Cerebral Palsy: Surgical Treatment of the Upper Extremity

AACPD Annual Meeting ICL 2015
ANN E. VAN HEEST, MD
UNIVERSITY OF MINNESOTA
GILLETTE CHILDREN’S HOSPITAL
SHRINER’S HOSPITAL-TWIN CITIES

OBJECTIVES

• ETIOLOGY
• PATIENT EVALUATION
• TREATMENT OPTIONS

“Primary Problems” of C.P.:

• Problems with equilibrium
• Loss of selective motor control
• Abnormal tone /spasticity
• “Weakness”
• Impaired sensation

The “Primary Problems”

• Generally, not remediable

The “Secondary Problems”

• JOINT MALPOSITIONING
• MUSCLE IMBALANCE
• FUNCTIONAL IMPAIRMENT

The “Secondary Problems”

• Generally, remediable by a variety of methods
  • therapy, splints, medications, surgery

“Tertiary Problems”

• Skeletal Deformity
• Joint Contracture
• Muscle Contracture

“Tertiary Problems” of C.P.

• Prevention by early intervention
• Operative salvage procedures
MOTOR HOMUNCULUS

- CP
- CVA
- TBI

The Cerebral Cortex of Man, Penfield & Rasmussen 1950

C. P. MANIFESTATIONS

- SHOULDER INTERNALLY ROTATED
- ELBOW FLEXED
- FOREARM PRONATED
- WRIST FLEXED
- THUMB-IN-PALM

PATIENT EVALUATION

- PROM
  - Joint contracture, muscle contracture

PATIENT EVALUATION

- PROM
  - Joint contracture, muscle contracture
- AROM
  - Patterns of muscle activity

MUSCLE MOVEMENT ASSESSMENT

- SPASTIC
- FLACCID
- ATHETOID

C.P. Disease Specific ASSESSMENT TOOLS

- House Upper Extremity Use (JBJS 1981)
- Manual Skills Assessment Classification (Dev Med Child Neurol 2006)
- Shriner’s Hospital Upper Extremity Evaluation (Davids JBJS 2005)
- Video Analysis (Waters J Hand Surg 2004, Carlson J Hand Surg)
- Melbourne Analysis of Unilateral Limb (Dev Med Child Neurol 2001)
- Motion Lab Analysis (VanHeest Hand Clinics 2003)
- Assistive Hand Assessment (Krumlinde-Sundholm, Develop Med & Child Neuro 2007)

VIDEO TAPE ANALYSIS OF ADL’S

- OBSERVE ARM POSITIONING IN SPACE
- Carlson et al JHandSurg 2007
- Pre-surgical plan
- Video analysis
- 72% changed surgical plan after video review
Use of Motion Lab to assess muscle spasticity vs phasic control

“TOOLS OF THE TRADE”

- Soft-tissue Releases
- Tendon Transfers
- Bone/Joint Stabilization

Common CP Deformities

- ELBOW: Flexion
- FOREARM: Pronation
- WRIST: Flexion-Ulnar deviation
- THUMB: In-the-Palm
- FINGERS: Swan-neck
  Flexor tightness

ELBOW FLEXION DEFORMITY

Soft-tissue Releases  Biceps lengthening
  Brachialis lengthening

Biceps and Brachialis Lengthening

PRONATION DEFORMITY

Soft-tissue Releases  Pronator Teres release
Tendon Transfers  Pronator Teres re-routing
**Pronator teres release**

**WRIST FLEXION DEFORMITY**

<table>
<thead>
<tr>
<th>Soft-tissue Releases</th>
<th>Tendon Transfers</th>
<th>Joint Stabilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCR lengthening</td>
<td>ECU to ECRB/L</td>
<td>Wrist fusion with PRC</td>
</tr>
<tr>
<td>FCU lengthening</td>
<td>FCU to ECRB/L (Green transfer)</td>
<td>PRC</td>
</tr>
<tr>
<td>Flexor pronator slide</td>
<td>BR to ECRB/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contraindicated: FCR to ECRB/L P. Teres to ECRL</td>
<td></td>
</tr>
</tbody>
</table>

**FCU to ECRB transfer (Green transfer)**

Green and Banks, JBJS. 44A, 1962

- Incision
- FCU exposure

**Wrist flexion deformity**
Mobilize to allow for muscle excursion

Neutral position at rest

Post-operative Result: FCU to ECRB

Wrist Flexion Deformity

- Soft-tissue Releases
  - FCR lengthening
  - FCU lengthening
  - Flexor pronator slide

- Tendon Transfers
  - ECU to ECRB/L
  - FCU to ECRB/L (Green transfer)
  - BR to ECRB/L
  - Contraindicated: FCR to ECRB/L
  - P. Teres to ECRL

- Joint Stabilization
  - Wrist fusion with PRC
  - PRC

Indications for Wrist Fusion

- Union
  - 41/42 wrists united
- Wrist Position
  - Preop: Max passive ext 28 deg of flexion
  - Postop: 5 deg of extension
  - Mean change: 40 deg
- Finger deformities
  - Swan Neck: 3 hands
  - Thumb in palm: 7 hands
  - Finger flexor tightness: 21 hands

The Supination Effect of Tendon Transfer of the Flexor Carpi Ulnaris to the Extensor Carpi Radialis Brevis or Longus: A Cadaveric Study

Ann E. Van Heest, M.D.

