INCORPORATING RESISTANCE TRAINING INTO EPISODIC CARE IMPROVES FUNCTION AND PARTICIPATION IN YOUTH WITH CEREBRAL PALSY

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We have no conflicts of interest or relevant financial interests to report.

We will not discuss off label/investigational drug use.

Objectives

- Understand the impact of muscular strength on function and participation in youth with CP
- Complete a clinical assessment to select ideal training parameters to achieve a patient’s specific goals
- Design a resistance and functional skill training program using appropriate dosing and outcomes assessment to address individualized goals
- Develop a plan to initiate a resistance training program for youth with cerebral palsy at their institution
CEREBRAL PALSY

IMPAIRMENTS
- Selective motor control
- Postural Control
- ROM
- Spasticity/Tone
- Endurance
- Strength

FUNCTIONAL LIMITATIONS
- Sitting
- Transitional movements
- Walking
- Stair negotiation
- Higher level gross motor tasks

PARTICIPATION RESTRICTIONS
- Environmental access
- Peer related activities
- Sports/Recreational Activities
- Family Routines

PERSONAL FACTORS
- Cognitive, academic, communication impairments
- Social stigma
- Psychological comorbidity
- Equipment/Brace use

ENVIRONMENTAL FACTORS
- Service availability
- Community accessibility

Strength significantly impacts gross motor capability in young children with CP.

Muscular weakness occurs early in development in children with CP.

- Strength and balance/postural control are the impairments that carry the most impact in young children with CP.
- Secondary impairments that impact function and participation already occur as young as 1.5-5 years.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Impairments</td>
<td></td>
</tr>
<tr>
<td>Tone (Ashworth)</td>
<td>0.68</td>
</tr>
<tr>
<td>Coordination (GMPM)</td>
<td>0.77</td>
</tr>
<tr>
<td>Balance/Postural Control (BAPC)</td>
<td>0.95</td>
</tr>
<tr>
<td>Strength (FST)</td>
<td>0.95</td>
</tr>
<tr>
<td>Secondary Impairments</td>
<td></td>
</tr>
<tr>
<td>Spasticity (GASP)</td>
<td>0.68</td>
</tr>
<tr>
<td>Range of Motion (SAROMM)</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Secondary Impairments: Spasticity

Strength impacts function in school-aged and adolescents with CP.

- Measures of strength are more related to performance on measures of gross motor performance and gait measures.
Strength is associated with participation across the life span

- Several measures of participation are significantly associated with measures of strength
- These relationships are more common and stronger than relationships to spasticity

Moreau 2010, Ross 2007, Ohata 2008

Ambulatory children with CP exhibit upwards of 50% strength deficit in key muscle for ambulation.

- Hamstrings, dorsiflexors, plantar flexors and hip abductors are the most impacted
- <50% age expected strength = walking with assistance


It isn’t all about how much you bench, bro.

- Rate of force development is diminished by upwards of 70% in children with CP compared to those with typical development
- Power generation is related to function and participation as is maximal strength

Moreau 2012, Nooijen 2014, Yancy 2016
Muscle structure in Children with CP is altered

- Decreased: Muscle fascicle length
- Decreased: Speed of contraction
- Decreased: Muscle volume
- Decreased: Muscle belly length
- Decreased: Myofiber number

Diminished physiological cross sectional area

Reduced Force Production Capability

ACTIVITY LIMITATION AND PARTICIPATION RESTRICTION

Barrett 2010, Gao 2011, Moreau 2013

Reduced Force Production Capability

Do you even lift?


Conflict of Evidence

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- Velocity dependent (AKA POWER) training positively alters function in children with CP, whereas maximal strength training did not
- Individual case reports have demonstrated functional improvements with other strength training focuses, but they were targeted at a specific function

<table>
<thead>
<tr>
<th>Training</th>
<th>Pre</th>
<th>Post</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre 1</td>
<td>150</td>
<td>160</td>
<td>6.7%</td>
</tr>
<tr>
<td>Pre 2</td>
<td>140</td>
<td>150</td>
<td>7.1%</td>
</tr>
<tr>
<td>Pre 3</td>
<td>130</td>
<td>140</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

Morrow 2013, Hedgecock 2015, Kenyon 2010, vanVulpen 2017
Safety Concerns

Patient Selection
- 3 years of age
- Able to follow your instructions
- Volitional control of the selected joint

Precautions
- Communication impairment
- Heat sensitivity
- Cardiac precautions
- Recent, minor musculoskeletal injury
- Joint contracture or skeletal malformation
- Sensory impairment

Contra-indications
- Recent orthopedic surgery
- Unable to follow directions or complete action safely
- <3 years of age
- Unhealed wound around moving joint

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Weight lifting, under supervision of a trained professional, has been found safe over, and over, and over again in children as young as 3 years. (Lloyd 2011, Faigenbaum 1998, Bauer 1999, Sheppard 2015)

What do we do?

