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Case Studies for the Master Clinician: Brachial Plexus Birth Injury

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Patti Sharp, OTD, MS, OTR/L

Learning Objectives

Participants will be able to:

- Describe the brachial plexus, epidemiology and presentation of a brachial plexus birth injury.
- List assessments and outcome measures used with this population.
- Explain several evidence-based interventions for brachial plexus birth injury, both conservative and post-operative.

Agenda

Part 1:

- Introduction

Part 2:

- Assessment and Intervention

Part 3:

- Case Introduction/Videos

Part 4:

- Parent Interview

Part 5:

- Clinician Interview

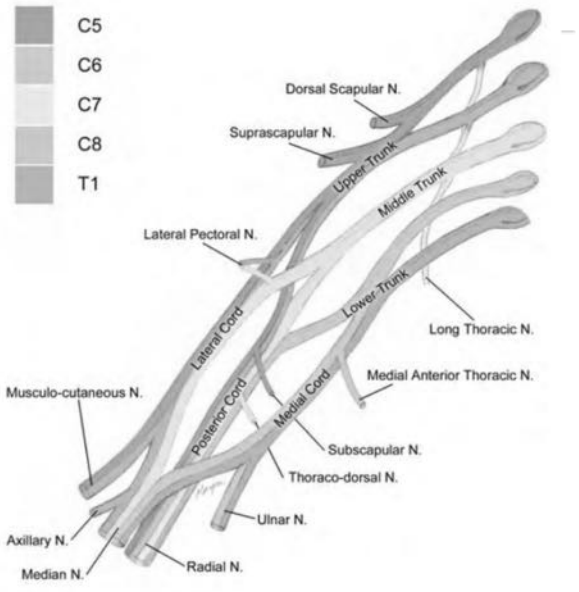
Part 6:

- Resources

Brachial Plexus Birth Injury

Introduction

Brachial Plexus Review



Nath, 2006. Image used with permission.

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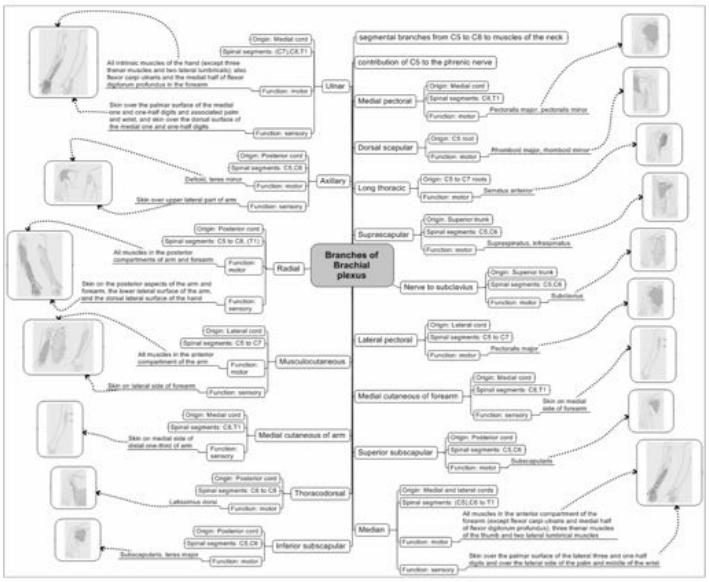
See attachment – PLEXUS CHART ILLUSTRATED



https://commons.wikimedia.org/wiki/File:Branches_of_Brachial_plexus.jpeg

Plexus Segments	Nerves	Muscles	Motion
C5	Dorsal scapular	Rhomboid, Levator scapulae	Scapular elevation
C5-7	Long thoracic	Serratus Anterior	Scapular stabilization
C5-6	Suprascapular	Supraspinatus & Infraspinatus	Shoulder abduction & ER
C5-T1	Pectoralis	Pectoralis	Shoulder flexion, extension, adduction
C5-6	Axillary	Deltoid, Teres minor, Triceps	Shoulder abduction & ER, elbow extension
C6-8	Thoracodorsal	Latissimus dorsi	Shoulder extension, adduction, IR
C5-7	Musculocutaneous	Biceps & Brachialis	Elbow flexion
C5-T1	Radial	Triceps, Extensor carpi, Radialis longus, Radialis brevis	Elbow extension, wrist extension
C5-T1	Median	Pronator teres & quadratus, Flexor carpi radialis, digit flexors	Wrist & digit flexors
C8-T1	Ulnar	Interossei & lumbricals, Adductor polices	Movement of medial 2 digits

