ICTUS CEREBELOSOS

Carlos S. Kase, M.D.
Department of Neurology
Boston University
Boston, MA
CEREBELLAR STROKES

- CEREBELLAR INFARCTION
- CEREBELLAR HEMORRHAGE
Distribution of Pathologically Confirmed Cerebellar Infarction

<table>
<thead>
<tr>
<th>Vascular territory involved</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior inferior cerebellar artery (PICA)</td>
<td>7</td>
</tr>
<tr>
<td>Superior cerebellar artery</td>
<td>7</td>
</tr>
<tr>
<td>Multiple random sites</td>
<td>3</td>
</tr>
<tr>
<td>White matter lacune</td>
<td>1</td>
</tr>
<tr>
<td>Bilateral watershed (PICA, superior cerebellar territory)</td>
<td>1</td>
</tr>
</tbody>
</table>

RAL Macdonell et al., Stroke 1987;18:849-855
PICA-DISTRIBUTION INFARCT

A.T. - MR # 2449318
SCA-DISTRIBUTION INFARCT
CEREBELLAR INFARCTION
Clinical Importance

- Differences in topography, clinical features, vascular pathology, treatment
- Potential for edema, mass effect, brainstem compression
- Associated brainstem infarction
ACUTE CEREBELLAR INFARCTION
(Autopsy series, 28 cases)

- Gait-trunk ataxia.................................71%
- Limb dysmetria.....................................57%
- Facial palsy........................................36%
- Facial hypesthesia.................................29%
- Nystagmus..........................................62%
- Dysarthria...........................................67%
- Gaze palsy..........................................32%
- 6th nerve palsy.....................................12%
- Mental changes....................................65%
Cerebellar infarction. Clinical and anatomic observations in 66 cases

CS Kase, B Norrving, SR Levine, VL Babikian, EH Chodosh, PA Wolf and KM Welch

Stroke 1993;24:76-83

- 36 patients with PICA-distribution infarcts
- 30 patients with SCA-distribution infarcts

PURPOSE: To compare clinical features, imaging characteristics, and clinical course in the main two types of cerebellar infarction
CEREBELLAR INFARCTION

Symptoms - PICA v. SCA

- Headache
- Vertigo
- Vomiting
- Gait imbal.

PICA

SCA
CEREBELLAR INFARCTION

Signs - PICA v. SCA

- Limb ataxia
- Nystagmus
- Gait ataxia
ACUTE CEREBELLAR INFARCTION IN THE PICA TERRITORY

Three pts. with acute onset of:
- Vertigo ↑'d by movt.
- Nausea, vomiting
- Imbalance
- Nystagmus
- No cerebellar ataxia on exam

Initial diagnosis: “Labyrinthitis”

Course: Progressive swelling c/brainstem compression

Duncan GW et al., Arch Neurol 1975;32:364-368
75 y/o MD, no significant PMH, while rounding developed severe vertigo, n/v, gait instability

PE: uncomfortable b/o vertigo; every movement caused severe vertigo, n/v; right-beating, non-direction-changing nystagmus only abn. in CN examination; no limb ataxia present
Prospective study, 24 pts., age 50-75
Isolated vertigo/imbalance

Infarct caudal cerebellum in 6 (25%)

Cardioembolic source in 3/6

Normal MRI, but occluded VA by Doppler in 2/18
CEREBELLAR INFARCTION
Brain stem signs

<table>
<thead>
<tr>
<th>PICA INFARCTS</th>
<th>12/36 patients (33%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral medullary syndrome</td>
<td></td>
</tr>
<tr>
<td>▪ Complete</td>
<td>6 patients</td>
</tr>
<tr>
<td>▪ Partial</td>
<td>6 patients</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCA INFARCTS</th>
<th>9/30 Patients (30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Dysarthria</td>
<td>9 patients</td>
</tr>
<tr>
<td>▪ Horner’s</td>
<td>6 patients</td>
</tr>
<tr>
<td>▪ Diplopia, vert. gaze palsy, 6th n. palsy, INO, dyskinesia</td>
<td>1 patient each</td>
</tr>
</tbody>
</table>
CEREBELLAR INFARCTION
Brain stem signs

