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Cerebral Palsy and Post-Op Treatment

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Objectives:

- As a result of this course, participants will be able to:
- 1) Identify 3 functional limitations of hemiplegic Cerebral Palsy related to the upper extremity involvement.
- 2) Recognize the general post operative therapy protocol for tendon transfer surgery in the upper extremity of a person with Cerebral Palsy.
- 3) Describe 2 potential functional changes following surgical intervention for the wrist or thumb of the individual with Cerebral Palsy.
Cerebral Palsy

- Non progressive neurological disorder of movement and posture that is related to an insult to the developing brain; cerebral anoxia in the perinatal period or acquired post-natally


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Cerebral Palsy - Classifications

**Based on Muscle Tone**

- Spastic
- Dystonia
- Athetoid
- Mixed
- Ataxic
Cerebral Palsy - Classifications

Based on Body Involvement:

- Monoplegia
- Hemiplegia
- Diplegia
- Double Hemiplegia
- Quadriplegia
- - (Pentaplegia)

Measures of Spasticity Severity

- Ashworth Scale
- Tardieu scale
Ashworth Scale:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No increase in muscle tone</td>
</tr>
<tr>
<td>1</td>
<td>Slight increase in muscle tone, manifested by a catch or by minimal resistance at the end of the range of motion (ROM) when the affected part(s) is moved in flexion or extension</td>
</tr>
<tr>
<td>1+</td>
<td>Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM</td>
</tr>
<tr>
<td>2</td>
<td>More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved</td>
</tr>
<tr>
<td>3</td>
<td>Considerable increase in muscle tone, passive movement difficult</td>
</tr>
<tr>
<td>4</td>
<td>Affected part(s) rigid in flexion or extension</td>
</tr>
<tr>
<td>9</td>
<td>Unable to test</td>
</tr>
</tbody>
</table>

Cerebral Palsy Upper Extremity

**Problem**
- Elbow flexed
- Forearm pronated/or reverse pronated
- Wrist flexed and/or ulnarly deviated
- Fingers flexed
- Thumb in palm
Cerebral Palsy - Elbow

- Limitations:
- Holding and carrying objects
- Reaching away from the body
- Reaching LEs
- Appearance

Cerebral Palsy - Forearm

- Limitations:
- Grasping and holding objects
- Palm to palm interface
- Visually seeing objects in their hand
- Bimanual tasks
- Fastening clothing at midline
Cerebral Palsy - Wrist

- Limitations:
  - Grasp/release of objects
  - Weight bearing
  - Palm to palm interface
  - Holding objects bimanually

Cerebral Palsy – Finger

- Limitations:
  - Grasp/release
  - In hand manipulation
  - Sustained hold
  - Weight bearing
Cerebral Palsy – Thumb

- Limitations:
  - Grasp
  - In hand manipulation
  - Fastening clothing
  - Sustained hold
  - Pinch

Treatment of Spasticity

- Muscle control or relaxation
- Splints and orthotics
- E-stim of antagonistic muscles
- Neurosurgical Procedures: dorsal rhizotomy
- Pharmacologic Agents
- Botulinum A- toxin agents
- **Musculoskeletal Surgical Procedures.**
Surgical Indications

If the child voluntarily uses extremity…
operation will potentially benefit

- Operation cannot induce an ignored limb to function

Cerebral Palsy Evaluation

- History
- ROM
- Muscle Tone/Strength in agonist/antagonist
- Sensibility
- Reflexes
- Vision/Visual Motor
Evaluation Continued:

- Perceptual Motor
- Developmental Status
- Medications
- Seizures
- Family/living situation
- Grasp/release ability

Cerebral Palsy Evaluation: continued

Functional: SHUEE  Box and Block
Stereognosis

Standard Evaluations:

• House Scale: Classification system
• MACS: The manual ability classification system. Descriptive
• Melbourne: Test of unilateral upper limb function.
• SHUEE:
**House Scale:**

