Endovascular Treatment of Ischemic Stroke

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Overview

- Definitions of terms
- Review basic anatomy pertinent to indications/techniques
- Rationale for mechanical thrombectomy as a treatment
- Example cases
- Tools of the trade
- Data/studies
- Indications and patient selection
Disclosures

• No financial interests
• Off-label use of devices and medications
Stroke Overview

- 5th leading cause of death in US
- ~795,000 per year
- 85% ischemic
  - Large artery thromboembolic/occlusion
  - Small artery occlusion (aka lacunar stroke)
  - Cardioembolic
  - Global
  - Occult
- 15% hemorrhagic
  - Intraparenchymal hemorrhage
  - Subarachnoid hemorrhage

Source: www.cdc.gov “Stroke Facts”
Stroke Overview
Nebraska

• www.dhhs.ne.gov
• 2010 report on Stroke
  • 3477 total
  • 2668 ischemic stroke
Definitions of Terms & Abbreviations

- AIS = Acute Ischemic Stroke
- LVO = Large Vessel Occlusion
  - aka Large Artery Occlusion
- MT = Mechanical Thrombectomy
Definitions of Terms & Abbreviations

- ICH = Intracerebral hemorrhage
- sICH = symptomatic ICH
- mRS = modified Rankin Score
- NIHSS = NIH stroke score
- ASPECT Score
Review of Cerebrovascular Anatomy

• “Anterior circulation”
  • Internal Carotid Artery (ICA)
    – Cervical
    – Intracranial
  • Middle Cerebral Artery (MCA)
    – M1 vs M2 vs M3 vs M4
  • Anterior Cerebral Artery
Review of Cerebrovascular Anatomy

- “Posterior circulation”
  - Vertebral/Basilar Artery
  - Posterior Cerebral Artery
- Variants
  - Example: fetal posterior communicating artery, persistent trigeminal artery
Anterior Circulation

- ICA terminus = carotid “T”
- MCA
  - M1 vs M2
ASPECTS

- Alberta Stroke Program Early CT Score
- 10 point quantitative CT score to identify core infarct
- MCA stroke hypodensity
- Deduct 1 point for each involved territory
- Lower score = larger stroke
  - Source: www.aspectsinstroke.com
Modified Rankin Score

• 0 = Normal
• 1 = Normal activities, some symptoms
• 2 = Independent, not able to do everything
• 3 = Walks unassisted, needs assistance with affairs
• 4 = Walks with assistance, needs assistance with bodily needs
• 5 = Constant nursing care, bedridden, incontinent
• 6 = Dead
NIH Stroke Scale

0 (normal) - 42
1-4 mild
5-15 moderate
16-20 moderate to severe
21-42 severe

>= 10 has ~75% probability of large artery occlusion
NINDS trial of IV tPA

- NEJM 1995
- First Level 1 Class A data for treatment of AIS
- Slow adoption
- <10%
  - “Too good to treat”
  - Improving
- Fear of symptomatic hemorrhage (sICH ~6%)
Reducing in-hospital delay to 20 minutes in stroke thrombolysis

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Daniel Srbljan, MD, PhD
Satu Mustanoja, MD, PhD, MSc (StrokeMed)
Turgut Tatlisumak, MD, PhD
Perttu J. Lindsberg, MD, PhD
Markku Kaste, MD, PhD

ABSTRACT

Objectives: Efficacy of thrombolytic therapy for ischemic stroke decreases with time elapsed from symptom onset. We analyzed the effect of interventions aimed to reduce treatment delays in our single-center observational series.

Methods: All consecutive ischemic stroke patients treated with IV alteplase (tissue plasminogen activator [tPA]) were prospectively registered in the Helsinki Stroke Thrombolysis Registry. A series of interventions to reduce treatment delays were implemented over the years 1998 to 2011. In-hospital delays were analyzed as annual median door-to-needle time (DNT) in minutes, with interquartile range.