See attachment – PLEXUS CHART

Brachial Plexus Birth Injury

- Incidence: 1.5 per 1,000 live births
- Evidence of decreasing rate in the US
- Motor impairment lasting >12 months
  - 10-18% in the US
  - 19-23% in other countries
- Chauhan, Blackwell, & Ananth, 2014

Risk Factors

- Shoulder dystocia
- Heavy-for-dates
- Macrosomia (>4.5Kg)
- Maternal obesity
- Maternal diabetes
- Breech delivery
- Instrumented birth
- Birth Hypoxia

Protective Factors

- Multiple gestation
- Cesarean delivery

- *54% with no known risk factors*

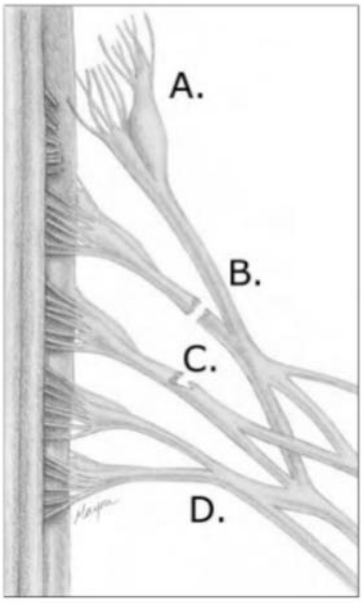
DeFrancesco, et al., 2017

Foad, Mehlman, & Ying, 2008

Types of nerve injuries

A. Avulsion – nerve is torn from the attachment at the spinal cord; Horner's Syndrome (eyelid droop) suggests very severe avulsion of the lower plexus

B. Rupture – nerve is torn along it's length



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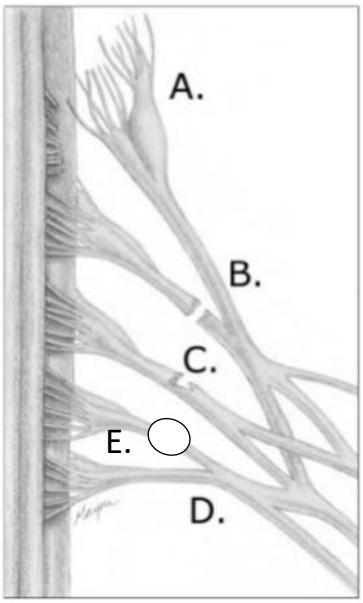
Types of nerve injuries

C. Partial rupture

D. Neurapraxia – stretch injury, in BPBI heals spontaneously 64% of the time

E. Neuroma – growth of scar tissue which prevents conduction



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Spontaneous Recovery

- 64% with functional recovery by 12 months
- Re-innervation ~ 1mm/day or ~1 inch/month
- Recovery of motor function occurs proximally to distally
- Motor return by injury:
  - C5-6 – by 3-5 months
  - C5-7 – by 7-9 months
  - Total (C5-T1) – by 14 months
- Sensory return up to 2+ years

Foad, et al., 2009

Global Treatment Goals

- Provide family/caregiver education and support
- Optimize positioning
- Promote/preserve joint integrity
- Improve range of motion (ROM)
- Improve strength
- Improve symmetry
- Promote development of gross motor and fine motor skills
- Improve sensory awareness/processing

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Parent Support

- Parents of children with BPBI experience the typical concerns of all new parents, plus added issues due to their child having special needs:
  - feelings of guilt
  - feeling overwhelmed with medical intervention, appointments, potential for surgery, etc.
  - grief
  - additional stress on a marriage
  - family and friends not understanding

Brachial Plexus Birth Injury

Assessment and Intervention

Treatment of the Infant with BPBI

- Positioning to preserve joint integrity in the face of muscle imbalance
- Alignment, alignment, alignment!
- PROM to maintain joint range
- Facilitation of AROM as able
- Sensory & visual stimulation
- Monitoring need for early surgical intervention

Infant PROM

- The home exercise program (HEP) should address all planes of motion showing signs of tightness and/or disuse
- Gentle PROM:
  - Shoulder abduction, flexion, external rotation
  - Elbow extension, flexion
  - Forearm supination, pronation
  - Wrist/digit extension
- Optimal to carry out PROM exercises with infant at least **4x/day** (every diaper change)

Infant Splinting

- Splinting should only be used when the infant is at risk for losing ROM or damaging joints
- Splinting when not necessary limits spontaneous use and sensory exposure
- Common infant splints:
  - Resting hand splint for night/nap wear
  - Wrist cock-up/dorsal wrist cock-up splint
  - Soft thumb abduction splint