<table>
<thead>
<tr>
<th>PICA INFARCTS</th>
<th>12/36 patients (33%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral medullary syndrome</td>
<td></td>
</tr>
<tr>
<td>▪ Complete</td>
<td>6 patients</td>
</tr>
<tr>
<td>▪ Partial</td>
<td>6 patients</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCA INFARCTS</th>
<th>9/30 Patients (30%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Dysarthria</td>
<td>9 patients</td>
</tr>
<tr>
<td>▪ Horner’s</td>
<td>6 patients</td>
</tr>
<tr>
<td>▪ Diplopia, vert. gaze palsy, 6\textsuperscript{th} n. palsy, INO, dyskinesia</td>
<td>1 patient each</td>
</tr>
</tbody>
</table>
CEREBELLAR INFARCTION
Common presenting signs

Vertigo = PICA
Dysarthria = SCA
CEREBELLAR INFARCTION
Mechanisms of infarction

PICA TERRITORY (N=28)

• Cardiac embolism 14 (50%)
• VA occlusion 7
• VA stenosis 3
• PICA occlusion 3
• ? Vasculitis 1
CEREBELLAR INFARCTION
Mechanisms of infarction

SCA TERRITORY (N=18)

- Cardiac embolism 11 (61%)
- Artery-to-artery emb. 3 (17%)
- Distal BA stenosis 2
- SCA stenosis/occlusion 2
CEREBELLAR INFARCTION
CT Findings

PICA INFARCTS (N = 36)

- Partial territory: 27 (75%)
- Full PICA territory: 9 (25%)

Displacement/obliteration of 4th ventricle: 8
Obstructive hydrocephalus: 7
PICA DISTRIBUTION CEREBELLAR INFARCTS

TOTAL

PARTIAL
In 7/36 (19%) full territory infarct: ME, brainstem compr., hydrocephalus

- 3 pts. died without undergoing surgery
- 4 pts. operated on
  - 1 ventriculostomy
  - 3 post. fossa decompression
## CEREBELLAR INFARCTION

### CT findings

| Partial territory (vermian or hemisphere branches) | 30 |
| Displacement/obliteration of 4th ventricle | 2 |
| Obstructive hydrocephalus | 2 |
SUPERIOR CEREBELLAR ARTERY-DISTRIBUTION INFARCTS

TOTAL

PARTIAL
Clinical Course

In 2/30 (7%) /deep WM infarct:
ME, brainstem compr., hydrocephalus

• Both patients had posterior fossa decompression
Pt. SM – MR # 928526

- 55 y/o ♂, hypertensive
- Abrupt onset vertigo, gait imbalance 9/27/90
- PE: A, Ox3; nl. speech; nl. strength & sensation; mod. ataxia ⬆ UL > LL; full EOMs, c/horizontal nystag. ⬆ > ⬇ gaze; normal pupillary size & reactivity
Pt. SM – MR # 928526

9/28/90, 6 PM:
Somnolent, disoriented, dysarthric

PE: nl. strength & sensation; mod. ataxia ⬅️ UL > LL; full EOMs, ⬅️/horizontal nystag. 
ียง > глас gaze; normal pupillary size & reactivity; ⬅️ facial palsy
Pt. SM – MR # 928526

- **9/28/90, 10 PM:**
  Ventriculostomy
  Hyperventilation

- **9/29/90:**
  Awake, following commands; full horiz. gaze; toes down

- **9/30/90:**
  Lethargic; full horiz. gaze; paralysis upward gaze; pupils 3 mm, barely reactive; bilat. Babinski

**SUB-OCCIPITAL DECOMPRESSIVE CRANIECTOMY**
Pt. SM - MR # 928526

- **10/1/90:**
  More alert, following commands; improved pupillary reactivity; paralysis upward gaze and Babinski signs still present

