Cerebral Palsy in the Hand & Upper Extremity

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The Natural History of the CP Hand

• Most with independent hand use (55%)
• Some with real impairments (30%)
• ≈15% with no hand function

Lawson & Badawi, 2003

What can a hand surgeon do for affected children?

• Improve function
  – ADL’s
• Aid caregivers
  – Hygiene and care
• Improve cosmesis
  – i.e., an independent, teenager with a hyperflexed wrist

We are going to review…

- Evaluation of the hand in CP
  - History & examination pearls
  - Tests and studies to aid in the assessment
- Initiating treatment for the hand in CP
  - Evidence-based non-operative treatment
- The role of surgery for the hand in CP
  - Who, when and what

Evaluating Children with CP

**History Pearls**

- How is the arm/hand currently used?
  - Is there upper extremity neglect?
  - What is the level of functioning?
- Are hopes & expectations realistic?
- Will the child complete treatment?
  - Support & resources
  - Motivation
    - Child, parents and/or caretakers
    - Cognitive level
    - Age-appropriate education level?

Evaluating Children with CP

**Examination Pearls**

- Systems to evaluate
  - Skin
  - Musculoskeletal
  - Neurological
  - Psych

Waters & Van Heest, 1998
Evaluating Children with CP

**Neurological Exam Pearls**

- **Motor**
  - Movement is absent
  - CNS paralysis vs. control?
  - Movement is present
    - Synkinesis (57%)
    - Mirroring (40%)
    - Co-contraction

- **Sensation**
  - Peripheral sensation impaired in > 40%
  - Central sensation
    - Stereognosis (36%)
    - Graphesthesia (47%)
    - Proprioception (19%)

*Waters & Van Heest, 1998; Kazin & Zlotolow*

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Evaluating Children with CP with adjunctive studies - *What ifs?*

- Particularly useful in evaluating the ‘functional’ hand
- What if the spastic muscles weren’t?
  - **Local anesthetic blockade**
    - Into the biceps m. to assess elbow flexor spasticity
    - Median n. & ulnar n.
      - At the wrist to assess intrinsic spasticity
      - At the elbow to assess extrinsic flexor spasticity
  - **Botulinum toxin A**
    - Blocks muscles instead of nerves
    - More precise and longer acting than motor block
    - Helpful to coordinate with physiotherapy

*Pierson, 1996; Van Heest 2003; Weigl, et al, 2007*

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Evaluating Children with CP

**Drawing Conclusions**

- Does the objective picture match the current level of function?
- Are the goals reasonable and achievable?
- Arriving at a final assessment requires effort
  - Multiple visits and examinations
  - Video is an excellent tool to evaluate the child in their ‘normal’ environment

Treating affected children with CP

**Physiotherapy – the latest**

- Functional training
  - Teach bimanual activities
  - Task-specific goals
  - Application of adaptive devices
  - Better than ‘traditional’ therapy
- Constraint therapy
  - Hemiplegia
  - ‘Dosage’ matters


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**Clostridium Botulinum A – the latest**

- Series of patient oriented injections improve function regardless of OT regimen
- Combination of injection and functional therapy
  - Botulinum improves mobility
  - Functional therapy improves strength
- Requires continued treatment


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**Surgery in the treatment of CP**

- A reduction in impairment will *improve function*
  - Increasing range of motion is not enough
- Improved posturing will *ease the care of the limb*
  - Or, improve skin hygiene
- When it will *improve the child’s self-image*
- Surgical treatment, when indicated, is superior to botulinum and therapy!!
  - It has the added value of being permanent

### Improving Function with Surgery

**Principle**
- Create joint 'balance'
  - Active ROM > strength
- Eliminating spasticity is not the goal
  - Task completion not associated with muscle tone

**Method**
1. Weaken the strong side
   - Lengthen spastic muscles
   - Titrate to need
2. Strengthen the weak side
   - Tendon transfer
3. Stabilize unstable joints

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### Improving Function with Surgery

**Part 2**

- The upper arm is the **crane**
  - Shoulder
  - Elbow
- The hand is the **tool**
  - Forearm rotates
  - Wrist adjusts
  - Fingers grab
  - Thumb pinches

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### Treating affected children with CP

**Weakening the strong side**

- Lengthen spastic muscles
  - Mild-moderate length
    - Fractional lengthening
      - 1 – 3cm lengthening
      - Best for mobile joints
      - Active, weak antagonists
      - Easy to rehabilitate
    - Release the muscle’s origination point
      - ‘Slide’
  - Moderate to large length
    - Z-lengthen
    - ‘Slide’

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Tendon transfer data

Treating affected children with CP
*Weakening the strong side - Flexor Pronator ‘Slide’*

Case Example
*Elbow flexion, Wrist flexion, Fist*
Treating affected children with CP
Strengthening the weak side

• If antagonist muscle is working...
  – Weakening/lengthening the spastic muscles may be enough
  – Tendon transfer
    • Avoid using a ‘spastic’ donor
    • Donor muscle does not change ‘phase’ in CP
      – Synergistic transfers become important

Patterson, et al., 2010; Van Heest, et al., 2010

Treating affected children with CP
Strengthening the weak side

• Forearm Pronation contracture
  – Weaken spastic side
    • Pronator teres (PT) release
  – Strengthen weak side
    • If supinator active...
      – Surgery complete
    • If supinator inactive...
      – PT rerouting transfer

• Results
  – Supination 65° actively
  – Static posturing to near neutral


Case Example: Hemiplegia

• Teenage male with left sided hemiplegia
  – Pronation spasticity
  – Thumb-in-palm deformity

Children's Healthcare of Atlanta
Severe contractures in CP

• The severely affected child
• Deformities exceed limitations of ‘functional techniques’
  – Cannot lengthen enough
  – Tendon transfers contraindicated
• Requires different tools
  – Surgery is permanent, so treatment goals must be clear

Severe contractures in CP

Elbow Flexion

• Extensive lengthenings
  – Consider complete myotomy
  – Account for skin contracture
• Musculocutaneous neurectomy
  – In absence of severe myostatic contracture


Severe contractures in CP

Wrist flexion

• Indications
  – Cosmesis!!!
  • Pre-teens and teens
  • Skin problems

• Arthrodesis
  – Proximal row carpectomy
  • Helps avoid need for simultaneous release of extrinsic finger flexors
  – Avoid physis (remove plate later)
• Can be combined with other procedures addressing fingers

Hoffer & Zeitzew, 1988; Rayan & Young 1999; Van Heest & Strothman, 2009
Severe contractures in CP

*Intrinsic Spasticity*

- May be hidden within extrinsic contractures
- There are too many muscles to treat
- Motor neurectomy
  - Ulnar motor branch
  - Median motor branch


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**Case Example: Hemiplegia**

- Young adult with hemiplegia
  - Wrist extension spasticity
  - Intrinsic spasticity
- Treatment
  - Wrist extension spasticity
    - ‘Slide’
  - Intrinsic spasticity
    - Neurectomies

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**Thank You**