Brain lesions relate to gait pathology in children with unilateral and bilateral cerebral palsy

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Introduction

It is unclear how primary motor deficits and gait pathologies relate to the broad range of brain lesions in children with cerebral palsy (CP). This study applied several MRI modalities, evaluating lesions in multiple brain areas both qualitatively and quantitatively, to identify relevant relationships with gait pathology in CP.

Aims

Retrospective cohort study to identify qualitative and/or quantitative parameters of brain lesions that might explain lower limb motor functioning in CP.

Methods

- Inclusion criteria:
  - Spastic CP
  - MRI brain imaging at min 3 y old (MPRAGE, FLAIR)
  - 3D gait analysis (3DGA) data
  - 3 – 12 y old, prior to any lower limb orthopedic surgery, prior to / ≥ 6 months after BTX-A injections

- Qualitative evaluation of brain lesions
  - FLAIR images
    - Corpus callosum (anterior - mid – posterior)
    - basal ganglia
    - Brainstem
    - cerebellum

- Quantitative analyses of brain lesions (Fig 1)
  - FLAIR:
    - Sub- & global scores for white matter involvement
    - MPRAGE
    - Length & volume of corpus callosum
    - olume lateral ventricles
    - asymmetry brainstem

- Lower limb motor functioning
  - Bilateral CP: both lower limbs; Unilateral CP: involved lower limb
  - Primary motor deficits
    - Muscle strength hip, knee and ankle flexors/extensors: manual muscle testing
    - Spasticity hip flexors/adductors, knee flexors/extensors, ankle dors/plantarflexors: modified Ashworth scale
  - Gait pathology: Gait Profile Score

Results

- 51 children with CP: 25 bilaterally involved, 26 unilaterally involved
- Bilateral group

<table>
<thead>
<tr>
<th>PLIC involvement (ipsi/contra)</th>
<th>LL spasticity</th>
<th>LL muscle strength</th>
<th>GPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>p &lt; .001 (both)</td>
<td>p &lt; .001</td>
<td>p &lt; .05</td>
<td></td>
</tr>
<tr>
<td>Anterior body CC involvement</td>
<td>ns</td>
<td>p &lt; .001</td>
<td>ns</td>
</tr>
<tr>
<td>Subcortical WM involvement</td>
<td>ns</td>
<td>ns</td>
<td>p &lt; .001</td>
</tr>
<tr>
<td>BG-BS involvement score (ipsi/contra)</td>
<td>r = 0.44</td>
<td>r = -0.56</td>
<td>ns</td>
</tr>
<tr>
<td>Middle WM involvement score</td>
<td>ns</td>
<td>ns</td>
<td>r = 0.41</td>
</tr>
<tr>
<td>Total brain involvement score</td>
<td>ns</td>
<td>ns</td>
<td>r = 0.53</td>
</tr>
<tr>
<td>CC volume splenium / length</td>
<td>r = -0.46 / -0.52</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

LL: lower limb, GPS: gait profile score, PLIC: posterior limb of internal capsule, ipsi:ipsilateral, CC: corpus callosum, WM: white matter, BGs: basal ganglia, BS: brainstem, ns: non-significant

- Unilateral group

<table>
<thead>
<tr>
<th>Middle WM involvement score (ipsi)</th>
<th>LL spasticity</th>
<th>LL muscle strength</th>
<th>GPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0.45</td>
<td>ns</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>CC length</td>
<td>ns</td>
<td>ns</td>
<td>r = -0.40</td>
</tr>
</tbody>
</table>

LL: lower limb, GPS: gait profile score, WM: white matter, ipsi:ipsilateral, CC: corpus callosum, ns: non-significant

Conclusions

- Several neurological parameters with potential role in lower limb motor functioning identified
- Potential neurological parameters indicated bilateral hemispheric influence on lower limb motor functioning
- Relations between brain lesions and gait pathology seem complex pointing to a multidimensional network involved

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References


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