Results: A total of 1,860 patients were treated between June 1995 and June 2011, which included 174 patients with basilar artery occlusion (BAO) treated mostly beyond 4.5 hours from symptom onset. In the non-BAO patients, the DNT was reduced annually, from median 105 minutes (65–120) in 1998, to 60 minutes (48–80) in 2003, further on to 20 minutes (14–32) in 2011. In 2011, we treated with tPA 31% of ischemic stroke patients admitted to our hospital. Of these, 94% were treated within 60 minutes from arrival. Performing angiography or perfusion imaging doubled the in-hospital delays. Patients with in-hospital stroke or arriving very soon from symptom onset had longer delays because there was no time to prepare for their arrival.

Conclusions: With multiple concurrent strategies it is possible to cut the median in-hospital delay to 20 minutes. The key is to do as little as possible after the patient has arrived at the emergency room and as much as possible before that, while the patient is being transported. Neurology® 2012;79:306-313
LVO

• Intracranial ICA, MCA account for ~30% of AIS presenting within 6 hours
  • Beumer, et al. Neurovascular Imaging, 2016

• LVO have larger territory strokes which lead to worse outcomes

• IV tPA achieves successful recanalization ~33% with LVO
Rationale for MT

• LVO cause severe strokes
• LVO are resistant to IV tPA
• Patients with LVO are just as likely to not make the stringent time window for IV tPA as are patients with non-LVO strokes
Rationale for MT

• We need a treatment for LVO (i.e. the worst strokes with the most disability/death) that extends the treatment window and improves outcomes without increasing complications (i.e. sICH, death, worse mRS)
Stent-Retriever
Aspiration Catheters
<table>
<thead>
<tr>
<th>Study</th>
<th>MR CLEAN</th>
<th>ESCAPE</th>
<th>SWIFT PRIME</th>
<th>EXTEND-IA</th>
<th>REVASCAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>500</td>
<td>316</td>
<td>196</td>
<td>70</td>
<td>206</td>
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<tr>
<td>Time to Tx</td>
<td>6</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>8</td>
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<td>Imaging</td>
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<td>CTA</td>
<td>CTA MRI/A</td>
<td>CTA/P</td>
<td>CT/MR</td>
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<td>ASPECTS &gt;=6</td>
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<td>ASPECTS &gt;=6</td>
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<tr>
<td>Median Baseline NIHSS</td>
<td>17.5</td>
<td>16</td>
<td>17</td>
<td>15</td>
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<td>LKN to Tx</td>
<td>260</td>
<td>241</td>
<td>252</td>
<td>248</td>
<td>269</td>
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<tr>
<td>Reperfusion TICI 2b/3</td>
<td>75 vs 33</td>
<td>73 vs 31</td>
<td>88 vs 40</td>
<td>94 vs 43</td>
<td>65.7</td>
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<tr>
<td>mRS 0-2 at 90Days</td>
<td>33 vs 19</td>
<td>53 vs 29</td>
<td>60 vs 36</td>
<td>51 vs 29</td>
<td>45 vs 29</td>
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<tr>
<td>NIHSS diff at 24hr</td>
<td>4 vs 2</td>
<td>10 vs 4</td>
<td>8 vs 4</td>
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<tr>
<td>Death at 90 Days (%)</td>
<td>18.9 vs 18.4</td>
<td>10.4 vs 19.0</td>
<td>9.2 vs 12.4</td>
<td>9.0 vs 20</td>
<td>18.4 vs 15.5</td>
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<td>NNT mRS 0-2</td>
<td>4</td>
<td>2.6</td>
<td>3.2</td>
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<td>Study or subgroup</td>
<td>Endovascular treatment (including AIMT)</td>
<td>Medical care</td>
<td>Risk ratio (95% CI) M-H, random</td>
<td>Weight (%)</td>
<td>Risk ratio (95% CI) M-H, random</td>
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<td>2013</td>
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<td>IMS III</td>
<td>177/434</td>
<td>86/222</td>
<td>1.05 (0.86 to 1.29)</td>
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<td>MR RESCUE</td>
<td>12/64</td>
<td>11/54</td>
<td>0.92 (0.44 to 1.92)</td>
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<td>SYNTHESIS</td>
<td>76/184</td>
<td>84/181</td>
<td>0.90 (0.72 to 1.14)</td>
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<td>Subtotal (95% CI)</td>
<td>265/679</td>
<td>181/457</td>
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<td>30.4</td>
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<td>Test for overall effect: $z = 0.21$, P = 0.83</td>
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<td>2015</td>
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<td>ESCAPE</td>
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<td>43/147</td>
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<td>EXTEND-Ia</td>
<td>25/35</td>
<td>14/35</td>
<td>1.79 (1.13 to 2.82)</td>
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<td>MR CLEAN</td>
<td>77/233</td>
<td>51/267</td>
<td>1.73 (1.27 to 2.35)</td>
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<td>SWIFT PRIME</td>
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<td>33/93</td>
<td>1.70 (1.23 to 2.33)</td>
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<td>REVASCAT</td>
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<td>29/103</td>
<td>1.55 (1.06 to 2.27)</td>
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<td>THERAPY</td>
<td>19/55</td>
<td>14/53</td>
<td>1.31 (0.73 to 2.33)</td>
<td>6.1</td>
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<td>THRACE</td>
<td>103/109</td>
<td>82/195</td>
<td>1.29 (1.04 to 1.59)</td>
<td>13.2</td>
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<td>Subtotal (95% CI)</td>
<td>417/878</td>
<td>266/893</td>
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<td>69.6</td>
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<td>Test for heterogeneity: $\chi^2 = 5.98$, df = 6, P = 0.43, $I^2 = 0%$</td>
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<td>Test for overall effect: $z = 7.24$, P &lt; 0.001</td>
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<td>Total (95% CI)</td>
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<td>100.0</td>
<td>1.37 (1.14 to 1.64)</td>
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<td>Test for heterogeneity: $\chi^2 = 29.12$, df = 9, P &lt; 0.001, $I^2 = 69%$</td>
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<td>Test for overall effect: $z = 3.41$, P &lt; 0.001</td>
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<td>Test for subgroup differences: $\chi^2 = 22.14$, df = 1, P &lt; 0.001, $I^2 = 95.5%$</td>
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</table>
Recommendations for Management of AIS with consideration of Endovascular Treatment

