Endoscopic Surgery for ICH

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David Geffen School of Medicine at UCLA
Uncertainties about surgery for ICH

• Causal relationship:
  – Is the maximal damage done at the onset of ICH?
  – Does the hematoma cause time dependent damage?
  – Does the removal of blood benefit the patient?
    • How much blood needs to be removed?

• Time window:
  – Is there a fundamental time window for surgical efficacy?
    • Is there a time window for blood removal?
  – Is there an optimal time window for surgical safety?

• Anatomic/Functional window:
  – Is (are) there regions of the brain that are more amenable to surgical efficacy?

• Technique dependency:
  – Is there an ideal surgical corridor that will limit surgical induced damage?
  – Are there suctioning and traction techniques that can be designed to reduce surgical trauma during the evacuation?
  – How much blood needs to be removed?
Previous Work with Endoscopic Surgery

Mortality in Endoscopic Surgery Studies

- Auer 1989
- Teernstra 2003
- Cho 2005
- Miller 2008
- Xu 2017
- Li 2017
- Labib 2017
- Vespa 2017
MISTIE - ICES

Intraoperative CT guided Endoscopic Surgery for intracerebral hemorrhage

PI: Paul Vespa, Neil Martin, Dan Hanley

7 sites: UCLA, Case Western, Univ Pittsburgh, UCSD, Barrow’s, MGH, Thomas Jefferson

Investigators/Surgeons: Amanda Bistran-Hall, Alan Hoffer, Johnathan Engh, Robert Carter, Peter Nakaji, Chris Ogilvy, John Frazee, Jack Jallo, Warren Selman
Overview of the Study Design

• Phase 2, Multicenter RCT of endoscopic surgery vs medical treatment for spontaneous ICH
• Randomized < 48 hrs
• Surgery < 48 hrs
• ICH > 20 cc
• BG or lobar, left or right
• IVH permissible
• Stereotactic Endoscopic surgery
• mRS at 180 and 365 days
Philosophy of this study

- Safety and planning study
- Many elements of the surgery uncertain
- Minimize trauma at every step
- Objectively measure the surgical steps
  - Surgical CRF
- Analyze is surgical technique matters
Protocol highlights

• Stability of ICH volume
  – two serial scans ≥ 6 hours apart

• Diagnostic imaging for AVM, aneurysm:
  – CTA, MRI, angio

• Required Stereotactic trajectory planning
  – approach review by surgical center

• Detailed Surgical CRF
  – insure procedural & data acquisition uniformity
## Stereotactic Trajectory Approach

<table>
<thead>
<tr>
<th>Designation</th>
<th>ICH Characteristics</th>
<th>Selected Entry Point</th>
<th>Chosen Trajectory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type A</strong></td>
<td>Deep-seated occupying the anterior third of the basal ganglia with typical “oval” shape (football shape)</td>
<td>Type A ICH should have an entry point in the low anterior frontal area frequently close to the midline near the eyebrow, and the trajectory of the catheter has to be along the longitudinal axis of the clot.</td>
<td></td>
</tr>
<tr>
<td><strong>Type B</strong></td>
<td>Deep-seated occupying the posterior third of the basal ganglia; the shape can range from more roundish to elliptical</td>
<td>Type B ICH should have an entry point in the posterior parietal-occipital area frequently several cm lateral from the midline to avoid the occipital ventricular hom, and the trajectory of the catheter has to be along the longitudinal axis of the clot.</td>
<td></td>
</tr>
<tr>
<td><strong>Type C</strong></td>
<td>Superficial (lobar) with variable shape, but often more spherical</td>
<td>Type C ICH should have an entry point at the superficial area closest to the clot. This is usually the widest “equatorial point” of a spherical-shaped clot. The trajectory of the catheter has to be along the widest, or “equatorial”, axis of the clot.</td>
<td></td>
</tr>
</tbody>
</table>
ICES Procedure

Long axis trajectory
Two suction/irrigation points:
  2/3 depth and 1/3 depth
30-60 minutes duration
Endoscopic guided hemostasis
Important Surgical Steps

