## Cerebral Palsy: Surgical Treatment of the Upper Extremity

AACPDM Annual Meeting ICL 2015

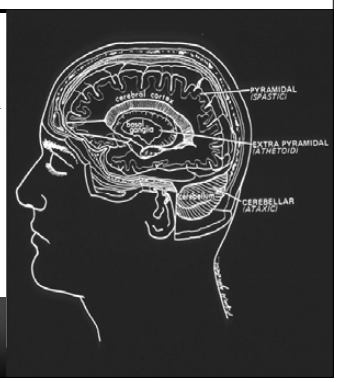
ANN E. VAN HEEST, MD
UNIVERSITY OF MINNESOTA
GILLETTE CHILDREN'S HOSPITAL
SHRINER'S HOSPITAL-TWIN CITIES

## 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"

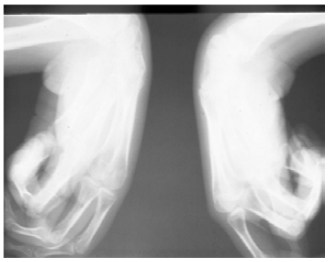
- ***JOINT MALPOSITIONING***
- ***MUSCLE IMBALANCE***
- ***FUNCTIONAL IMPAIRMENT***

## The "Secondary Problems"

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

## "Tertiary Problems"

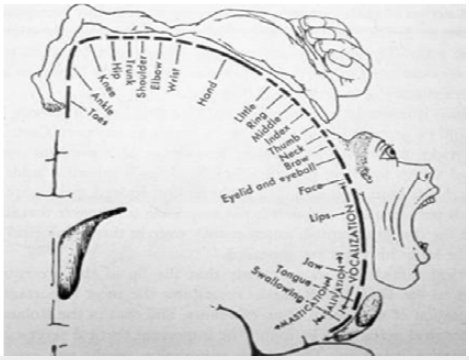
- **Skeletal Deformity**
- **Joint Contracture**
- **Muscle Contracture**



## "Tertiary Problems" of C.P.

- **Prevention by early intervention**
- **Operative salvage procedures**

## MOTOR HOMUNCULUS




The Cerebral Cortex of Man, Penfield & Rassmussen 1950

- CP
- CVA
- TBI

## C. P. MANIFESTATIONS

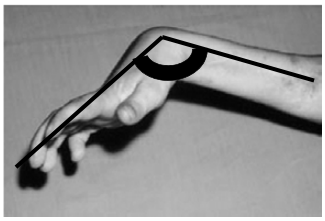
- SHOULDER INTERNALLY ROTATED
- ELBOW FLEXED
- FOREARM PRONATED
- WRIST FLEXED
- THUMB-IN-PALM

## PATIENT EVALUATION

- PROM
  - Joint contracture, muscle contracture

## JOINT vs MUSCLE CONTRACTURE

- FINGER FLEXORS ARE BI-ARTICULAR MUSCLES
- WRIST POSITION AFFECTS FINGER POSITION IF FINGER FLEXOR MUSCLE CONTRACTURE



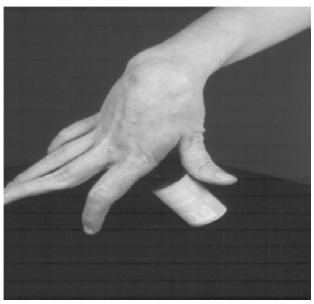
**Volkmannn's Angle**

## 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

HAND CLINICS

Hand Clin 19 (2003) 565–571

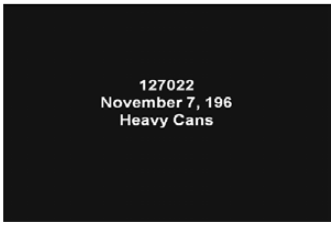
Functional assessment aided by motion laboratory studies

Ann E. Van Heest, MD*

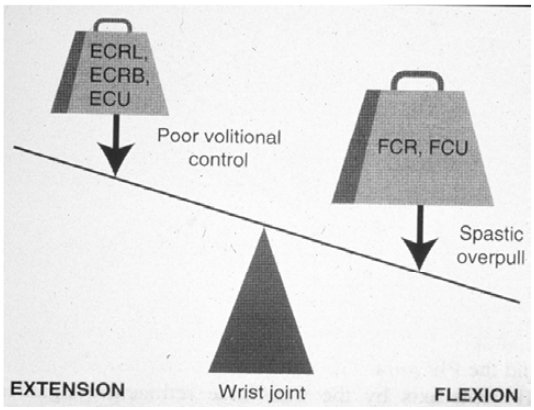
*Department of Orthopedic Surgery, University of Minnesota, 2450 Riverside Avenue South R200, Minneapolis, MN 55454, USA*