**TABLE III**

**FUNCTIONAL CLASSIFICATION SYSTEM**

<table>
<thead>
<tr>
<th>Class</th>
<th>Designation</th>
<th>Activity Level</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>Does not use</td>
<td>Does not use</td>
</tr>
<tr>
<td>1</td>
<td>Poor passive assist</td>
<td>Uses as stabilizing weight only</td>
</tr>
<tr>
<td>2</td>
<td>Fair passive assist</td>
<td>Can hold onto object placed in hand</td>
</tr>
<tr>
<td>3</td>
<td>Good passive assist</td>
<td>Can hold onto object and stabilize it for use by either hand</td>
</tr>
<tr>
<td>4</td>
<td>Poor active assist</td>
<td>Can actively grasp object and hold it weakly</td>
</tr>
<tr>
<td>5</td>
<td>Fair active assist</td>
<td>Can actively grasp object and stabilize it well</td>
</tr>
<tr>
<td>6</td>
<td>Good active assist</td>
<td>Can actively grasp object and then manipulate it against other hand</td>
</tr>
<tr>
<td>7</td>
<td>Spontaneous use, partial</td>
<td>Can perform bimanual activities easily and occasionally uses the hand spontaneously</td>
</tr>
<tr>
<td>8</td>
<td>Spontaneous use, complete</td>
<td>Uses hand completely independently without reference to the other hand</td>
</tr>
</tbody>
</table>
Cerebral Palsy – Elbow Flexion

**Preferred** Surgical

**Anterior Elbow Release**
- Release biceps aponeurosis
- Fractional lengthen brachialis
- Release origin of brachialis
- Strip adventitia biceps tendon

Elbow Flexion Evaluation

- AROM/PROM
- Functional Problems
- Social Emotional Concerns
- Reflexes/Tone
- Carrying Angle
- Dressing
- Improves ADL, use of walker, two handed activities
Protocol: Anterior Elbow Release

**Pre-op:**
- Administer SHUEE

**Post-op:**
- Long arm plaster cast applied in OR with elbow in 25 to 30 degrees of flexion, forearm and wrist in neutral.

- **3 -4 weeks post-op:** Returns to clinic for cast removal, splint fabrication and family education
  - Fabricate long arm splint with elbow in extension and forearm in neutral position
  - Splint is worn at all times except for exercises and bathing—only night splinting if ambulatory
  - Begin AROM exercises and PROM if procedure performed alone for elbow extension and supination
  - Patient/family exercise instruction
  - Scar management—assess need for elastomer with splint
Post operative Splint for AER:

- **6 weeks post-op:**
  - May discontinue day splint (depends on amount of abnormal muscle tone and obligatory reflexes)
  - Continue with night splinting.
  - Use of arm in daily activities and play
- **3 months post-op:**
  - May discontinue night splint
Elbow Flexion

- Patients 41
- Hemiplegia 22
- Quadriplegia 9
- Age at operation 9 (2-17.5)
- Follow up 25 mo

(J Ped Orthop. 2001)

Elbow Flexion

<table>
<thead>
<tr>
<th></th>
<th>Pre-Op</th>
<th>Post-Op</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carry Angle</td>
<td>104°(65-140)</td>
<td>55°(10-105)</td>
</tr>
<tr>
<td>Flexion</td>
<td>133°(110-145)</td>
<td>133°(105-145)</td>
</tr>
<tr>
<td>Extension</td>
<td>41°(5-120)</td>
<td>27°(0-90)</td>
</tr>
</tbody>
</table>

33/39 improved

(J Ped Orthop. 2001)
Forearm Pronation

Surgical Objectives:
- Release spastic deformity
- Reposition extremity
  - more functional
  - aesthetically appealing
Cerebral Palsy – Forearm Pronation

**Preferred**

**Pronator Teres Rerouting**

**Other**

Pronator Tenotomy

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**Forearm Pronation Evaluation**

- AROM/PROM
- Head/Trunk Control
- Reverse pronated grasp
- Amount of effort to supinate
Pronator Teres Rerouting

Transfer muscle causing deformity (pronation) to position of desired function (supination)
Pronator Rerouting Protocol

- **Pre-op:**
  - Occupational Therapy CP Upper Extremity Evaluation
  - Document position of forearm during ambulation, ADLs, and at rest
  - Assess A/P forearm ROM
  - Administer SHUEE
- **Post-op:**
  - Long arm plaster cast applied in operating room with elbow in 90 degrees flexion, forearm in maximum comfortable supination and wrist in neutral position.

---

**Pronator Rerouting:**

- **4-6 weeks post-op:** Returns to clinic for cast removal, splint fabrication and family education
- **Precaution:** If pronator re-routment is performed, no passive forearm pronation is indicated until 6 weeks post-op.
  - Fabricate long arm volar splint with elbow in 90° flexion, forearm in 45° of supination and wrist in
    - 15° of dorsiflexion
  - Splint is worn at all times except for exercises and bathing
  - Begin AROM exercises for forearm rotation
  - Scar management
Post op Splint:

Pronator Reroutment

- **6 weeks post-op:**
  - May discontinue day splint (depends on amount of abnormal muscle tone and obligatory reflexes) and continue with night wear.
  - Light functional activities allowed with involved extremity.
- **3 months post-op:**
  - May discontinue night splint
Results:

42 Patients (4ys – 16 yrs)
Supination improved 89°
  pre-op -41°
  post-op 48°

No patient lost active pronation
No patient had “too much” supination
  . . . . Pronator quadratus retained

JHS, 1988

Wrist Flexion and Deviation

[Images of wrist flexion and deviation]
Wrist Flexion and Ulnar Deviation Evaluation

- R/O Tenodesis
- Check tightness of wrist and finger flexors
- AROM/PROM

Wrist Flexion and Deviation Evaluation: cont.