• Careful stereotactic planning
• Insertion of Endoscope but minimize exploration – endoscope fixed in place
• Irrigation and suctioning starting with small amounts of suction vacuum
• Visualization for bleeding
• Hemostasis
Outcome Measures

• Primary:
  – Mortality – surgical, 7, 30, 180, 365 days

• Secondary:
  – Reduction in Volume
  – Surgical SAEs
  – mRS: 180 and 365 days
## Results – group characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>MISTIE-Overall Medical n =42</th>
<th>MISTIE-ICES Medical n = 6</th>
<th>Endoscopic Surgery n= 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>61.1 ± 12</td>
<td>61.8 ± 11</td>
<td>61.8 ± 10</td>
</tr>
<tr>
<td>Female: Male</td>
<td>14:28</td>
<td>1:5</td>
<td>6:12</td>
</tr>
<tr>
<td>ICH Volume cc (stability)</td>
<td>43 ± 15</td>
<td>39 ± 13</td>
<td>45 ± 22</td>
</tr>
<tr>
<td>Deep: Lobar</td>
<td>64:36</td>
<td>60:40</td>
<td>75:35</td>
</tr>
<tr>
<td>Left: Right</td>
<td>52:48</td>
<td>50:50</td>
<td>66:33</td>
</tr>
<tr>
<td>Time interval to Surgery (hours)</td>
<td>NA</td>
<td>NA</td>
<td>32.8 ± 14</td>
</tr>
<tr>
<td>Admission NIHSS</td>
<td>22 ± 9</td>
<td>21 ± 8</td>
<td>21 ± 7</td>
</tr>
<tr>
<td>Admission GCS</td>
<td>10 ± 4</td>
<td>10.6 ± 4</td>
<td>9.8 ± 3</td>
</tr>
<tr>
<td>SBP (mm Hg, randomization)</td>
<td>146 ± 24</td>
<td>148 ± 41</td>
<td>137 ± 14</td>
</tr>
</tbody>
</table>
Results – surgical details

68 ± 22% reduction

p < 0.001
Result – Medical Controls for MISTIE and MISTIE-ICES

n = 42
Questions about the technique?

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<table>
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<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ictus to op procedure (h) [IQR]</td>
<td>29.9 [24.7, 37.7]</td>
</tr>
<tr>
<td>procedure length (h) [IQR]</td>
<td>1.9 [1.4, 2.6]</td>
</tr>
<tr>
<td>irrigation duration (min) [IQR]</td>
<td>52.5 [30, 65]</td>
</tr>
<tr>
<td>active bleeding Visible</td>
<td>5 (35.7%)</td>
</tr>
<tr>
<td>bleed control by electrocautery</td>
<td>3 (21.4%)</td>
</tr>
<tr>
<td>bleeding control by ddavp</td>
<td>6 (42.9%)</td>
</tr>
<tr>
<td>bleeding control by irrigation</td>
<td>9 (64.3%)</td>
</tr>
<tr>
<td>ICH reduced by EOT (pct) [IQR]</td>
<td>71.2 [61, 84.7]</td>
</tr>
<tr>
<td>Luken’s trap volume (mL) [IQR]</td>
<td>42 [31, 51]</td>
</tr>
</tbody>
</table>
Change in volume in individual cases
(n = 18)
Lack of effect of initial volume or duration of surgery on percentage evacuation
1b. Supplemental Figure II: Relationship of suction pressure to hematoma removal.
ICH Volume evolution
MISTIE-Total controls vs Surgery

Estimated Clot Reduction
N = 60

ICH Volume as % of Stability CT

Days from Stability CT

95% CI
% of Stability Clot Remaining
Endpoint Frequency and Safety Thresholds
ICES (N=14) vs. Medical (N=42)

- 30 Day Mortality (70%)
- Symptomatic Bleeding (35%)
- Brain Infection (15%)
- 7 Day Mortality (10%)

Percent of Subjects with Event:

Surgical: 7.1% (7-Day), 7.1% (30-Day), 0% (Symptomatic Bleed), 0% (Brain Infection)
Medical: 9.5% (7-Day), 2.4% (30-Day), 2.4% (Symptomatic Bleed), 2.4% (Brain Infection)
ICES (Intraoperative Stereotactic Computed Tomography-Guided Endoscopic Surgery) for Brain Hemorrhage
A Multicenter Randomized Controlled Trial

Paul Vespa, MD; Daniel Hanley, MD; Joshua Betz, MS; Alan Hoffer, MD; Johnathan Engh, MD; Robert Carter, MD; Peter Nakaji, MD; Chris Ogilvy, MD; Jack Jallo, MD; Warren Selman, MD; Amanda Bistrian-Hall, BS; Karen Lane, CMA; Nichol McBe, MPH; Jeffery Saver, MD; Richard E. Thompson, PhD; Neil Martin, MD; on behalf of the ICES Investigators

(Stroke. 2016;47:2749-2755)
ICES Conclusions

• Lower mortality in ICES vs medical at all time points
• Endoscopic surgery results in immediate a 70% reduction in ICH volume
• Endoscopic surgery conveys a 15% advantage for good clinical outcome (mRS ≤ 3) at 180 days
• Endoscopic surgery for ICH is safe, generalizable and reproducible across multiple centers and surgeons
Questions

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Quantitative Intracerebral Hemorrhage Localization

John Muschelli, ScM; Natalie L. Ullman, BS; Elizabeth M. Sweeney, ScM; Ani Eloyan, PhD; Neil Martin, MD; Paul Vespa, MD; Daniel F. Hanley, MD; Ciprian M. Crainiceanu, PhD

NIHSS Score-HPR Coverage Relationship

GCS Score-HPR Coverage Relationship

Stroke. 2015;46:3270-3273
Quantitative Intracerebral Hemorrhage Localization

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<table>
<thead>
<tr>
<th>Area</th>
<th>Population Prevalence</th>
<th>NIHSS HPR</th>
<th>GCS HPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF (ventricular and subarachnoid spaces)</td>
<td>7.9</td>
<td>10.9</td>
<td>...</td>
</tr>
<tr>
<td>Insular</td>
<td>7.6</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Superior temporal gyrus</td>
<td>5.5</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Putamen</td>
<td>4.8</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>External capsule</td>
<td>3.9</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Posterior limb of internal capsule</td>
<td>12.0</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Superior corona radiate</td>
<td>11.0</td>
<td>27.9</td>
<td>...</td>
</tr>
<tr>
<td>Thalamus</td>
<td>10.1</td>
<td>33.9</td>
<td>...</td>
</tr>
<tr>
<td>Caudate nucleus</td>
<td>8.4</td>
<td>9.6</td>
<td>...</td>
</tr>
<tr>
<td>Postcentral WM</td>
<td>6.7</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Superior longitudinal fasciculus</td>
<td>5.9</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*Stroke. 2015;46:3270-3273*
Borderline basal ganglia hemorrhage volume: patient selection for good clinical outcome after stereotactic catheter drainage

Yeon Soo Choo, MD,1 Joonho Chung, MD, PhD,2,3 Jin-Yang Joo, MD, PhD,2 Yong Bae Kim, MD, PhD,2,3 and Chang-Ki Hong, MD2,3

J Neurosurg Volume 125 • November 2016

<table>
<thead>
<tr>
<th>mRS0</th>
<th>mRS1</th>
<th>mRS2</th>
<th>mRS3</th>
<th>mRS4</th>
<th>mRS5</th>
<th>mRS6</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>5</td>
<td>15</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>13</td>
<td>10</td>
<td>3</td>
<td></td>
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</tr>
</tbody>
</table>

Medical (n = 44)

Surgical (n = 49)
The Safety and Feasibility of Image-Guided BrainPath-Mediated Transsulcal Hematoma Evacuation: A Multicenter Study

Mohamed A. Labib, MDCM

Neurosurgery 80:515–524, 2017
Summary

• Endoscopic surgery holds promise as a safe method to remove intraparenchymal blood
• Important questions that may influence outcome exist
• RCT are needed to test these methods but careful planning, staged method is necessary