Effects of Electrical Stimulation, Exercise Training & Motor Skills Training on Strength for Children with Meningomyelocele:

A Systematic Review

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Supervisor - Susan Harris
Acknowledgements

Susan Harris
Supervisor and mentor

Charlotte Beck
Reference Librarian
Outline

• Introduction
• Purpose
• Methods
• Results
• Discussion
Introduction
Spina bifida

• Congenital abnormality
• Incomplete closure of the spinal column\(^1\)
• \(\sim 1/1000\) births annually\(^2\)
• 94% classified as meningomyelocele
Spina bifida

- Spina bifida occulta
- Meningocele
- Myelomeningocele
Meningomyelocele

• Results in nerve damage below level of lesion\(^1\)

• Common impairments\(^1\)
  – Muscle weakness
  – Muscle paralysis
  – Sensory impairments
  – Bowel & bladder dysfunction
Interventions

• Multidisciplinary approach to treatment is ideal

• Physical therapy plays a key role

• Interventions include
  – Muscle strengthening
  – Positioning
  – Improving postural control
  – Increasing independence & mobility
Existing Research

- Limited evidence regarding efficacy of physical therapy interventions for children with meningomyelocele

- Systematic review: Mazur JM & Kyle S, 2004
  - Inconsistent results
  - No conclusive findings
  - Further research necessary
Cerebral Palsy Research

• Current & high quality articles available

• Systematic review: Dodd KJ et al., 2002
  – 23 relevant articles
  – 11 high quality
To provide an overview of the existing research regarding the effects of electrical stimulation, exercise training and motor skills training on muscle strengthening for children with meningomyelocele.
Methods
Literature Search

• **Electronic databases**
  - Limits: English language
  - PEDro
  - CENTRAL
  - DARE
  - CIRRIE
  - Cochrane database
  - Pubmed
  - Embase
  - Cinahl
  - Medline

• **Hand Search**
  - Reference lists of selected articles
Spina Bifida
Meningomyelocele
Spinal Dysraphism

Search Terms

Functional mobility
Muscle strength
Gait / Ambulation
Physical therapy
Physical therapy modalities
Rehabilitation
Exercise
Electrical stimulation
Inclusion & Exclusion Criteria

• Inclusion
  – Participants diagnosed with meningomyelocele
  – Participants 21 years of age and under
  – Study involves physical therapy intervention

• Exclusions
  – Book chapters
  – Duplicate publications
  – Focus on surgical techniques, orthoses, bowel & bladder function, cognition or scoliosis
Inclusion & Exclusion Criteria

- Resulting 11 studies extremely heterogeneous
- Therefore...

  STRENGTH was used as an outcome measure
• **Population**: participants 21 years of age and under with a diagnosis of meningomyelocele

• **Intervention**: Electrical stimulation, exercise training & motor skills training

• **Comparison**: N/A

• **Outcome**: Strength
Studies included in Review (N = 6)

Failed to meet full text inclusion/exclusion criteria (N=9)

After Screening Full Text (N = 11)

Obtained by Hand Searching (N = 2)

Failed to meet abstract inclusion/exclusion criteria (N=120)

After Screening Abstracts (N = 18)

Failed to meet title inclusion/exclusion criteria (N=160)

After Screening Titles (N = 138)

Retrieved for Evaluation (N = 20)

Potentially Relevant Citations (N = 298)
Full Text Exclusions

- 5 did not use ‘strength’ as outcome measure
- 3 duplicates
- 2 did not have a relevant physical therapy intervention
- 1 focused on scoliosis
- 1 did not have a diagnosis of meningomyelocele
- 1 book chapter
- 1 participants did not meet age requirement
Included Studies

6 Studies

- 2 Electrical Stimulation
- 3 Exercise Training
- 1 Motor Skills Training
## AACPD DM Levels of Evidence

<table>
<thead>
<tr>
<th>Level</th>
<th>Intervention (Group) Studies</th>
</tr>
</thead>
</table>
| I     | Systematic Review of randomized controlled trials (RCT’s)  
Large RCT (with narrow confidence intervals) (n>100) |
| II    | Smaller RCT’s (with wider confidence intervals) (n<100)  
Systematic Reviews of cohort studies  
“Outcomes research” (very large ecologic studies) |
| III   | Cohort studies (must have concurrent control group)  
Systematic Reviews of Case Control Studies |
| IV    | Case series  
Cohort study without concurrent control group (e.g. with historical control group)  
Case-control Study |
| V     | Expert Opinion  
Case Study or report  
Bench research  
Expert opinion based on theory or physiologic research  
Common sense/anecdotes |