- **10/2/90:**
  Awake, following commands; improved upward gaze; toes down; normal pupillary reactivity

- **10/3/90:**
  Awake and alert; full upward gaze; toes down; normal pupillary reactivity
Pt. SM – MR # 928526

Lessons

- Large PICA infarct c/progressive neurological decline
- Temporary effect of ventriculostomy
- Potential for upward transtentorial herniation after ventriculostomy
- Value of wide posterior fossa decompressive craniectomy
### CEREBELLAR INFARCTION

Swelling and Hydrocephalus

<table>
<thead>
<tr>
<th>AUTHORS</th>
<th># cases</th>
<th># (%) cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scotti et al.</td>
<td>21</td>
<td>6 (29%)</td>
</tr>
<tr>
<td>Shenkin, Zavala</td>
<td>55</td>
<td>6 (11%)</td>
</tr>
<tr>
<td>Macdonell et al.</td>
<td>30</td>
<td>4 (13%)</td>
</tr>
<tr>
<td>Kase et al.</td>
<td>36 PICA</td>
<td>7 (19%)</td>
</tr>
<tr>
<td></td>
<td>30 SCA</td>
<td>2 (7%)</td>
</tr>
</tbody>
</table>
CEREBELLAR INFARCTION
Imaging Features Predictive of Mass Effect and Neurological Deterioration

- Fourth ventricle deformity
- Fourth ventricle shift
- Hydrocephalus
- Brain stem deformity
- Compression of basal cisterns

MG Koh et al., Stroke 2000;31:2062-2067
CEREBELLAR INFARCTION

Suggested management

- SCA cases more benign than PICA
- In PICA cases, close clinical monitoring, early MRI
- If swelling / brainstem compression, hydrocephalus → ventriculostomy
- If further progression, posterior fossa decompression
ALGORITHM FOR THE MANAGEMENT OF CEREBELLAR INFARCTION

CLINICAL PRESENTATION

- Isolated vertigo or PICA, SCA, AICA syndrome

CT scan, MRI

Cerebellar infarction

Small, partial inf. in PICA, SCA, AICA territory

Clinically stable for 48 hours

Work-up for cardiac source of embolism, post. circulation arterial disease

Large, full PICA inf., white matter SCA inf., bilat. or multiple cerebellar infarcts

ICU monitoring

Progressive ↓ LOC, ipsilateral gaze palsy, upward or downward herniation

Emergency CT, MRI

Hydrocephalus, post. fossa mass effect

VENTRICULOOSTOMY

Improvement

No further surgical therapy

No Improvement

POSTERIOR FOSSA, DE-COMPRESSIVE CRANIOTOMY
Mean time to neurological decompensation: 50 hrs.
ACUTE ONSET VERTIGO/IMBALANCE

DIFFERENTIAL DIAGNOSIS

Acute unilateral vestibulopathy
- Menière’s disease
- “Labyrinthitis”
- “Vestibular neuronitis”
- “Peripheral vestibulopathy”

Posterior fossa vascular disorder
- Brainstem infarct/hemorrhage
- Cerebellar infarct/hemorrhage
## Types of Cerebellar Herniation

<table>
<thead>
<tr>
<th></th>
<th>Ascending Transtentorial</th>
<th>Descending Tonsilar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direction of tissue displacement</strong></td>
<td>Upward</td>
<td>Downward</td>
</tr>
<tr>
<td><strong>Portion of cerebellum displaced</strong></td>
<td>Superior aspect of hemisphere</td>
<td>Tonsils</td>
</tr>
<tr>
<td><strong>Site of herniation</strong></td>
<td>Free edge of the tentorial incisura</td>
<td>Foramen magnum</td>
</tr>
<tr>
<td><strong>Portion of brainstem compressed</strong></td>
<td>Midbrain</td>
<td>Medulla</td>
</tr>
<tr>
<td><strong>Clinical manifestations</strong></td>
<td>Lethargy, coma</td>
<td>Neck stiffness</td>
</tr>
</tbody>
</table>
SUPERIOR CEREBELLAR ARTERY
Pontine territory

