Muscle-adaptation in children with acquired brain injuries

Christine Jansen
Christine Wimmer
Sebastian Schroeder
Steffen Berweck

Background

In children with CP several changes of muscles are known:

- Reduced muscle volume
- Reduced fascicle length
- Changes in muscle fibers (variability in fiber thickness)
- Higher proportion of collagen and fat in the muscle
- Differences in echo intensity in children with CP
- Higher echo intensity in muscles with a higher proportion of fat or connective tissue
- Less response to treatment with BoNT/A in muscles with high echo intensity in adults

Little is known about (early) changes of muscles in children with acquired brain injuries over time...

Study design

Prospective cohort study
Children between 0 – 18 years
Acquired brain injury
First examination not longer than three months after the injury
Clinical examination
Passive ROM
Mod. Tardieu Scale (mTS 0-5)
Muscle Force (MRC 0-5)
GMFM 88
2D Ultrasound
Mod. Heckmatt Scale (mHS 1-4)

Hypotheses

1) Higher Echo intensity in muscles of children after acquired brain injury

2) Correlation of echo intensity and clinical examination:
   - Higher echo intensity in immobile children
   - Higher echo intensity in children with a reduced level of muscle force
   - Higher echo intensity in children with a higher level of spasticity

3) Echo intensity over time:
   - Echo intensity changes during rehabilitation
   - Muscles with higher echo intensity need longer for rehabilitation of muscle force

Modified Heckmatt scale (mHS: w/o boney signal)

1: normal with clearly visible internal septa
2: mildly abnormal with increase in background echogenicity while intramuscular septa are still definable
3: moderately abnormal muscle structure with increase in background echogenicity and less definable intramuscular septa
4: severely abnormal muscle structure with increase in background echogenicity without definable septa

Rating by 4 blinded MSK experienced raters
was ist mit Spasticity Outcome?
Kraft?
Sebastian, 10/20/2015
Heckmatt 1: normal with clearly visible internal septa

Heckmatt 2: increase in background echogenicity while intramuscular septa are still definable

Heckmatt 3: increase in background echogenicity and less definable intramuscular septa

Heckmatt 4: increase in background echogenicity without definable septa

Results

30 Children
Median Age: 7.7 years (3 months – 16 years)

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>n</th>
</tr>
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<tbody>
<tr>
<td>Traumatic brain injury</td>
<td>15</td>
</tr>
<tr>
<td>Hypoxia</td>
<td>5</td>
</tr>
<tr>
<td>Intracerebral bleeding/stroke</td>
<td>≤4</td>
</tr>
<tr>
<td>Tumor excision</td>
<td>≤3</td>
</tr>
<tr>
<td>Infectious disease</td>
<td>≤3</td>
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</tbody>
</table>

17 Children with at least three examinations

Hypothesis 1: ABI & higher echo intensity

Mod. Heckmatt Scale: ≥ 2

In 3 / 4 children (77%) in at least one muscle

Most often: M. soleus
Hypothesis 2: Echo intensity and clinical examination:

- Higher echo intensity in immobile children:
  Negative correlation between mHS in gastrocnemius muscle and GMFM at first examination (-0.481; p<0.05)

- Higher echo intensity in children with reduced muscle force:
  Negative correlation between MRC and mHS of gastrocnemius muscle is increasing: 1st examination: -0.480, 2nd examination: -0.555, 3rd examination: -0.762 (p<0.05)

- Higher echo intensity in children with higher level of spasticity:
  Positive correlation between mTS at first examination and mHS of the gastrocnemius muscle (0.787; p<0.05) and soleus muscle (0.701; p<0.05) in the fourth examination

Results hypothesis 3: Echo intensity over time

- Echo intensity changes over time (12-20 weeks):
  No significant difference between mHS at first and last examination

- Muscles with higher echo intensity need longer for rehabilitation:
  No significant correlation between mHS at first examination and MRC of plantar flexors during the examinations 2-4.

Elisabeth, 7 years of age

Stroke of the left A. cerebri media
First Examination 14 days after the injury
- mTS right plantar flexors: 3
- MRC: Plantar flexors right 0-1 (Feeling of slight muscle contraction)
- GMFM: 53.08% (patient mobile)

Leon, 12 years age

Bleeding of the left A. cerebri media
First Examination 40 days after the injury
- mTS right plantar flexors: 4
- MRC right plantar flexors: 0-1
- GMFM: 25.34%

Last Examination 106 days after the injury
- mTS right plantar flexors: 4
- MRC right plantar flexors: 1
- GMFM: 71.42%
Conclusion

- Alterations of muscle echo intensity can be detected using MSK ultrasound
- Immobilisation influences muscle echo intensity
- Muscle force influences muscle echo intensity
- Elevated muscle tone leads to increased muscle echo intensity (predictive?)
- Changes of muscle echo intensity are dynamic