- UD at rest and passive RD
- Wrist extension with fingers flexed and extended
- Note if finger extensors are stronger than wrist extensors
Wrist Surgery

• Spastic Muscle Release
  • FCU fractional Lengthening
  • ECU release for transfer

Tendon Transfer:
ECU to ECRB or ECRL

Wrist Tendon Transfer: Tensioning

- Tension Transfer at 5 to 10 degrees flexion
- Use wrist flexion to extend fingers
- Don’t want to limit finger extension
EXTENSOR CARPI ULNARIS TRANSFER TO EXTENSOR CARPI RADIALIS BREVIS OR LONGUS WITH OPTIONAL FRACTIONAL LENGTHENING OF FLEXOR CARPI ULNARIS

- **Definition:** Movement of ECU tendon more radially to improve ulnar deviated (often with some wrist flexion) posture of wrist. May combine with FCU tendon lengthening procedure.
- **Indications:** Primarily ulnar deviated wrist (mild wrist flexion wrist may exist).
- **Precautions:** Tensioning in the operating room at 0-5 degrees of flexion to avoid over-tightening that can lead to a fixed wrist extension posture and limited finger extension. If finger flexors are tight, fractional lengthening may be necessary to prevent worsening flexion posture of fingers.
- **Functional Goal:** Improved wrist position for improved grasp and hand function.

---

**ECU to ECRB or ECRL:**

- **Pre-op:**
  - Perform Occupational Therapy CP Upper Extremity Evaluation
  - Document position of wrist during ambulation, ADLs, and at rest along with A/P ROM of wrist and fingers
  - Administer SHUEE
- **Post-op:**
  - Pt. is placed in long arm plaster cast with wrist in neutral posture
Protocol cont:

- **4-5 weeks post-op:** Returns to clinic for cast removal, splint fabrication and family education
  - Precaution: No passive wrist flexion or ulnar deviation until 6 weeks.
  - Fabricate volar forearm splint with wrist in 15° extension and in radial deviation. Include fingers if fractional lengthening performed.
  - Splint is worn at all times except for exercises and bathing
  - Begin gentle P/AROM wrist extension and radial deviation exercises/activities.
  - Patient/family exercise instruction including scar management.

Protocol:

- **6 weeks post-op:**
  - May discontinue day splint (depends on amount of abnormal muscle tone and obligatory reflexes)
  - Continue night splinting
  - Light functional activities allowed with involved extremity
  - Active/passive wrist flexion
- **3 months post-op:**
  - May discontinue night splint
Wrist flexion Posture:
Green Procedure Protocol: FCU to ECRB

- **Indications:** CP patients with moderate to severe dynamic flexion posture
- **Precautions:** Overly tight finger flexors; loss of grasp/release function if transfer too tight (transfer typically tensioned in slight wrist flexion to prevent a wrist extended posture precluding grasp/release- most important in those patients who need wrist flexion to allow digit extension)
- **Functional Goal:** Improved wrist extension for improved grasp and hand function.

Green Transfer:

- **Pre-op:**
  - Perform Occupational Therapy CP Upper Extremity Evaluation
  - Document position of wrist during ambulation, ADLs, and at rest
  - Assess grasp/release function with wrist flexed, extended and in neutral
  - Assess resting wrist posture, maximum wrist passive extension, and ability to extend fingers passively with the Wrist maximally extended.
  - Administer SHUEE
- **Post-op**
  - Pt. placed in long arm plaster splint with wrist in neutral position
  - Passive ROM to uninvolved joints.
**Green Transfer:**

- **4 -5 weeks post-op:** Returns to clinic for cast removal, splint fabrication and family education
  - Precaution: No passive wrist flexion until 6 weeks post-op.
- Fabricate short arm volar splint with wrist in neutral flexion/extension and neutral deviation. To be worn at all times except for bathing and exercises. Must include fingers if fractional lengthening of flexors preformed.
- Begin gentle A/PROM of wrist extension and forearm supination exercises/activities and progress ROM.
- Scar management

