[Intracranial thrombus with penumbra]
      I --> K[No penumbra ± thrombus]
      J --> L[Consider IA therapy]
      K --> M[IA therapy may not be useful]
    
```

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Conclusions

- Advanced neuroimaging techniques will make symptom onset time increasingly obsolete
 - Wake up stroke
 - Onset time unclear
- Application of visual estimation of penumbral volumes versus automated measurement requires further study
- These techniques can
 - Distinguish penumbra from infarct
 - Will drive acute stroke care therapeutic decisions in the future

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Questions?

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