Exercise Selection
- Mimics Targeted Function?
- Complete with minimal assist
- Single vs. Multi-Joint
- Repeatable
- Adaptable

Prescription - 1 Repetition Maximum Testing

Select weight for movement
Guess a weight that you think a child can successfully complete <5 times - 1-5 repetitions. (http://www.exrx.net/Calculators/OneRepMax.html)

Adjust Weight
Child completed <5 repetitions of previous weight then increase weight
Child unable to complete a successful attempt then decrease weight

Continue Adjusting Weight
Child completes <5 repetitions, estimate 1RM
Child unable to complete repetition >5 repetitions, then adjust

Sheppard 2015, Faigenbaum 2012
Training Goal | Load (1RM) | Goal | Repetitions | Sets | Rest Period
--- | --- | --- | --- | --- | ---
**Strength** | >85% | 25 | 2-6 | 2-5 min | 5 min
**Power** | 75-90% | 1-5 | 3-5 | 2-5 min | 5 min
**Hypertrophy** | 60-75% | 6-12 | 3-5 | 10 sec-1.5 min | 5 min

*Work within above 1RM guides or 7-9/10 RPE (last reps of last 2-3 sets should be very hard to do)*

*Advance weight 5-10% percent when efforts become easier*


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**ADAPT**

- **Sheppard** – 80% 1RM at 50 degrees/second movement, 6 sets, 5 reps, 15 session over 8-10 weeks (2-3 sessions/week); Quadriceps only
- **Verschuren** – Suggested 1-3 sets, 6-12 reps; 2-3x/week, 12 weeks, increased rest periods (follows NSCA novice lifting guidelines); Noted most studies are not intense enough
- **Van Vulpen** – 50-70% 1RM; Functionally based intervals (25” on, 30-60” rest) x 6 reps, 10% load increase to progress, 4 exercises, 3x/week, 16 weeks; Plantar flexor focused
- **Damiano** – Unknown intensity, 30 repetitions (3 sets, 8-12 reps), 3x/week, 8 weeks

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**Other Considerations**

- Guarding/Spotting
- Assistance?
- Verbal Cuing
- Concentric and Eccentric Control
- Encouragement
- Rest Periods

Sheppard 2015
Our Hospital: CHCO

New Ideas:
CSM 2013 pre-con
Linking Structure to Function:
Muscle, Bone, Brain

Therapeutic threshold
Training specificity:
brain, bone, muscle

WEAKNESS
POWER

Motivation
Change emphasis

Intensive Programs at CHCO:

History

Big Ideas
Establish Program
Evaluate Educate Expand
Core concepts of RTI:
No recipe book for program design

Individualized
Family, Goals and treatment

Dosing
What impairment needs improvement?

Focus and Breaks

Model:
- Brief episodes of intense intervention
- Periodic follow-up

Patients:
- Neuro impairment
- Safe
- Motivated

Muscle Groups:
- Typical - Gastrosoleus, glutes maximus, medius, quadriceps, hip flexor, dorsiflexion

Time Frame:
- 8-12 weeks, 2-3 sessions per week

Dosing:
- Typically - power training
- Occasionally - strength training
- Always - functional skill practice

Outcomes:
- consistent
- individual outcome added as needed

References:
Individualization & Assessment: How do we do it?

RTI in Action!

Functional Activities

Left is her more involved leg!
Post-Intervention

Re-assess the child/family goals
Re-assess the outcome measures

What’s next?
Patient and family are the drivers

Resistance Training:
It’s working

Resistance Training:
It’s working

Gross Motor Function Measure - 88

Patient Specific Functional Scale

*Change greater than MDC

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What has changed?

RTI Program Evaluation

Areas of Growth
- GROUPS
- Participation outcome measures
- Equipment
- Increase referrals
- Nutrition

Take Home
- Weakness
- Specificity of training
- FOCUS
- Be surprised
- Don’t water down your intervention!
- Don’t strive for perfection, but for PROGRESSION!
Case Discussions and Troubleshooting: 20 minutes

- Review case examples. (10 minutes)
  - Get in small groups (2-4 people)
  - Review 1-2 case presentations, patient goals, initial outcome assessment and intervention choices
  - Discuss why you may agree or disagree with the prescription, what might you have done differently?
  - Jim and Nicole will be available for questions
- We will re-group to discuss next steps/barriers to implementation of an RTI at your site (10 minutes)
- General questions
- Contact Us:
  - Nicole.Harris@childrenscolorado.org
  - James.Hedgecock@childrenscolorado.org

Next Steps | Needs | Barriers
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Next Steps

Needs

Barriers
References