*Hand Surgery Section, Gillette Children's Specialtycare Hospital, Shriner's Hospital–Twin Cities Unit, Minneapolis, MN 55414, USA*

## Use of Motion Lab to assess muscle spasticity vs phasic control





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## "TOOLS OF THE TRADE"

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

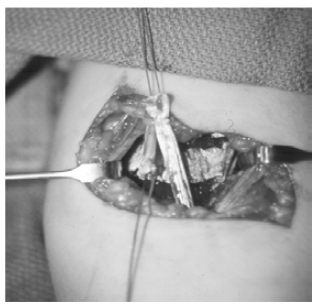
## Common CP Deformities

- 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

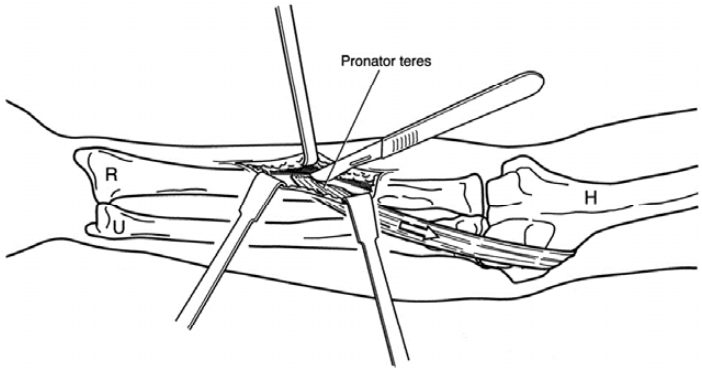


## PRONATION DEFORMITY

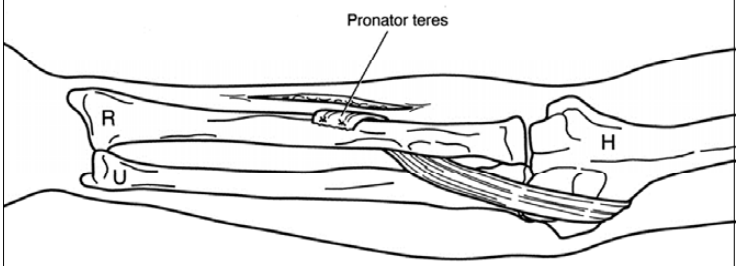
Soft-tissue Releases — Pronator Teres release

Tendon Transfers — Pronator Teres re-routing

## Pronator teres release




Pronator teres release



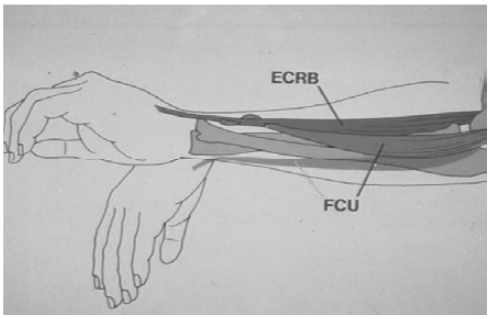

Pronator teres re-routing

## WRIST FLEXION DEFORMITY

| | |
|---|---|
| Soft-tissue Releases | FCR lengthening |
| SPASTIC CONTRACTED MUSCLE | FCU lengthening |
| | Flexor pronator slide |
| Tendon Transfers | ECU to ECRB/L |
| VOLITIONAL CONTROL MUSCLE | 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 |

## FCU to ECRB transfer (Green transfer)

Green and Banks, JBJS. 44A, 1962




## Wrist flexion deformity

## FCU to ECRB

- Incision
- FCU exposure

## Mobilize to allow for muscle excursion


## Tensioning

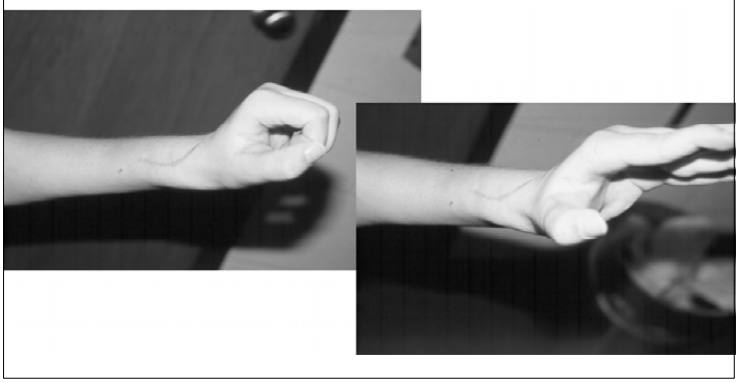

## Neutral position at rest


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, MD, Naveen S. Murthy, MD, Michael R. Sathy, MD, Fred A. Wentorf, MS, *Minneapolis, MN*