Infant AROM

- Younger Infant (< 4 months) rely on sensory stimulation and reflexes
  - Use Moro to promote shoulder responsiveness in abduction and external rotation
  - Use ATNR to promote bicep responsiveness
- Older infant (> 4 months) reaching activities
  - Always begin with gravity eliminated positions when working for active muscle contractions
  - Eccentric contractions can often be stimulated prior to concentric contractions (i.e. hold after being placed)

Infant AROM

- Therapeutic taping can be used to facilitate movement and provide stability
- Used most often with BPBI to address:
  - Facilitation of shoulder abduction/external rotation
  - Facilitation of biceps
  - Facilitation of wrist extension
- Good reference for taping specifics:

  Kase, K., Martin, P., & Yasukawa, A. (2006). *Kinesio Taping in Pediatrics: Fundamentals and Whole Body Taping*. Kinesio.

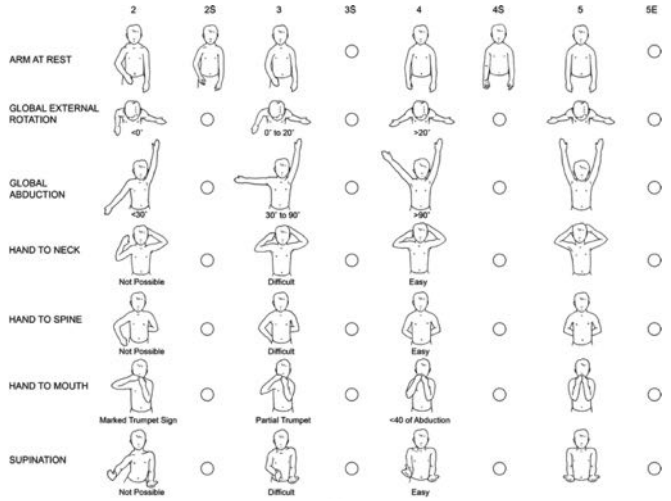
Time is of the essence

- Minimize or prevent compensatory motor patterns as much as possible
- Always start proximally; all distal function is built on proximal stability
- Balance between extensors and flexors as well as symmetry is crucial for the development of adequate movement patterns
- As child begins to attempt to utilize his affected extremity, core stability becomes threatened and must be monitored closely

Formal Assessment of BPBI

- Narakas Classification (Narakas, 1985)
  - Used at 2-3 weeks, prognostic
- Toronto Test Score (Michelow, 1994)
  - Quantifies UE function, predicts recovery based on age
- Active Movement Scale (Clarke, 1995)
  - Measures UE function in detail
- Mallet Classification (Mallet, 1972)
  - Classifies shoulder function
- Above are reliable and valid (Bae, 2003)
- *See "ASSESSMENTS" attachment*

Mallet Scale – Nath Modification



Nath, 2006. Image used with permission.

Infant Assessment

- (video)

Infant Assessment

ROM	PASSIVE	ACTIVE
Shoulder ER	85	-90
Supination	90	-90
Pronation	90	-90

AMS

Shld Abd	0
Shld Add	7
Shld Flex	0
Shld ER	0
Shld IR	2
Elbow Flex	0
Elbow Ext	2
FA Pron	7
FA Sup	0
Wrist Flex	7
Wrist Ext	2
Digit Flex	7
Digit Ext	2
Thumb Flex	7
Thumb Ext	0

- Likely a near-global plexus injury; C5-C8?
- Most likely will recommend surgery

Indications for Surgery

- Global BPBI – hand involvement
- Horner's Syndrome – indicates avulsion
- No sensation – indicates rupture or avulsion
- No biceps function against gravity at 3 months

Infant Surgical Protocols

- If there is no motor return within the first 3-6 months after birth, surgery is recommended
  - When surgery is scheduled, it should not be the first time the parent is hearing about this
  - Parents need constant reassurance that their participation in the HEP is important, but that it won't prevent surgery
  - Surgery is needed when the nerves are irreversibly damaged, not when a parent doesn't try hard enough
- The procedure chosen is based on the extent of the damage observed upon exploration

BP Exploration & Nerve Repair

Surgery completed between 3-6 months of age:

- Neurolysis - removal of the constrictive scar tissue surrounding the nerve
- Neuroma Excision – large neuromas can develop when the trauma causes persistent swelling; must be removed and the nerve can be reattached or grafted
- Nerve Grafting – needed when the gap in healthy nerve is too large to reattach without tension; donor nerve is most often the Sural nerve in the legs

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BP Exploration & Nerve Repair