1. IV tPA per prior (1A)
2. Endovascular therapy with a stent-retriever per criteria (1A)

Criteria for MT

- Pre stroke mRS 0-1
- ICA or M1 occlusion
  - ?M2, M3, ACA, PCA, VA, BA
- >=18 years
  - ?<18, ?>80
- NIHSS >= 6
- ASPECTS >= 6
- Treatment (i.e. groin access) begun within 6 hours
What is the risk of sICH after MT for AIS?

• 0-7% risk for sICH with patient having MT
• No increased risk of sICH in patients treated with MT even with IV tPA

• Boyle et al. *Neurovascular Imaging*, 2017
MT Technical Considerations

• Conscious sedation vs GETA
• IA tPA in addition to stent retriever
• Tandem lesions (cervical ICA with distal embolus)
• Distal occlusions (M2, M3, ACA)
• Posterior circulation
  • Basilar artery occlusion
Pediatric Mechanical Thrombectomy

• Madaelil et al, 2016 *Interventional Neuroradiology*
  • 2010-2016
  • 22 cases
  • 1.8 - 17 years old
  • Stent-retriever and aspiration technology
  • Anterior and posterior circulation AIS
  • 3 with IV tPA and 2 with IA tPA
  • 20 cases with mRS 0 - 2

• Powers, et al. 2015 AHA/ASA Focused Update of the 2013 Guidelines for Early Management of AIS
  • Class 2b; Level of Evidence C
  • Stent retrievers “may be reasonable” in patients <18 years
AIS/MT after 6 hours

- Extending the window for MT with perfusion imaging to identify core infarction and penumbra

- DAWN
- DEFUSE-3
El-Koussy et al. Eur Neurol 2014
Additional Special Circumstances

- Dementia
- Thrombocytopenia
- Anticoagulation
- Terminal cancer
- Renal disease
- Aortic occlusion
- ?
Summary/Review

• Indications for IV tPA are unchanged
• Mechanical thrombectomy for AIS for:
  • Independent 18 yo or older
  • LVO
  • Anterior circulation
  • Small core infarct
  • <6 hours
  • NIHSS >=6
Summary/Review

• Other considerations:
  • Kids with stroke
  • Stroke patients with co-morbidities
  • Basilar artery occlusion
  • Extending the time window with advanced brain imaging (CTP/DWI/PI)
Questions/Discussion