Flexor carpi ulnaris (FCU) transfer to the extensor carpi radialis brevis (ECRB) and/or the


## Post-operative Result: FCU to ECRB



## WRIST FLEXION DEFORMITY

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

SCIENTIFIC ARTICLE

Wrist Arthrodesis in Cerebral Palsy

Ann E. Van Heest, MD, David Strothman, MD

*J Hand Surg 2009*

- 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

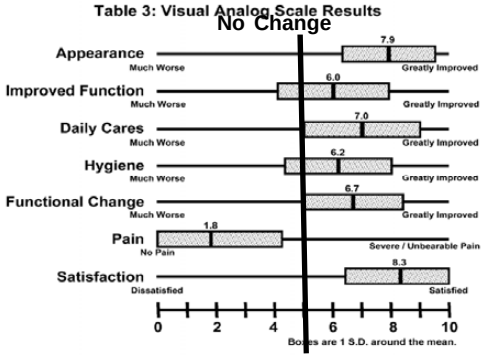
## Indications for Wrist Fusion

- Severe joint contracture
- Poor Hygiene
- Difficulty with daily care acitivities
- 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)

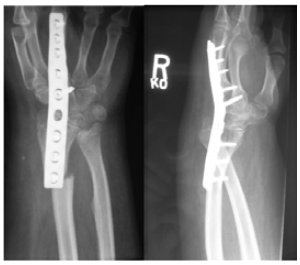
## Subjective Visual Analog Scale




## DJD and Carpal Tunnel Syndrome

## Complications

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



## 91% fusion, improved wrist position

## Summary: WRIST FLEXION DEFORMITY

| | |
|---|---|
| Soft-tissue Releases | FCR lengthening |
| SPASTIC CONTRACTED MUSCLE | FCU lengthening |
| | Flexor pronator slide |
| Tendon Transfers | ECU to ECRB/L |
| PHASIC CONTROLLED MUSCLE | 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 |
| NO DIGITAL CONTROL | PRC |

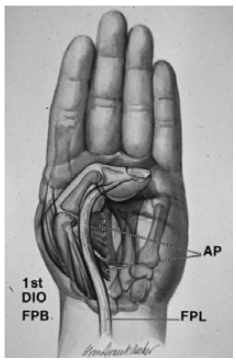
## THUMB IN PALM DEFORMITY

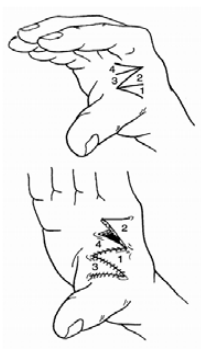
Soft-tissue Releases

Tendon Transfers

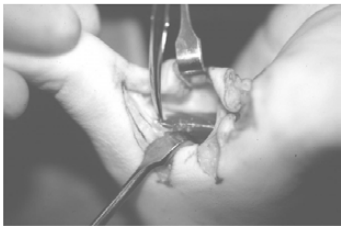
Bone/Joint Stabilization

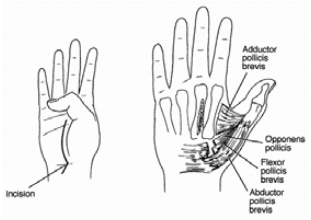
STEP 1: RELEASE OF CONTRACTURES



## ADDUCTOR RELEASE

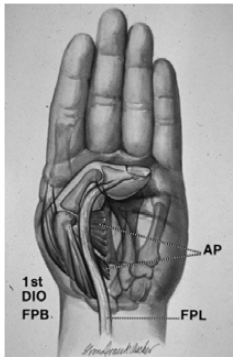




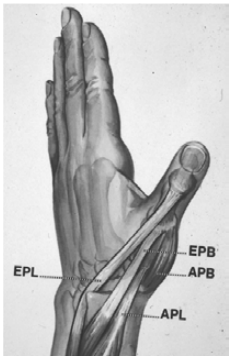

Matev I. Surgical treatment of spastic "thumb-in-palm" deformity. *J Bone Joint Surg [Br]*, 1963;45:703-708

## Thumb Muscle Function:
**Flexion-Adduction vs Abduction-Extension**

Release Tight Structures




Augment Weak Structures




## 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=14years)
- Male=79 : Female=55
- 180 Operations with 718 Procedures
- 4 Procedures/operation