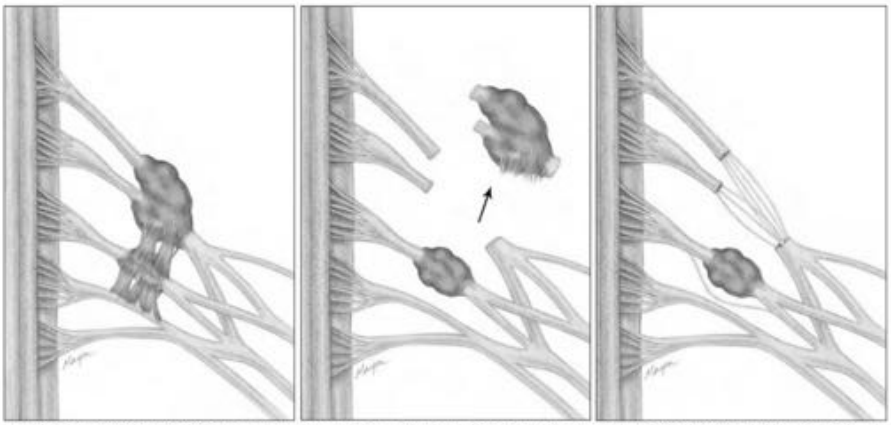

Figure1.8A. Neuroma formation at site of nerve injury may obstruct the regenerated nerve muscle connection.

Figure 1.8B. Resection is performed to remove non-conducting neuromas.

Figure 1.8C. Nerve grafting is used to replace or bypass the gap produced in healthy nerve after resection of the neuroma. Nerve grafting can also be used to repair gaps resulting from ruptures.

Nath, 2006. Image used with permission.

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Nerve Repair Post-Op

- Patients are typically immobilized for 2-3 weeks post repair
- No ROM for 2 weeks
- 2 weeks post-op
  - Initiate shoulder PROM to 50% (90º) at 2 weeks
  - AROM as able
  - Scar massage once incision is closed
- 8 weeks post-op
  - No restrictions
  - Begin resistive exercises and weight-bearing
  - Aquatic therapy if possible

Nerve Transfers

- Cross transfer
- Isolated transfers
  - spinal accessory to suprascapular
  - triceps nerve branch to axillary
  - ulnar nerve branch to musculocutaneous
- Isolated nerve transfers can be done until ~18 months
  - if done later, muscles will have atrophied to the point that nerve innervation will not impact active motor function
- Post-op: Immobilization for 3 days, resume therapy without restriction after 3 weeks

Evidence-Based Interventions

- Serial Casting
- Neuromuscular Electrical Stimulation (NMES)
- Botulinum Toxin A
- Constraint Induced Movement Therapy (CIMT) and modifications thereof (mCIMT)
- Virtual Reality

Serial Casting

- Successful for elbow flexion contractures
  - Ho, et al., 2018
  - Duijnisveld, et al., 2016
- Surgical tendon lengthening is more effective
  - Nath & Somasundaram, 2016
  - Nath & Somasundaram, 2015

Neuromuscular Electrical Stimulation

- BPBI - Elnaggar, 2016
- Hemiplegic CP – Qi, et al., 2018
- CP – Elbasan, et al., 2017

Botulinum Toxin A

- Buchanan, et al., 2018 (systematic review)
- Greenhill, et al., 2018
- Duijnisveld, et al., 2017

CIMT

- CIMT
  - Hoare, et al., 2007
  - Fritz, Butts, & Wolf, 2012
  - Abdel-Kafy, et al., 2013
  - Smania, et al., 2012
  - Vaz, et al., 2010 (case study)
  - Buesch, et al., 2010 (case series)

Multimodal Therapies

- CIMT with NMES
  - Berggren & Baker, 2015
- CIMT with Botox
  - Santamato, et al., 2011

Virtual Reality

- El-Shamy,& Alsharif, 2017
  - Used the Armeo Spring with kids with BPBI
  - Armeo used with other populations as well
  - https://www.hocoma.com/us/solutions/armeo-spring/