Level of Agreement = 100%
1. Was inclusion criteria well described & followed?
2. Were interventions well described & was there adherence?
3. Were measures clearly described, valid & reliable?
4. Were there blind assessments?
5. Were appropriate statistical evaluations conducted & reported?
6. Were dropouts reported and less than 20%?
7. Were appropriate methods for controlling confounding variables & limiting potential biases used?
1. Was the purpose clearly stated?
2. Was the hypothesis clearly stated?
3. Were participants described in sufficient detail?
4. Were interventions & treatment settings described in sufficient detail?
5. Were measures clearly described, valid & reliable?
6. Was the effect size clinically important?
7. Were limitations of the study identified & discussed?
## Study Quality

<table>
<thead>
<tr>
<th>Study</th>
<th>Level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AACPDM Quality Assessment</strong>&lt;sup&gt;4&lt;/sup&gt;</td>
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<tr>
<td>Karmel-Ross et al.&lt;sup&gt;6&lt;/sup&gt;</td>
<td>II</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Andrade et al.&lt;sup&gt;8&lt;/sup&gt;</td>
<td>II</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td>5</td>
</tr>
<tr>
<td><strong>Case Study Quality Assessment</strong>&lt;sup&gt;5&lt;/sup&gt;</td>
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</tr>
<tr>
<td>O’Connell &amp; Barnhart&lt;sup&gt;9&lt;/sup&gt;</td>
<td>IV</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>5</td>
</tr>
<tr>
<td>Mazliiah et al.&lt;sup&gt;7&lt;/sup&gt;</td>
<td>IV</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td>√</td>
<td>6</td>
</tr>
<tr>
<td>Rapport &amp; Bailey&lt;sup&gt;10&lt;/sup&gt;</td>
<td>V</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>5</td>
</tr>
<tr>
<td>Manella &amp; Varni&lt;sup&gt;11&lt;/sup&gt;</td>
<td>V</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td>√</td>
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<td>4</td>
</tr>
</tbody>
</table>

Strong = score of 6-7  
Moderate = score of 4-5  
Weak = score of ≤ 3  

Level of Agreement = 83%
Data Extraction & Analysis

- Standardized data extraction form
- Summary tables
- Descriptive synthesis method of data analysis
  - Evaluating participants, interventions, outcomes
  - Determine if findings can be generalized
  - Limitations investigated
Results
<table>
<thead>
<tr>
<th>Authors</th>
<th>Therapy Interventions</th>
<th>Control Intervention</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karmel-Ross et al.⁶</td>
<td>Applied to quadriceps femoris unilaterally -30 minute sessions 6x/wk for 8 wks</td>
<td>Contralateral limb</td>
<td>N=5 (2 males; 3 females) -Children with Spina Bifida; lesion at level L2-3 -5-21 years</td>
</tr>
<tr>
<td>Mazliyah et al.⁷</td>
<td>Applied to quadriceps femoris bilaterally -1-2 hour sessions daily for 6 months</td>
<td>N/A</td>
<td>N=3 - Children with lumbar MM -Knee flexion contractures &gt;15 ° -9-12 years</td>
</tr>
</tbody>
</table>
# Electrical Stimulation: Results

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome of Interest</th>
<th>Measure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karmel Ross et al.(^6)</td>
<td>Quadriceps femoris muscle strength</td>
<td>Maximum isometric voluntary knee extension torque</td>
<td>2/5 statistically significant improvement</td>
</tr>
<tr>
<td>Mazliah et al.(^7)</td>
<td>Quadriceps femoris muscle strength</td>
<td>Isometric Torque measurements</td>
<td>2/3 improved</td>
</tr>
</tbody>
</table>
# Exercise Training

<table>
<thead>
<tr>
<th>Authors</th>
<th>Therapy Intervention</th>
<th>Control Intervention</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Andrade et al.</strong>&lt;sup&gt;8&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRE TEST - POST TEST CONTROL Level II Quality 5/7</td>
<td>Aerobic and UE strengthening -1 hr/wk for 10 wks</td>
<td>Children not attending exercise program</td>
<td>N=13 (7 males; 6 females) - MM; lesion below T6 - 8-13 years</td>
</tr>
<tr>
<td><strong>O’Connell &amp; Barnhart</strong>&lt;sup&gt;9&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ONE GROUP PRE TEST – POST TEST Level IV Quality 5/7</td>
<td>UE strengthening -30 min 3x/wk for 9 wks</td>
<td>N/A</td>
<td>N=6 - MM (N=3); lesion below T8 - Children diagnosed with CP (N=3) - 4-16 years</td>
</tr>
<tr>
<td><strong>Rapport &amp; Bailey</strong>&lt;sup&gt;10&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SINGLE SUBJECT Level V Quality 5/7</td>
<td>Fine/gross motor -Clinic: 90 min 1x/wk for 6 wks -Home: 30 min/day 5x/wk for 56 wks</td>
<td>N/A</td>
<td>N=1 (male) - Child with MM - 8.5 years</td>
</tr>
</tbody>
</table>
## Exercise Training: Results