## OUTCOME: Functional Use Scores

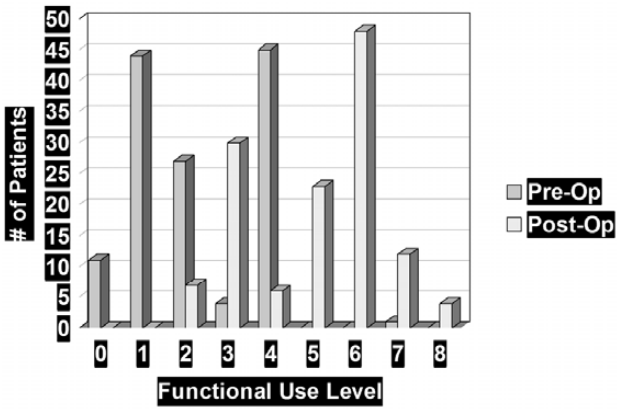
JBJS 63A:216-225, 1981

| Level | |
|---|---|
| 0 | Does not use |
| 1 | Poor passive assist |
| 2 | Fair passive assist |
| 3 | Good passive assist |
| 4 | Poor active assist |
| 5 | Fair active assist |
| 6 | Good active assist |
| 7 | Partial spontaneous use |
| 8 | Spontaneous use |

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 |

# Tendon Transfer Surgery in Upper-Extremity Cerebral Palsy Is More Effective Than Botulinum Toxin Injections or Regular, Ongoing Therapy

Ann E. Van Heest, MD, Anita Bagley, PhD, Fred Molitor, PhD, and Michelle A. James, MD

*Investigation performed at Shriners Hospitals for Children: Chicago, Illinois; Greenville, South Carolina; Northern California, Sacramento, California; Salt Lake City, Utah; Shreveport, Louisiana; Tampa, Florida; and Twin Cities, Minneapolis, Minnesota*

## Disclosure

SHC UECP Shriners Hospitals for Children Upper Extremity Cerebral Palsy Study

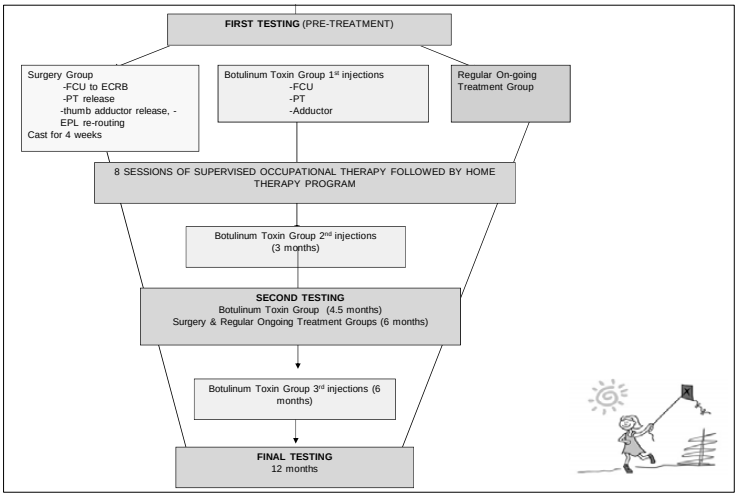
- Clinical Outcomes Studies Advisory Board Grant, Shriners Hospital for Children
- Multi-center Study
  - Northern California
  - Twin Cities
  - Greenville
  - Intermountain
  - Shreveport
  - Tampa
  - Chicago
- No other Disclosures

## 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)

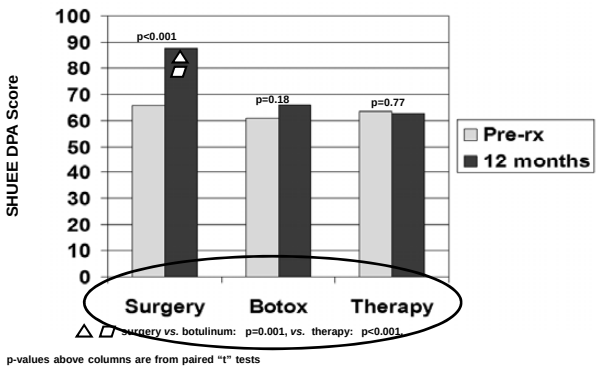



## WHO Definition of Disability

- 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**

## SHUEE Dynamic Positional Analysis




## CONCLUSION: Those children receiving surgical treatment showed significantly greater improvement

**Standardized, Validated Outcome Tools**

- Bodily Impairment
  - Grip, Pinch Strength, VAS (Parent), AROM (Supination↑, Wrist Ext↑, Wrist Flex↓)
- Activity Limitation
  - SHUEE DPA, Box and Blocks, AHA
- Participation Restriction
  - PODCI (UE,Transfers, Global scales) PedsQL (CP movement, eating), CAPE, COPM (satisfaction)

## 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.

SHC UECP Shriners Hospitals for Children Upper Extremity Cerebral Palsy Study

## SELF