The use of instrumented gait analysis in interdisciplinary interventions for children with cerebral palsy

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Cerebral palsy

Definition
“a group of permanent but not unchanging disorders of movement and/or posture and motor function, which are due to a non-progressive interference, lesion or abnormality of the developing/immature brain.”

Surveillance of cerebral palsy in Europe (2000)
Cerebral palsy subtypes

Spastic (66%)
Ataxic (9%)
Dyskinetic (15%)
Unclassified or mixed (10%)

Surveillance of cerebral palsy in Europe (2000)
Rodby-Bousquet & Hägglund (2012)

Spastic CP
- unilateral (44%)
- bilateral (56%)

Surveillance of cerebral palsy in Europe (2000)
Rodby-Bousquet & Hägglund (2012)
GMFCS

Gross Motor Function Classification System

I

II

60% of childen with CP
Rodby-Bousquet & Hägglund (2012)

Rosenbaum PL at al (2008)
www.canchild.ca
The Danish Cerebral Palsy Follow-up Program (CPOP)
National clinical quality database & Follow-up program

Standardized examinations
Gross motor function
Muscle tone
Passive range of motion
Orthotics and assistive devices

www.cpguiden.dk

Rasmussen et al (2016)
Passive Range of Motion

Dorsiflexion with extended knee

Alriksson-Schmidt AL et al (2016)
Passive Range of Motion

Dorsiflexion with extended knee

Alriksson-Schmidt AI et al (2016)
"For children on GMFCS levels I to III, the threshold values of passive range of motion are set to ensure that the patient is able to dorsiflex adequately in the stance and swing of walking.”

Cerebral Parese Oppfølgingsprogram (CPOP)
Alarmverdier for passive bevegeutslag 2014
CPOP - Traffic light

<0°

“Alert” and that treatment is urgently needed (assuming no specific contraindications).

0-10°

”Yellow indicates that vigilant observation or potentially treatment is recommended”.

>10°

”Clear and that no indication of deterioration was noted during assessment”.

Dorsiflexion with extended knee

Alriksson-Schmidt AI et al (2016)
The aim of the study was to investigate the threshold values used by the CPUP by testing the hypothesis that passive range of motion in ankle dorsiflexion is associated with gross motor function and that gross motor function differs between the groups of participants in each category.
Materials and Methods

RCT (CPinMotion) baseline data
ClinicalTrails.gov (NCT02160457)

<table>
<thead>
<tr>
<th></th>
<th>Reference</th>
<th>Study II-III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number, n</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>6 y 10 m</td>
<td>6 y 10 m</td>
</tr>
<tr>
<td></td>
<td>(1 y 8 m)</td>
<td>(1 y 3 m)</td>
</tr>
<tr>
<td>Sex, boys/girls, n (%)</td>
<td>7/8</td>
<td>21/39</td>
</tr>
<tr>
<td></td>
<td>(47/53)</td>
<td>(35/65)</td>
</tr>
<tr>
<td>CP subtype, UL/BL, n (%)</td>
<td>-</td>
<td>43/17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(72/28)</td>
</tr>
<tr>
<td>GMFCS I / II, n (%)</td>
<td>-</td>
<td>42/18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(70/30)</td>
</tr>
</tbody>
</table>

Abbreviations: BL: Bilateral spastic cerebral palsy; CP: Cerebral palsy; GMFCS: Gross Motor Function Classification System; SD: Standard deviation; UL: Unilateral spastic cerebral palsy (UL).
Methods

- Passive range of motion
- Overall gross motor capacity
- Ankle-specific gait capacity
- Goss motor skills in everyday life.

<table>
<thead>
<tr>
<th>Instrumented gait analysis</th>
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<tbody>
<tr>
<td>Passive range of motion in dorsiflexion</td>
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<tr>
<td>Gait Deviation Index</td>
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<tr>
<td>Gait Variable Score, ankle</td>
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<tr>
<td>Peak dorsiflexion during gait</td>
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<tr>
<td>1-minute walk</td>
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<tr>
<td>Gross Motor Function Measure (selected items)</td>
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</tbody>
</table>

<table>
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<tr>
<th>Patient reported outcome measures</th>
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<tr>
<td>Pediatric Outcome Data Collection Instrument</td>
</tr>
<tr>
<td>The Pediatric Quality of Life Inventory Cerebral Palsy Module</td>
</tr>
</tbody>
</table>
Results

Range of Motion in ankle dorsiflexion
(Extended knee)

Gait Deviation Index

Gait variable score

\[ r = 0.05 \]
95% CI [-0.21 - 0.30]

\[ r = -0.37 \]
95% CI [-0.57 - -0.13]
Results

Threshold values - ankle dorsiflexion
(Extended knee)

Gait Deviation Index

Gait variable score

\[ p = 0.6 \]

\[ p = 0.02 \]
Results

Passive Range of Motion in ankle dorsiflexion
(Extended knee & Flexion knee)

Association and difference between
Gait Variable Score, ankle
Peak dorsiflexion during gait

NO associatio and NO difference
Gait Deviation Index
1-minute walk
Gross Motor Function Measure (selected items)
The Pediatric Quality of Life Inventory CP Module
Pediatric Outcome Data Collection Instrument
Examples - "traffic light"

High GDI - red values
GDI: 88.8
Dorsiflexion: 5° / 0°

Low GDI - green values
GDI: 48.9 - GVS: 33.5°
Dorsiflexion: 20° / 15°
Study aim
The aim of this study was to investigate the threshold values used by the CPUP by testing the hypothesis that passive range of motion in ankle dorsiflexion is associated with gross motor function and that gross motor function differs between the groups of participants in each category.

Conclusion
Passive range of motion in ankle dorsiflexion is moderately associated with ankle-specific measures of gross motor function, and the mean scores of the ankle-specific measures were different in the three categorical groups.

In contrast to our hypothesis, we did not find an important relationship between passive range of motion in ankle dorsiflexion or the three related categories and overall measures of gross motor capacity or the use of gross motor skills in everyday life.
Perspective

Example:
Hip surveillance and CPUP hip score
- inter- and intra-rater reliability
- odds ratio for hip displacement
- risk score for hip displacement
Thanks!

Participants and their parents
The local teams and healthcare professionals
Research assistants & colleagues

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The Linex Foundation and
The Danish Physiotherapy Research Fund.
## Physical examination

<table>
<thead>
<tr>
<th>Muscle function</th>
<th>Muscle tone</th>
<th>Range of motion</th>
<th>Deformities</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Kendall 0-5</em></td>
<td><em>Modified Ashworth Tardieu</em></td>
<td><em>Goniometer</em></td>
<td><em>Goniometer Observation</em></td>
</tr>
</tbody>
</table>
| Hip             | Hip flexion  
                Hip extension | Extension  
                Abduction  
                Internal rotation  
                External rotation |            |
| Knee and tibia  | Knee extension  
                Knee flexion  
                Quadriceps lag | Hamstring  
                Rectus femoris | Popliteal angle  
                Hamstring shift  
                Knee extension  
                Quadriceps lag  
                Rectus femoris length | Tibial torsion  
                Knee (valgus / varus) |
| Ankle and feet  | Plantar flexion  
                Dorsiflexion  
                Inversion  
                Eversion  
                Confusion test | Plantar flexor | Dorsiflexion  
                (knee 90° and 0°) | Posture of feet |