Spina Bifida – management towards optimal standing and walking

Åsa Bartonek\textsuperscript{1,2} PT PhD
Marie Eriksson\textsuperscript{1,3} CPO PhD
Lanie Gutierrez-Farewik\textsuperscript{1,4} PhD
Eva Pontén\textsuperscript{1,2} MD PhD

\textsuperscript{1}Dept. of Women’s and Children’s Health, Karolinska Institutet
\textsuperscript{2}Dept. of Musculoskeletal Disorders, Karolinska University Hospital
\textsuperscript{3}TeamOlmed
\textsuperscript{4}KTH Royal Institute of Technology


<table>
<thead>
<tr>
<th>Muscle Function Class MFC I-V</th>
<th>I: Sacral</th>
<th>II: Low Lumbar</th>
<th>III: Mid-lumbar</th>
<th>IV: High Lumbar</th>
<th>V: High Lumbar/Thoracic</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Low’ lesion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle Strength grade 1-5,</td>
<td>Weakness of intrinsic foot muscles</td>
<td>Plantar flexion ≤ 3, fair or less</td>
<td>Hip flexion 4-5</td>
<td>No knee extension</td>
<td>No muscle activity in the lower limbs</td>
</tr>
<tr>
<td>1 = no trace of contraction,</td>
<td>Plantarflexion: 4-5</td>
<td>Knee flexion ≥ 3, Hip extension and/or hip abduction ≥ 2-3</td>
<td>Knee extension 4-5 good-to-normal</td>
<td>No hip adduction</td>
<td>No pelvic elevation</td>
</tr>
<tr>
<td>5 = normal strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘High’ lesion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muscle Strength grade 1-5,</td>
<td>No muscle activity in the lower limbs</td>
<td>No hip adduction</td>
<td>Hip flexion ≤ 2, poor or less</td>
<td>Pelvic elevation 2-3, fair or poor</td>
<td></td>
</tr>
<tr>
<td>1 = no trace of contraction,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 = normal strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1= no trace of contraction, 5=normal strength
Realistic prognosis of ambulation

- Level of motor paresis
- Analysis of additional ambulation-related factors
  - Contractures
  - Spasticity
  - Balance problems
  - Generalized muscle hypotonia
Orthotics vocabulary

Categories of orthoses → reference to the anatomical segments and joints they encompass

- FO       foot orthosis
- AFO      ankle-foot orthosis
- KAFO     knee-ankle-foot orthosis
- HKAFO    hip-knee-ankle-foot orthosis
- THKAFO   trunk-hip-knee-ankle-foot orthosis

(ISO 8449-3 : 1989)
Orthosis types

AFO
- Solid
- Overlapping
- Polycentric

KAFO
- Freely-articulating
- Locked

HKAFO
- 3-D
- Reciprocal
MFC I

- Weakness of intrinsic foot muscles and flexor hallucis longus

Expected ambulation:
Community ambulation. Ability to keep up with peers when walking outdoors

Orthoses: Insoles, FO
Gait analysis

- Foot contact
- Stance
- Swing
- Foot off
- 0%
- 100%
- Frontal
- Sagittal
- Transverse
- Trunk Sway
- Pelvic Obliquity
- Hip Ab-Adduction
- Trunk Tilt
- Pelvic Tilt
- Hip Flexion-Extension
- Knee Flexion-Extension
- Dorsi-Plantarflexion
- Trunk Rotation
- Pelvic Rotation
- Hip Rotation
- Foot Progression
MFC I

- Trunk Sway: 30° -30°
  - Up
  - Down
- Pelvic Obl.: 20° -20°
  - Up
  - Down
- Hip Ab-Add.: 25° -25°
  - Add
  - Abd
- Knee Valg-Var: 30° -30°
  - Var
  - Val
- Trunk Tilt: 20°
  - Post
  - Ant
- Pelvic Tilt: 35°
  - Ant
  - Post
- Hip Flex/Ext.: 60° -10°
  - Flex
  - Ext
- Knee Flex/Ext.: 85° -10°
  - Flex
  - Ext
- Dorsi-Plantarflex.: 30° -20°
  - Dors
  - Plant
- Trunk Rot.: 20° -20°
  - Int
  - Ext
- Pelvic Rot.: 30° -30°
  - Int
  - Ext
- Hip Rotation: 30° -30°
  - Int
  - Ext
- Foot Progression: 40° -40°
  - Int
  - Ext
MFC II