- Superior cerebellar peduncle
- Lateral lemniscus
- Spinothalamic tract
- Descending sympathetic tract
- Mesencephalic trigeminal tract
- Locus coeruleus
- Root of contralat. 4th n. (pontine tectum)
CEREBELLAR INFARCTION
(Autopsy series, 28 cases)

• Infarct in P-1 aspect of cerebellum (93%)

Vascular occlusion:
  VA (18 cases)
  PICA (10 cases)

Mechanism of occlusion:
  Embolic (25%)
  Thrombotic (75%)

Assoc. with Wallenberg’s: 18%
Death 6-30 hrs. from onset M.S.
CT Findings in Cases of Cerebellar Softening

<table>
<thead>
<tr>
<th>FINDINGS</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group 1</td>
</tr>
<tr>
<td></td>
<td>N=6</td>
</tr>
<tr>
<td>Location of softening</td>
<td></td>
</tr>
<tr>
<td>- Left hemisphere</td>
<td>4</td>
</tr>
<tr>
<td>- Right hemisphere</td>
<td>2</td>
</tr>
<tr>
<td>- Deep</td>
<td>...a</td>
</tr>
<tr>
<td>- Superficial</td>
<td>...a</td>
</tr>
<tr>
<td>Triventricular hydrocephalus</td>
<td>6</td>
</tr>
<tr>
<td>4(^{th}) ventricle compression</td>
<td>6</td>
</tr>
<tr>
<td>Cisterns obliterated</td>
<td>6</td>
</tr>
</tbody>
</table>
| Contrast enhancement                          | 0        | \(\frac{1}{4}\)
SCA – DISTRIBUTION INFARCT
“Classic” Syndrome

Ipsilateral
- Limb ataxia
- Horner’s syndrome
- Choreic dyskinesia

Contralateral
- Thermoanalgesia
- Fourth n. palsy
CEREBELLAR STROKES

- CEREBELLAR INFARCTION
- CEREBELLAR HEMORRHAGE
CEREBELLAR HEMORRHAGE
Clinical Presentation

- Inability to stand/walk: > 90%
- Vertigo: 50-60%
- Headache: 60-75%
- Vomiting: 70-95%
CEREBELLAR HEMORRHAGE
Clinical Presentation

Inability to stand/walk, Vertigo, Headache, Vomiting
CEREBELLAR HEMORRHAGE
CT Features Suggesting Surgical Rx

• Hematoma $\geq$ 3 cm

• Hydrocephalus
# Cerebellar Hemorrhage

**CT Aspects and Outcome**

Little et al., J Neurosurg 1978;48:575

<table>
<thead>
<tr>
<th>Case #</th>
<th>Location</th>
<th>Size</th>
<th>Hydrocephalus</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medial</td>
<td>x</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Vermis</td>
<td>x</td>
<td>Marked</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Medial</td>
<td>x</td>
<td>Marked</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Medial</td>
<td>x</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Vermis</td>
<td>x</td>
<td>Marked</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Medial</td>
<td>x</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Vermis</td>
<td>x</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Lateral</td>
<td>x</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Medial</td>
<td>x</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Medial</td>
<td>x</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

5 SURGERY
2 DEATHS

RECOVERED
CEREBELLAR HEMORRHAGE
CT Features Suggesting Surgical Rx

- Hematoma > 3 cm
- Hydrocephalus
- Obliteration quadrigeminal cistern
- Deformation/compression of 4th ventr.?
50 pts. with cerebellar hemorrhage

**Purpose:** Assess influence of degree of 4th ventricular mass effect in clinical and CT features, as well as treatment results

