Spasticity Management: Upper Extremity
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Introduction

Spasticity Results in

• Abnormal Tone
• Abnormal Bone Growth
• Muscle Contractures
• Poor Motor Control
Introduction

• Spasticity results in significant impairment in upper extremity function in children with cerebral palsy

• Other problems include:
  • Movement disorders (athetosis, dystonia, ataxia)
  • Poor motor control
  • Poor sensory integration
  • Poor coordination
Complexities of Upper Extremity Function

- Multiplanar joints such as the shoulder, elbow and wrist
- Multiple small muscles with varying index of architecture and moment potential
- Need for fine motor pattern integration
- Need for coordinated sensory input and integration
Evaluation Techniques

- Functional Assessments
- Range of Motion
- Spasticity Assessment
  - Tardieu
  - Ashworth
- Sensory Evaluation: light touch, pressure, proprioception, stereognosis
Motion Analysis

Functional testing with

- Video documentation
- Functional tasks
- Electromyography
Management Options

- Oral Medications
- Physical Therapy*
- Orthotics
- Botulinum Toxin*
- Rhizotomy
- Intrathecal Baclofen*
- Orthopedic Surgery*
Botulinum Toxin

• Option to hold off child for surgery

• Upper Extremity Management
Intrathecal Baclofen

- Decreases need for orthopedic surgery
- Initiate prior to orthopedic procedures

Orthopedic Surgery-Muscle

- Release Muscle
- Lengthen Muscle-Tendon unit
- Transfer muscle
  - Unpredictable, even with EMG data

Orthopedic Surgery-Muscle

Decrease Tone (by lengthening muscle?)

By altering the tension in the intrafusal muscle spindle, the stimulus for further contraction is diminished, which should lead to less spasticity
Orthopedic Surgery-Bone

Correct Lever-Arm Dysfunction

- Occur 2° to abnormal muscle tone, contractures, bony malalignment
- Osteotomies/bony realignment
- Predictable

First day of orthopedic residency
Materials and Methods

47 children with Cerebral Palsy

- Most of children had mixed motor impairments
- Follow-up: 2.3 years (1.8-4.5)

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Age (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemiplegia</td>
<td>28</td>
<td>7.4 (4-15)</td>
</tr>
<tr>
<td>Quadriplegia</td>
<td>16</td>
<td>10.5 (3-22)</td>
</tr>
<tr>
<td>Diplegia</td>
<td>3</td>
<td>5 (3,5,7)</td>
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</table>
Problems Encountered

• Elbow flexion
• Forearm pronation
• Wrist flexion
• Finger flexion
• Thumb-in-palm
• Shoulder adduction
Functional Level

• Most of the children with hemiplegia and diplegia were seeking functional and/or cosmetic improvement.

• Most of the children with quadriplegia had the treatment for hygienic reasons.
Botulinum Toxin A

- BOTOX was injected into each muscle by palpating the muscle. In deep muscles or those in which there is difficulty palpating, electrical stimulation was used.
- 1 cc injection into each muscle except:
  - Biceps - 2cc
  - 1st dorsal interosseous, adductor pollicis and interossei - 0.5 cc
- Dose of 25-40 U/cc. Based on 12U/kg max
# Muscles injected

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Hemiplegia</th>
<th>Diplegia</th>
<th>Quadriplegia</th>
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<tbody>
<tr>
<td>Pectoralis</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Biceps</td>
<td>28</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>Brachioradialis</td>
<td>2</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>FCU</td>
<td>28</td>
<td>3</td>
<td>16</td>
</tr>
<tr>
<td>FCR</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pron Teres</td>
<td>28</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>FDS</td>
<td>25</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>FDP</td>
<td>25</td>
<td>3</td>
<td>15</td>
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</tbody>
</table>
Muscles injected for thumb-in-palm

<table>
<thead>
<tr>
<th>Muscle</th>
<th>hemiplegia</th>
<th>diplegia</th>
<th>quadriplegia</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPL</td>
<td>12</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>1st Dor inter</td>
<td>15</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Add Pollicis</td>
<td>15</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Interossei</td>
<td>2</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>
Results

• Based on improvements in patient satisfaction, House ratings, improved function and/or cosmesis

• In the quadriplegic patients result based on caregiver reports of improved hygiene or activities of daily living such as dressing.
Results

Hemiplegia

• Elbow flexion
  • 26/28 had good results
  • BOTOX reinjections in all from 4-6 months

• Forearm Pronation
  • 12/28 had good results
  • 4 have had pronator release surgery

• Wrist Flexion
  • 25/28 had good results
  • BOTOX reinjections in all from 4-6 months
Results

Hemiplegia

- **Finger Flexion**
  - 24/28 had good results
  - Continued BOTOX

- **Thumb-in-palm**
  - 20/28 had good results
  - 4 required surgery and 4 others are considered for surgery
Results

Quadriplegia

• Elbow flexion
  • 5/16 had good results but parents were happy with results in 10/16
  • 6 have had surgery

• Wrist flexion
  • 10/16 had good results
  • 6 have had surgery
Results

Quadriplegia

- Finger flexion
  - 8/16 improved
  - 6 had surgery

- Thumb-in-palm
  - 8/16 improved
  - 6 had surgery
Discussion and Conclusions

- Descriptive study of small cohort
- Longer term follow-up will be necessary to see if there is any effect on function or need for surgery
- Patients with movement abnormalities such as athetosis benefit from BOTOX injections
- Must be given in conjunction with splinting and occupational therapy
- Starting younger may have benefit.
Upper Extremity Surgery

Quadriplegia

• Goal is to improve hygiene and positioning of hand in space
  • Wrist Fusion
  • Transfers to improve hand position
  • Biceps, brachioradialis lengthening
  • Thumb transfers
Upper Extremity Surgery

Hemi → Tendon transfers to improve function

- Improve position of hand
- Increase grasp strength
  - FCU/FCR → ECRB (wrist extension)
  - FDS fractional lengthening (finger extension)
  - biceps/brachioradialis lengthening
  - pronator teres lengthening or transfer to supinator
  - transfers about thumb (brachioradialis to APL)
Upper Extremity Surgery

Hemiplegia

• Criteria for surgery
  • Ability to position hand in space voluntarily
  • Lack of athetosis
  • Cognitive ability in trainable range

• If criteria are met, 15/17 patients showed improvement and would do surgery again

Upper Extremity Surgery

Flexor Release

FDP, FDS and intrinsics fractional lengthening improved functional scores in 26/31 patients

Matsuo, T MD et al. CORR 384:162-168, 2001
Upper Extremity Surgery

Thumb In Palm Deformity Release

Shows functional improvement in all patients to some extent

Upper Extremity Surgery

Anterior Elbow Release

• Improves posture of resting elbow
• Improves function
• No difference in improvement based on severity of involvement of child