Perfusion-CT of the Brain: Stroke, TBI and Beyond
Max Wintermark, MD
Associate Professor of Radiology
Director, NeuroCardioVascular Imaging Lab
University of California San Francisco, Department of Radiology, Neuroradiology Section

State-of-the-art work-up of an acute stroke patient

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**Time is Brain!**

### NINDS - PROACT

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Drug / Route</td>
<td>IV rtPA</td>
<td>IV rtPA</td>
<td>IA pro-UK</td>
</tr>
<tr>
<td>Time window</td>
<td>0 - 3h</td>
<td>0 - 6h</td>
<td>0 - 6h</td>
</tr>
<tr>
<td>Imaging</td>
<td>CT</td>
<td>CT</td>
<td>CT/DSA</td>
</tr>
<tr>
<td>Outcome 90d mRS</td>
<td>39% vs 26%</td>
<td>40% vs 37%</td>
<td>40% vs 25%</td>
</tr>
<tr>
<td>TTT vs control</td>
<td></td>
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</tr>
<tr>
<td>Death</td>
<td>17% vs 21%</td>
<td>11% vs 10%</td>
<td>25% vs 27%</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>6% vs 0.6%</td>
<td>9% vs 3%</td>
<td>10% vs 2%</td>
</tr>
<tr>
<td>Recanalization</td>
<td>-</td>
<td>-</td>
<td>66% vs 18%</td>
</tr>
</tbody>
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**Conventional Noncontrast CT in Acute Stroke Patients**

- Identifies hemorrhagic stroke
- Limited sensitivity of conventional CT for acute cerebral ischemia (14-43%)
- Moderate inter-observer agreement in the identification of early cerebral ischemia
- 11% of patients inappropriately included in ECASS

* von Kummer R et al. AJNR 1996;17:1743-1748
### Stroke Thrombolysis Trials

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<td>3 - 9h</td>
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<td>CT / DSA</td>
<td>DWI/PWI (PCT)</td>
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<td>Outcome</td>
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<td>90d mRS TTT vs control</td>
<td>39% vs 26%</td>
<td>40% vs 25%</td>
<td>60% vs 22%</td>
</tr>
<tr>
<td>Death</td>
<td>17% vs 21%</td>
<td>25% vs 27%</td>
<td>4.4 vs 3.7%</td>
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<td>Hemorrhage</td>
<td>6% vs 0.6%</td>
<td>9% vs 3%</td>
<td>3 vs 0%</td>
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<td>71% vs 19%</td>
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### How Many Percent of Acute Stroke Patients are Admitted in the 0-3h Time Window?

3%

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CTA

**3 hour time window for i.v. thrombolysis**

Combined analysis 2776 patients

"Time is brain"

**mRS 0-1 at day 90**

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How Many Percent of Acute Stroke Patients are Admitted in the 0-3h Time Window?

3%
How Many Percent of Acute Stroke Patients are Admitted in the 0-9h Time Window?

40%

MRI Stroke Imaging

<table>
<thead>
<tr>
<th>GRE</th>
<th>DWI</th>
<th>PWI</th>
<th>MRA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemorrhage</td>
<td>Ischemic Injury</td>
<td>Perfusion Status</td>
<td>Vessel Status</td>
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<td>Infarct Core</td>
<td>Mismatch</td>
<td>Large Vessel Occlusions</td>
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CT Stroke Imaging

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Interpretation of PCT Maps

<table>
<thead>
<tr>
<th>TIA</th>
<th>Penumbra</th>
<th>Infarct</th>
</tr>
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<tbody>
<tr>
<td>↑</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>normal</td>
<td></td>
<td>↑</td>
</tr>
<tr>
<td>↑</td>
<td>↓</td>
<td>↓</td>
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Perfusion-CT or DWI-/PWI-MR: Which One in Acute Stroke Patients?

Perfusion-CT

- 10 min
- Iodinated contrast medium
- X-ray

DWI-/PWI-MR

- 30 min
- Gadolinium
- RF waves

NCT/PCT/CTA: Time Duration

NCT: 20 sec
PCT: 40 sec + 3 min + 40 sec = 4 minutes
CTA: 10 sec
TOTAL = 5 minutes
Perfusion-CT or DWI-/PWI-MR: Which One in Acute Stroke Patients?

**Perfusion-CT**
- Widely available
- 10 min
- Iodinated contrast medium
- X-ray

**DWI-/PWI-MR**
- Equivalent results
- Less available
- 30 min
- Gadolinium
- RF waves

Excellent Correlation Between Admission Perfusion-CT and DWI-/PWI-MR

PCT Misses Lacunae
Admission NCT 2h

Admission PCT 2h

DWI 15h

PCT Is Not Adequate For Posterior Fossa

Perfusion-CT or DWI-/PWI-MR: Which One in Acute Stroke Patients?

Perfusion-CT

- limited spatial coverage
- hemispheric strokes
- widely available
- 10 min
- iodinated contrast medium
- X-ray

DWI-/PWI-MR

- whole brain
- small strokes/posterior fossa
- equivalent results
- less available
- 30 min
- gadolinium
- RF waves

Extent penumbra / Extent infarct

Extent < or > 1/3 ?

Brain Ischemia

present or absent?

Toggle-Table PCT technique
256-slice CT scanner

Perfusion-CT or DWI-/PWI-MR: Which One in Acute Stroke Patients?

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MODERN work-up of an acute stroke patient

FUTURE DIRECTIONS

Intracardiac Clots
Specific Aim #4: CARDIAC FUNCTION

Coronary Vessels

Permeability Imaging

Hemorrhagic Transformation

Infarct Penumbra
CBV
CBF
MTT

BBB permeability

Follow-up CT
Perfusion-CT: not only Stroke... but also Head Trauma

Perfusion-CT: not only Stroke... but also Head Trauma

Admission PCT for Early Detection of Contusions in Severe Head Trauma Patients

Admission PCT for Assessment of Treatment Efficiency in Case of Epi/Subdural Hematoma

Admission PCT for Assessment of Treatment Efficiency in Case of Epi/Subdural Hematoma

Perfusion-CT: a New Insight in the Concept of Traumatic Cerebral Edema in Severe Head Trauma Patients
CONCLUSION

- Perfusion-CT
- Functional Imaging
- Stroke, TBI, vasospasm, etc
- Positive impact on patients' management and outcome