WRIST FLEXION DEFORMITY

- Union
- 41/42 wrists united
- Wrist Position
  - Preop: Max passive ext 28 deg of flexion
  - Postop: 5 deg of extension
  - Mean change: 40 deg
- Finger deformities
  - Swan Neck: 3 hands
  - Thumb in palm: 7 hands
  - Finger flexor tightness: 21 hands

Indications for Wrist Fusion

- Severe joint contracture
- Poor Hygiene
- Difficulty with daily care activities
- Cosmesis
- Poor function
- Poor sensibility
- Poor volitional control
### Demographics
- 24 males, 11 females
- Average age at surgery: 21 years (14-50)
- Average follow-up 13 months (1-70)
- CP: 21 triplegia, 14 quadriplegia
- CP: 33 spastic, 2 mixed tone
- Pre-op functional use: House scale 0.5 (range 0-2)

### Subjective Visual Analog Scale
![Table 3: Visual Analog Scale Results]

### Complications
- Complication Rate 5 wrists (12%)
- Fractures: 4 wrists (10%)
  - 3 pts fractured at proximal screw holes
  - 1 pt fractured at distal screw hole
- Nonunion: 1 wrist

### Soft-tissue Releases
- FCR lengthening
- FCU lengthening
- Flexor pronator slide

### Tendon Transfers
- ECU to ECRB/L
- FCU to ECRB/L (Green transfer)
- BR to ECRB/L
- Contraindicated: FCR to ECRB/L
- P. Teres to ECRL

### Joint Stabilization
- NO DIGITAL CONTROL
  - Wrist fusion with PRC
  - PRC

### Summary: WRIST FLEXION DEFORMITY

#### Soft-tissue Releases
- FCR lengthening
- FCU lengthening
- Flexor pronator slide

#### Tendon Transfers
- ECU to ECRB/L
- FCU to ECRB/L (Green transfer)
- BR to ECRB/L
- Contraindicated: FCR to ECRB/L
  - P. Teres to ECRL

#### Joint Stabilization
- NO DIGITAL CONTROL
  - Wrist fusion with PRC
  - PRC

### THUMB IN PALM DEFORMITY

#### Soft-tissue Releases

#### Tendon Transfers

#### Bone/Joint Stabilization

### DJD and Carpal Tunnel Syndrome

### 91% fusion, improved wrist position

### STEP 1: RELEASE OF CONTRACTURES

![Step 1: Release of Contractures]
ADDUCTOR RELEASE


EPL Re-routing to 1st Dorsal Compartment

Manske, Hand Clinics, 1990

Thumb as ADductor

Thumb as ABductor

SKELETAL JOINT STABILIZATION

• MCP Fusion
• MCP Joint Capsulodesis

SURGICAL OUTCOMES

• House, J. Van Heest, A. Cariello, C.
  Surgical Treatment of the Upper Extremity in Cerebral Palsy J. Hand Surgery 24A, 323-330, 1999
• 134 Patients: age 4-37 (Ave=14 years)
  Male=79 : Female=55
• 180 Operations with 718 Procedures
• 4 Procedures/operation

OUTCOME: Functional Use Scores

<table>
<thead>
<tr>
<th>Level</th>
<th>JBJS 63A:216-225, 1981</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Does not use</td>
</tr>
<tr>
<td>1</td>
<td>Poor passive assist</td>
</tr>
<tr>
<td>2</td>
<td>Fair passive assist</td>
</tr>
<tr>
<td>3</td>
<td>Good passive assist</td>
</tr>
<tr>
<td>4</td>
<td>Poor active assist</td>
</tr>
<tr>
<td>5</td>
<td>Fair active assist</td>
</tr>
<tr>
<td>6</td>
<td>Good active assist</td>
</tr>
<tr>
<td>7</td>
<td>Partial spontaneous use</td>
</tr>
<tr>
<td>8</td>
<td>Spontaneous use</td>
</tr>
</tbody>
</table>

Pre-operative Average 2.3
Post-operative Average 5.0
Improvement Average 2.6

OUTCOME: Predictive Factors

- Functional Activity Level
  - CP Type \( p = 0.09 \)
  - Intelligence \( p = 0.40 \)
  - Stereognosis \( p = 0.51 \)
  - Two-point discrimination \( p = 0.49 \)
  - Voluntary Control \( p = 0.039 \)
Hypothesis

For children with upper extremity cerebral palsy who meet standard clinical indications for tendon transfer, those who receive surgical treatment would have greater improvement in function than either children receiving botulinum toxin injections, or children receiving regular ongoing treatment, as measured by validated appropriate assessment tools.

Materials and Methods

• Surgery (P. teres release, FCU to ECRB tendon transfer, thumb adductor release, EPL re-routing)
• Botulinum toxin injections (10u/kg max, P. teres, FCU, thumb adductor, 3 injections)
• Regular Ongoing Therapy (standardized protocol)
• Comparison at Pre- vs 12 months Post of 3 treatment groups (ANOVA, p<0.05)

CONCLUSION: Those children receiving surgical treatment showed significantly greater improvement

WHO Definition of Disability

• Bodily Impairment
  – Grip, Pinch Strength, Stereognosis, VAS, AROM
• Activity Limitation
  – SHUEE, Box and Blocks, AHA
• Participation Restriction
  – PODCI, PedsQL (CP module), CAPE, COPM

Standardized, Validated Outcome Tools

SHUEEE Dynamic Positional Analysis

p-values above columns are from paired "t" tests

CONCLUSION: Those children receiving surgical treatment showed significantly greater improvement
For Hemiplegic Children meeting standard indications for surgical treatment

• Tendon Transfer Surgery in Upper Extremity Cerebral Palsy Is More Effective than Botulinum Toxin Injections or Regular Ongoing Therapy
• Based on our findings, the authors of this study no longer recommend Botulinum toxin injections
• This study did not provide evidence against therapeutic modalities as maintenance treatments, and we continue to recommend them.