The upper limb in cerebral palsy
A functional approach to diagnosis and treatment

S. Lauwagie
F. Plasschaert
N. Vermeire
C. Schaep
M. Forward

Kinderorthopedie/CPRC UZ Gent
primitive reflex patterns
<table>
<thead>
<tr>
<th>milestone</th>
<th>age</th>
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<tbody>
<tr>
<td>Lifts head and torso from prone position</td>
<td>1-3 mo</td>
</tr>
<tr>
<td>Hand-eye coordination</td>
<td>2 - 4 mo</td>
</tr>
<tr>
<td>Rudimentary grasp</td>
<td>4 - 5 mo</td>
</tr>
<tr>
<td>Hand support in sitting position</td>
<td>6 mo</td>
</tr>
<tr>
<td>Crosses midline with both hands</td>
<td>7-9 mo</td>
</tr>
<tr>
<td>Pinch</td>
<td>12-18 mo</td>
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</tbody>
</table>
Both hemispheres have both ipsi- and contralateral corticospinal projections

Staudt et al, Journal of Anatomy 2010, Reorganization after pre- and perinatal brain lesions
Lesional hemisphere corticospinal projections are lost.
Contralesional hemisphere corticospinal projections are maintained.

Staudt et al, Journal of Anatomy 2010, Reorganization after pre- and perinatal brain lesions
Can lesion characteristics predict upper limb function in cerebral palsy?

- **SIZE** and **LOCATION** of central neurologic lesion: thalamus / basal ganglia
- **TIMING** of the brain lesion
  - Malformations
  - Predominantly white matter lesions (PVL, IVH)
  - Predominantly grey matter lesions (basal ganglia, (sub)cortical lesions, ACM-infarction)
- **NEUROPLASTICITY**: how did rewiring happen?
  - controlateral/ipsilateral/bilateral
**GMFCS for children aged 6-12 years: Descriptors and illustrations**

<table>
<thead>
<tr>
<th>GMFCS Level I</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>Children walk indoors and outdoors and climb stairs without limitation. Children perform gross motor skills including running and jumping, but speed, balance and coordination are impaired.</td>
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<thead>
<tr>
<th>GMFCS Level II</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>Children walk indoors and outdoors and climb stairs holding onto a railing but experience limitations walking on uneven surfaces and inclines and walking in crowds or confined spaces and with long distances.</td>
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<thead>
<tr>
<th>GMFCS Level III</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>Children walk indoors or outdoors on a level surface with an assistive mobility device and may climb stairs holding onto a railing. Children may use wheelchair mobility when traveling for long distances or outdoors on uneven terrains.</td>
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<thead>
<tr>
<th>GMFCS Level IV</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>Children use methods of mobility that usually require adult assistance. They may continue to walk for short distances with physical assistance at home but rely more on wheeled mobility (pushed by an adult or operate a powered chair) outdoors, at school and in the community.</td>
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<thead>
<tr>
<th>GMFCS Level V</th>
<th>Descriptions</th>
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<tbody>
<tr>
<td>Physical impairment restricts voluntary control of movement and the ability to maintain antigravity head and trunk postures. All areas of motor function are limited. Children have no means of independent mobility and are transported by an adult.</td>
<td></td>
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# House unimanual score

<table>
<thead>
<tr>
<th>Class</th>
<th>Designation</th>
<th>Activity level</th>
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<tbody>
<tr>
<td>0</td>
<td>Does not use</td>
<td>Does not use</td>
</tr>
<tr>
<td>1</td>
<td>Poor passive assist</td>
<td>Uses as stabilizing weight only</td>
</tr>
<tr>
<td>2</td>
<td>Fair passive assist</td>
<td>Can hold onto object placed in hand</td>
</tr>
<tr>
<td>3</td>
<td>Good passive assist</td>
<td>Can hold onto object and stabilize it for use by other hand</td>
</tr>
<tr>
<td>4</td>
<td>Poor active assist</td>
<td>Can actively grasp object and hold it weakly</td>
</tr>
<tr>
<td>5</td>
<td>Fair active assist</td>
<td>Can actively grasp object and stabilize it well</td>
</tr>
<tr>
<td>6</td>
<td>Good active assist</td>
<td>Can actively grasp object and then manipulate it against other hand</td>
</tr>
<tr>
<td>7</td>
<td>Spontaneous use</td>
<td>Can perform bimanual activities easily and occasionally uses the hand spontaneously</td>
</tr>
<tr>
<td>8</td>
<td>Spontaneous use</td>
<td>Uses hand completely independently without reference to the other hand</td>
</tr>
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Functional Evaluation Tools

SHUEE - Shriners Hospital for children Upper Extremity Evaluation tool
AHA – Assisting Hand Assessment
Jebson-Taylor, MUUL, Abilhand, CPQOL, PedsQLCP, GAS
Proper coördination of agonist and antagonist muscles is necessary for joint stabilization, movement synergy and ability.
Surface EMG

- Uses electrodes to detect and measure electrical signals from superficial muscles and measures the sum of potentials of activated motor units.

- It allows us to detect voluntary muscle activity or the absence thereof but also measures involuntary co-contraction and spasticity.

- Captured synchronously with kinematic and video data, it is an important guide to treatment: botulinum toxin, muscle transfert..
Muscle power determines treatment
Upper Limb Kinematics

wrist flexion - extension

forearm pro-supination
Antagonist power directs treatment
Treatment options

- **REGULAR ONGOING THERAPY**
  - stretching, strengthening, bimanual functional therapy, CIMT …
- **ORTHOSES**
  - static night vs functional day splinting
- **BOTULINUM TOXIN**
  - in selected patients
- **SURGERY**
Surgery for the spastic upper limb

RESTORING THE BALANCE

- Soft tissue releases of deforming spastic muscles
- Augmenting weak antagonists by tendon transfer
  - Joint stabilization
    (= capsulodesis, arthrodesis)
- Reducing spasticity by peripheral neurotomies
Surgery for the spastic upper limb

- Soft tissue releases of deforming spastic muscles
Surgery for the spastic upper limb

- Soft tissue releases of deforming spastic muscles

- Augmenting weak antagonists by tendon transfer
  
  - Joint stabilization
    (= capsulodesis, arthrodesis)
Surgery for the spastic upper limb

RESTORING THE BALANCE

- Soft tissue releases of deforming spastic muscles
- Augmenting weak antagonists by tendon transfer
  - Joint stabilization
    (= capsulodesis, arthrodesis)
Recommendations

Start upper limb therapy early

Use night splints

Understanding agonist/antagonist balance is KEY

Botulinum toxine for clearly defined treatment goals, and define them together with patient and therapist

Tendon transfert surgery is more effective ico weak antagonist
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Orthopedie – kinderorthopedie - CPRC
SOPHIE.LAUWAGIE@UZGENT.BE