**4th ventricular mass effect:**

- **Grade I:** no mass effect
- **Grade II:** partial compression, shifted
- **Grade III:** complete obliteration
<table>
<thead>
<tr>
<th>Grade</th>
<th>#</th>
<th>Size (cm)</th>
<th>Hydroc. (%)</th>
<th>% coma onset</th>
<th>% coma final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>6</td>
<td>3</td>
<td>50</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Grade II</td>
<td>26</td>
<td>4.2</td>
<td>61</td>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>Grade III</td>
<td>18</td>
<td>5</td>
<td>100</td>
<td>22</td>
<td>67</td>
</tr>
</tbody>
</table>
CEREBELLAR HEMORRHAGE
Degree of 4th ventricular compression

Neurosurgery 2001;49:1378-1387

<table>
<thead>
<tr>
<th>Grade</th>
<th>#</th>
<th>Evac.</th>
<th>CSF drain.</th>
<th>Conserv.</th>
<th>% good outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Grade II</td>
<td>19</td>
<td>4</td>
<td>6</td>
<td>9</td>
<td>58</td>
</tr>
<tr>
<td>Grade II GCS &gt; 8</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>57</td>
</tr>
<tr>
<td>Grade II GCS &lt; 8</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>Grade III GCS &gt; 8</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>38</td>
</tr>
<tr>
<td>Grade III GCS &lt; 8</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
42 pts. with cerebellar hemorrhage, alert on presentation - Deterioration into coma after admission

Ott KH, et al., Arch Neurol 1974; 31; 160-167
43 pts. with cerebellar ICH, alert on admission

Rate of deterioration into coma in days after onset

Ott KH, Kase CS, Ojemann RG, Mohr JP. Arch Neurol 1974;31:160
<table>
<thead>
<tr>
<th>Cases</th>
<th>No.</th>
<th>Died</th>
<th>%</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>...</td>
</tr>
<tr>
<td>Drowsy</td>
<td>10</td>
<td>2</td>
<td>20</td>
<td>Death 18th PO day, myocardial infarction;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>death 32nd PO day, rebled into metastatic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>cerebellar tumor</td>
</tr>
<tr>
<td>Stuporous</td>
<td>4</td>
<td>2</td>
<td>50</td>
<td>Death 1st PO day, rebled after reoperation;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>death after 9 hr, probably rebled</td>
</tr>
<tr>
<td>Coma</td>
<td>12</td>
<td>10</td>
<td>83</td>
<td>Two survivals, moderate disability and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>complete disability</td>
</tr>
</tbody>
</table>

* Postoperative.
CEREBELLAR STROKES

Conclusions

• CEREBELLAR INFARCTION

PICA: Presents with vertigo and headache; limb ataxia may be absent; severe mass effect/hydrocephalus: 19%

SCA: Presents with gait disturbance, dysarthria; severe mass effect/hydrocephalus: 7%

• CEREBELLAR HEMORRHAGE

Presents with sudden onset of inability to walk; ipsilateral cerebellar ataxia, horizontal gaze palsy and facial palsy common; notorious tendency to deterioration and brainstem compression; surgical treatment should be an early consideration
The management of cerebellar hemorrhagic and ischemic stroke is controversial. Issues such as the difference in the treatment algorithm of cerebellar ICH versus infarction, criteria for imaging to exclude an underlying structural lesion, the value of MRI for patient selection, the role of external ventricular drainage, the indications for operative management, the timing of surgical intervention, and various options of surgical technique remain unresolved. Professional society guidelines for these considerations are sparse and based on relatively poor quality data. Nonetheless, the potential value of neurosurgical intervention remains well established.
CEREBELLAR INFARCTION
Conclusions

- **PICA:**
  Usually presents with vertigo and headache; limb ataxia may be absent; severe mass effect/hydrocephalus: 24%

- **SCA:**
  Usually presents with gait disturbance; severe mass effect/hydrocephalus: 7%

- **For both groups:**
  Associated with brain stem signs in 1/3 of cases; cardiac embolism most important mechanism