Imaging of SIH: Past, Current and Future Modalities

Marcel Maya, MD
Cedars Sinai
CSF LEAK
Imaging

- Radionuclide Cisternography
- MRI Brain
- MRI Spine
- MR Myelogram
- Intrathecal Gado MR Spine
- Conventional CT Myelogram
- Dynamic CT guided Myelogram
- Digital Subtraction Myelogram
Radionuclide Cisternography

Paucity of activity over the convexities
Parathecral activity
Not good for localizing site of leak
Helpful when all else is unconvincing
Imaging

- Radionuclide Cisternography
- MRI Brain
- MRI Spine
- MR Myelogram
- Intrathecal Gado MR Spine
- Conventional CT Myelogram
- Dynamic CT guided Myelogram
- Digital Subtraction Myelogram
Normal Brain

- Monro-Kellie hypothesis
  - Blood
  - Brain
  - CSF

- In adults the intracranial compartment is protected by the skull
- There is a fixed internal volume of 1400-1700mL
Monro-Kellie Hypothesis
Hypotension or Hypovolemia?

CSF hypovolemia (CSF volume depletion)

- Decreased CSF pressure
- Pressure can be normal
- MRI abnormalities
- MR maybe normal
- Headache can be absent
- Clinical Manifestations
Intracranial Hypotension/Hypovolemia

- Pachymeningeal enhancement
- Brain “sagging” or “sinking”
  - cerebellar tonsils low
  - brainstem distortion
  - Pontine enlargement
  - crowding of the posterior fossa
  - flattening of the optic chiasm
- Subdural hygromas/hematomas
- Engorged venous sinuses
- Pituitary hyperemia
Cranial MRI

S Subdural hygroma/hematoma
E Enhancement of pachymeninges
E Enlargement of veins
P Pituitary hyperemia
S Sagging of brain
Cranial MRI

S  Subdural hygroma/hematoma
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S  Sagging of brain
PRE and POST Treatment
Coma
Frontotemporal Dementia
SDH due to CSF leak
SDH due to CSF leak
Direct proof of spinal CSF leakage in 25.9% of patients suggests that spinal CSF leaks may be a frequent cause of nongeriatric CSDH
Siderosis
Spinal Leak Detection and Localization
## Classification of CSF Leaks

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Incidence</th>
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<tbody>
<tr>
<td>Type 1</td>
<td>Dural Tear</td>
<td>26.6%</td>
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<td>Meningeal Diverticulum</td>
<td>42.3%</td>
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## Classification of CSF Leaks recent data since April 2018

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Type 1 (Dural tear)
False localizing C1-2
Ventral Leak DSM
Ventral Leak Dynamic CT guided Myelogram
Type 2 (Meningeal diverticulum)
Type2 (Meningeal diverticulum)
Type 3 (CSF Venous Fistula)
CSF Venous Fistula

DSM in lateral decubitus position
23 new patients April-September 2018
16 patients positive for fistula
## Spinal Leak Detection and Localization

<table>
<thead>
<tr>
<th>Modality</th>
<th>Initial</th>
<th>High Flow</th>
<th>Low Flow</th>
<th>Radiation</th>
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<tbody>
<tr>
<td>CTM</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>10-30 mSv</td>
</tr>
<tr>
<td>Dynamic CTM</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>20-200</td>
</tr>
<tr>
<td>DSM</td>
<td>?</td>
<td>+++</td>
<td>+</td>
<td>2-35</td>
</tr>
<tr>
<td>MR/MYEOLO</td>
<td>+++</td>
<td>-</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>MR IT Gado</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>0</td>
</tr>
<tr>
<td>Radionuclide</td>
<td>-</td>
<td></td>
<td>++</td>
<td>2-6</td>
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Kranz et al AJR
Thank You
Percutaneous Treatment: Cedars-Sinai Approach

Charles Luoy and Marcel Maya
Cedars Sinai
Clinical suspicion for SIH

Obtain MRI brain w/o contrast

Diagnosis not confirmed, and clinical suspicion low for SIH/CSF-Leak

Consider other causes for symptoms

Diagnosis not confirmed, but clinical suspicion high for SIH/CSF-Leak

Obtain “diagnostic” EBP

First line treatment (non-targeted)

No symptomatic improvement

Obtain “diagnostic” EBP

Symptoms improve

SIH diagnosis confirmed

Inadequate response

EBP (possibly series of several repeat treatments, and consider high volume injections)

Sustained good response

Follow up as needed

Additional dedicated spine diagnostic imaging

Specifically identify leak site & leak type. (Can consider DSM at this point).

IF CSF leak site/leak identified

IF CSF leak site/leak NOT identified on conventional spinal imaging

Further specialized spine imaging with DSM

Type 4 (Indeterminate type) Leak?

Yes

Difficult to cure

Type 3 Leak?

Yes

Generally, try to manage symptoms conservatively or with only minimally invasive interventions, and avoid surgery

No

Type 1 leak?

Leak site amenable to targeting by minimally invasive percutaneous approach?

Yes

Consider:
Flouro/CT-guided Fibrin Sealant injection

No

Consider:
Targeted Surgical Intervention

Type 2 leak?

Yes

Type 1 leak?

No

Consider:
Targeted Surgical Intervention

Type 2 leak?

Yes

Consider:
Indirect Surgical Interventions

(such as lumbar dural reduction surgery, or epidural saline catheter/Infusion surgery)

Key/Abbreviations:
SIH: Spontaneous intracranial hypotension
EBP: Epidural blood patch
DSM: Digital Subtraction Myelography
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Interventional Options

- Blood Patch
  - Single level
  - Multilevel
  - Targeted
- Fibrin Glue
Quadris Order#: 3738058
Location: OP01
Date of Birth: 01/01/1959

NERVE ROOT LOCALIZATION
AND FIBRIN GLUE DEPOSITION

DATE OF STUDY: 01/30/2003

CLINICAL INDICATION: CSF leak.
<table>
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<tr>
<th>Year</th>
<th>Blood Patch</th>
<th>Fibrin Glue</th>
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<tbody>
<tr>
<td>2013</td>
<td>138</td>
<td>46</td>
</tr>
<tr>
<td>2014</td>
<td>160</td>
<td>34</td>
</tr>
<tr>
<td>2015</td>
<td>169</td>
<td>40</td>
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<td>2016</td>
<td>209</td>
<td>51</td>
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Fibrin Glue
Fibrin Glue CSF fistula
Fibrin Glue CSF fistula
Fibrin Glue CSF fistula

Pre Treatment

Post Treatment
Sacral cysts
Meningeal diverticulum
Results

Epidural blood patch
- 30-70% initial response
- Relapse not uncommon
- Maintenance patching may be necessary

Percutaneous glue
- 40% cure rate
- Depends on accurate localization of leak