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**Green Protocol:**

- **6 weeks post-op:**
  - May discontinue day splint (depends on amount of abnormal muscle tone and obligatory reflexes)
  - May begin active wrist flexion exercises
  - Light functional activities allowed with involved extremity
- **3 months post-op:**
  - May discontinue night splint

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[CONTINUED]
### Results of Green Transfer in Treatment of Children with Cerebral Palsy

- 40 patients (3 - 16.5 yrs of age)
- FCU to ECRB or ECRL
- Arc of 47° did not change but was centered around neutral
- 88% had cosmetic improvement
- 79% had functional improvement

Beach et al, J Ped Orth Pediatrics, 1991

### Salvage Procedure: Wrist Arthrodesis

![Image of wrist arthrodesis procedure]
Wrist Arthrodesis:
- Trial wrist fusion
- UE dressing
- Emotional/Social Problem
- Finger extension
- Thumb extension

Thumb In Palm
Thumb In Palm: Non Surgical

- Stretching
- Splinting
- Botulin Toxin
- Constraint casting

Thumb In Palm Evaluation

- Position at Rest
- IP Hyperextension = better result
- MCP Hyperextension = MCP Pinning
- MCP/CMC Arthrodesis
- IP Flexion = Tight FPL
- Hygiene
### Thumb in Palm

- **Weaken Spastic Muscle:**
  - Adductor Pollicis
  - Origin or insertion
  - FPB
  - Opponens pollicis
  - 1st Dorsal Interosseus

### EPL Rerouting with Adductor Release:

- **Definition:** Rerouting transfer of the EPL from the 3rd extensor compartment through the 1st compartment. Typically combined with adductor pollicis, flexor pollicis brevis and first dorsal interosseous release at the muscle origins.
- **Indications:** Child with spastic thumb adduction contracture (thumb-in-palm deformity)
- **Precautions:** Possible thumb MCP hyperextension. Check for this deformity before surgery and if present, temporary K-wire fixation of the MCP joint after surgery. Recurrent deformity.
- **Functional Goal:** Improved finger flexion (once thumb is out of the palm); improved thumb function, large object grasp.
Results:

- Pre op: 20 patients
  - Thumb clenched in fist
  - Thumb ray adducted with extension
  - IP extension
  - Volitional use of hand
    - JHS, 1985
Results: Post op 20 patients

- Thumb outside of clenched fist: 18/20
- Thumb ray outside of palm: 20/20
- Improved use: 18/20

Thumb in Palm: 1985-1994

197 Patients
103 Reviewed
  51 Hemiplegia
  52 Quadriplegia

Ages: 6-7 yrs (4-16)
FU: 5-6 yrs (1-10)

- Recurrences: 9 patients
  (7 re-operations)
- Complications:
  - MP hyperextension
    4
  - De Quervain’s
    1
  - Radial n. neuroma
    1
THUMB-IN-PALM
1985 - 1994

103 Patients Cerebral Palsy

Pre-op 2.6
Post-op 5.1
Improve 2.5

<table>
<thead>
<tr>
<th>Category</th>
<th>Pre-op</th>
<th>Post-op</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Use (0)</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Passive Use (1-3)</td>
<td>52</td>
<td>10</td>
</tr>
<tr>
<td>Active Use (4-6)</td>
<td>40</td>
<td>88</td>
</tr>
<tr>
<td>Spontaneous Use (7-8)</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>No Improvement</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Improved WITHIN category</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Improved to HIGHER category</td>
<td>62</td>
<td></td>
</tr>
</tbody>
</table>
Recent Outcome Study:

- Those who are candidates for standard surgery of FCU to ECRB; Pronator release; and EPL reroutement.
- SHUEE; outcome tood PedsQL and COPM
- Therapy Role

- Van Heest, Bagley, Molitor and James, *Tendon Transfer Surgery in Upper-Extremity Cerebral Palsy Is More Effective Than Botulinum Toxin Injections or Regular, Ongoing Therapy*. J. Bone and Joint Surgery, Am. 2015; 97; 529-36

Summary:

- Upper Extremity Overlooked in Preference to Lower Extremity
- If the Child is Voluntarily Attempting to Use Arm
- Surgical Objective is to Reposition Extremity for More Effective Function and Appearance
**Summary:**

– Weaken Spastic Muscles

– Tendon Transfer
  Use Muscle Causing Deformity

– Post-Op Muscle Retraining Facilitated

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**Bibliography:** CP surgeries in the upper extremity


Koman, LA, Sarlikiotis, Smith, BP., Surgery of the Upper Extremity in CP, Orthopedic Clinic N. America; 2010, Oct 41(4).


THANK YOU

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continued