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome of Interest</th>
<th>Measure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andrade et al.⁸</td>
<td>Strength</td>
<td>Isometric tests using hand held dynamometer</td>
<td>Ss (p&lt;0.01)</td>
</tr>
<tr>
<td>O’Connell &amp; Barnhart⁹</td>
<td>Wheelchair propulsion</td>
<td>6 repetition maximum</td>
<td>Ss (p= .018-.031)</td>
</tr>
<tr>
<td>Rapport &amp; Bailey¹⁰</td>
<td>UE fine motor</td>
<td>OSCO Pinchmeter</td>
<td>All Improved</td>
</tr>
<tr>
<td></td>
<td>UE gross motor</td>
<td>Dynamometer grip strength</td>
<td>All Improved</td>
</tr>
</tbody>
</table>
## Motor Skills Training

<table>
<thead>
<tr>
<th>Authors</th>
<th>Therapy Intervention</th>
<th>Control Intervention</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manella &amp; Varni¹¹</td>
<td>Functional activities &amp; behavioural therapy</td>
<td>N/A</td>
<td>N=1 (female)</td>
</tr>
<tr>
<td></td>
<td>-Clinic: 30 min 4 wks</td>
<td></td>
<td>-Child with MM @ L3</td>
</tr>
<tr>
<td></td>
<td>-Home: 30 min daily</td>
<td></td>
<td>- 5 years</td>
</tr>
<tr>
<td></td>
<td>-Follow up: 1x/month for 5 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SINGLE SUBJECT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level V Quality 4/7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V Quality 4/7</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

N/A = Not Available

MM = Motor Skills

Clinic: 30 min 4 wks
Home: 30 min daily
Follow up: 1x/month for 5 months
Motor Skills Training: Results

<table>
<thead>
<tr>
<th>Study</th>
<th>Outcome of Interest</th>
<th>Measure</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manella &amp; Varni\textsuperscript{11}</td>
<td>Independence in motor skills</td>
<td>Quadriceps manual muscle test</td>
<td>Improved grade 3 to grade 4 bilaterally</td>
</tr>
</tbody>
</table>
Discussion
This systematic review concludes there is a positive trend towards increasing muscle strength using electrical stimulation, exercise training and motor skills training for children with meningomyelocele.
# Electrical Stimulation

<table>
<thead>
<tr>
<th>Karmel-Ross et al.(^6)</th>
<th>Mazliah et al.(^7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Level II</td>
<td>• Level IV</td>
</tr>
<tr>
<td>• Functional activities during e-stim</td>
<td>• Longer e-stim application &amp; study duration</td>
</tr>
<tr>
<td>• Improvements in gait</td>
<td>• Sedentary during e-stim</td>
</tr>
<tr>
<td>• Health &amp; instructional issues</td>
<td>• No improvements in gait</td>
</tr>
<tr>
<td></td>
<td>• Possible low adherence or ineffective application</td>
</tr>
<tr>
<td>Andrade et al.\textsuperscript{8}</td>
<td>O’Connell &amp; Barnhart\textsuperscript{9}</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>• Level II</td>
<td>• Level IV</td>
</tr>
<tr>
<td>• 10 week program</td>
<td>• 9 week program</td>
</tr>
<tr>
<td>• Resistance training</td>
<td>• Resistance training</td>
</tr>
</tbody>
</table>
Motor Skills Training

Manella & Varni\textsuperscript{12}

- Task specific training
- Behavioral therapy
Limitations

- Limited search to English
- Limited search to published articles
- Did not extensively search grey literature
- Descriptive synthesis vs. meta-analysis
- Small sample sizes
- Dated studies
- Lack of literature and low levels of evidence
Strengths of Review

- Investigations of LE & UE
- Relating strength gains to function
- Extensive literature search
- Monthly updates
- 5 reviewers to limit bias
- High inter-rater reliability
- Spina bifida expert
Future Research

- Effects of electrical stimulation on ambulation ability$^6$ & knee flexion contractures$^7$

- Effects of compliance, motivation, education & parental involvement

- Optimal treatment protocols & duration
Conclusion

Although this review supports aspects of physical therapy interventions, the literature is out of date and scarce.

In order to ensure physical therapy is delivered in an effective and efficient manner, further research is necessary.
References


Picture References

- http://www.mulhollandinc.com/images/WAJake.JPG
- http://www.rsc-sw-scotland.ac.uk/project_pages/Hospitality_Sport_Leisure_Tourism/anatomy/images/pic005.gif
- http://www.anglofritz.com/weakness_large.jpg
- http://www.glassstairs.com/images/GlassStairsGold01.jpg
- http://www.bilicki.us/images/083005.gif
- http://lafetabridgeclub.tripod.com/sitebuildercontent/sitebuilderpictures/abc_blocks_small.jpg
- http://webserver.mcl.org/images/computer.gif
- http://www.specialkidsfund.org/images/mainpic.jpg
- http://www.enter.net/~forester/images/jennstand.gif
- http://content.ennwslettersonline.com/11213/017049.jpg
Thank you