- Main problem: Plantarflexion weakness

Expected ambulation
- Community ambulation with need of orthoses.
- No walking aid.
- Wheelchair use only for long distances outdoors

**Orthoses**: Initially free-articulated KAFO, thereafter AFO

Freely-articulating KAFO  AFO (solid/overlap)  AFO (polycentric)
Ex. MFC II with AFOs, 11.7 years

- **Trunk Sway**
  - Up: 30
  - Down: -30

- **Pelvic Obl.**
  - Up: 20
  - Down: -20

- **Hip Ab-Add.**
  - Add: 25
  - Abd: -25

- **Knee Valg-Var**
  - Var: 30
  - Val: -30

- **Trunk Tilt**
  - Post: 20
  - Ant: -20

- **Pelvic Tilt**
  - Ant: 35
  - Post: -20

- **Hip Flex/Ext.**
  - Flex: 60
  - Ext: -10

- **Knee Flex/Ext.**
  - Flex: 85
  - Ext: -10

- **Dorsi-Plantarflex.**
  - Dors: 30
  - Plantar: -20

- **Trunk Rot.**
  - Int: 20
  - Ext: -20

- **Pelvic Rot.**
  - Int: 30
  - Ext: -30

- **Hip Rotation**
  - Int: 30
  - Ext: -30

- **Foot Progression**
  - Int: 40
  - Ext: -40
MFC III

- No below-knee muscle strength
- Weakness of hip extensors, hip abductors

Expected ambulation:
- Household ambulation with orthoses, sometimes walking aids
- Wheelchair use only outdoors, and for long distances indoors

Orthoses: HKAFO, KAFO, AFO with condylar support
Ex. MFC III with KAFOs, 7.8 years
Hips contained
Compensatory gait

With stable hips

<table>
<thead>
<tr>
<th>TD</th>
<th>MFC III</th>
<th>MFC III</th>
</tr>
</thead>
</table>

MFC III
Midlumbar

Keep the hips reduced!

- Modern hip surgery, without tendon transfers, combined with well-aligned orthoses

- For children with potential walking capacity
  - Contained hips
  - Higher quality of life
  
  Danielsson et al 2008

- No walking aids
  - Hands are free to be used for other things!
Effect of Spasticity: Standing

MFC I
No spast | Ankle | Ankle + knee/hip

Group 1a
1 2 3 4 5 6
Group 1b
7 8 9 10

MFC II
No spast | Ankle | Ankle + knee+/hip

Group 2a
11 12
Group 2b
14 15 16 17 18
Group 2c
19 20 21

MFC III
No spast | Ankle | Ankle + knee/hip

Group 3a
22 23
Group 3b
24 25 26
Group 3c
27 28 29

Group 1b
32 6 4 5 1
7 10

Group 1a
11 15
12 16
18
14 17
21
19
20

Group 2a
Group 2b
Group 2c

Group 3a
Group 3b
Group 3c
MFC IV

- Knee extensor weakness
- Remaining pelvic elevation

Expected ambulation: Household ambulation with orthoses and walking aids. Wheelchair use both in- and outdoors

**Orthoses:** HKAFO, locked knee joint

HKAFO (3-D hip joint)  
Reciprocating gait orthosis (RGO)
MFC V

- No muscle activity in the lower limbs
- No pelvic elevation

Expected ambulation: Non-functional ambulation
- Ambulation during therapy, in school, and for limited time at home
- Wheelchair is used for mobility

Orthoses: THKAFO

Standing device  Swivel walker  Para walker
Physiotherapy

- Orthosis timing
- Standing
- Walking
- Orthosis acceptance
- Orientation in space
- Avoiding muscle imbalance
Standing and Walking

Side steps for pelvic elevation
Orthosis acceptance and Orientation in space
Avoiding muscle inbalance
Summary

- Characteristic similarities in muscle function classes
- Heterogeneity within and between groups
- Optimal gait achieved by body alignment
  - Contained hips
  - Prevention of deformities
  - Stable orthoses in frontal and transverse planes

Thanks for your attention