Brachial Plexus Birth Injury

Case Study

Meet Kristen

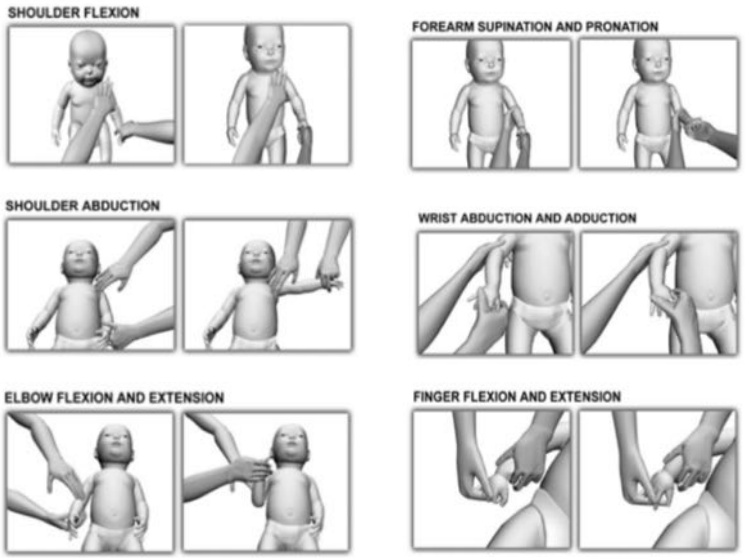
- Mom normal weight and health
- No gestational diabetes identified with testing
- Sub-preeclamptic
- Large baby, though no ultrasound done

- Difficult vaginal delivery; 9lb 10.5oz
- L Shoulder dystocia
- Horner's syndrome
- Waiter's tip
- Flail arm

Extent of Injury

- Was seen in Brachial Plexus Clinic at Cincinnati Children's Hospital at 3 days
- Diagnosed with suspected global BPBI affecting nerves C5-T1
- Began OT immediately to prevent further injury and promote motor return if possible
- Without surgical examination, it's impossible to tell the true extent of the injury

Infant PROM



Graciously provided by the Nath Brachial Plexus Institute http://www.dmathbrachialplexus.com/

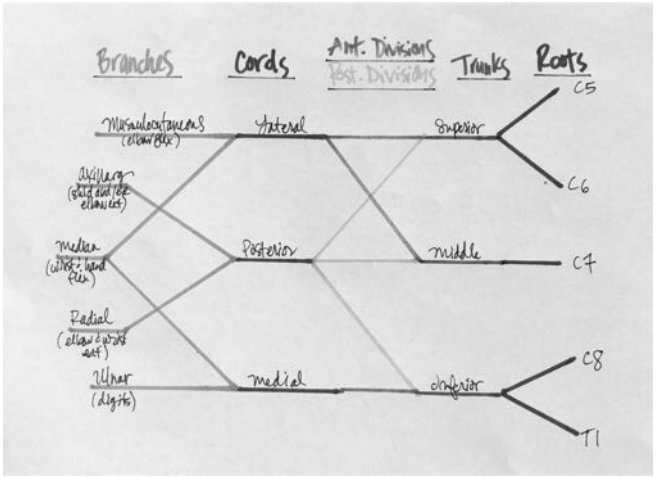
Extent of Injury

- Kristen's arm remained limp and flaccid
- No motor return within the first 3 months
- Scheduled for surgery as per protocol
- Surgical examination
  - T1 & C8 intact but stretched
  - C7 ruptured
  - C5-6 roots fully avulsed with neuroma formation

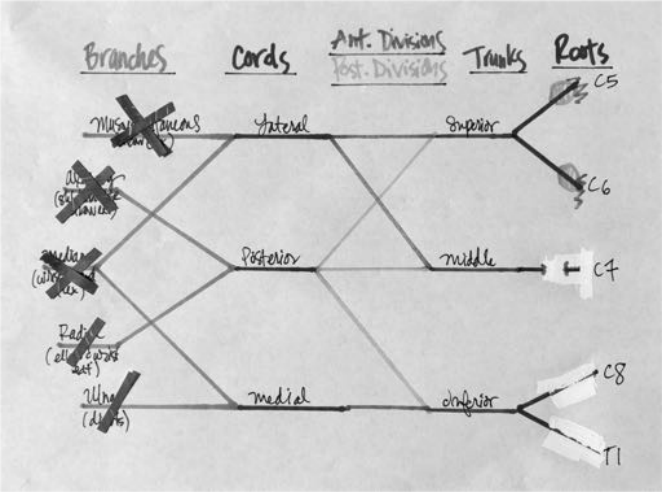
Pre-op Toronto – 12/2/10

Joint	Numerical Score
Elbow flexion (0-2)	0
Elbow extension (0-2)	0
Wrist extension (0-2)	0
Finger extension (0-2)	0
Thumb extension (0-2)	0
Total score (0-10)	0

Extent of Injury- Normal Plexus



Extent of Injury - Kristen



1st Surgery at 3 months 3-19-11: Nerve graft & nerve transfer

- Nerve grafts to repair C7
  - Root to anterior division of upper trunk
  - One link for each of the posterior divisions of the upper and middle trunks
  - Sural nerve used for donor
- Isolated nerve transfer
  - spinal accessory to suprascapular

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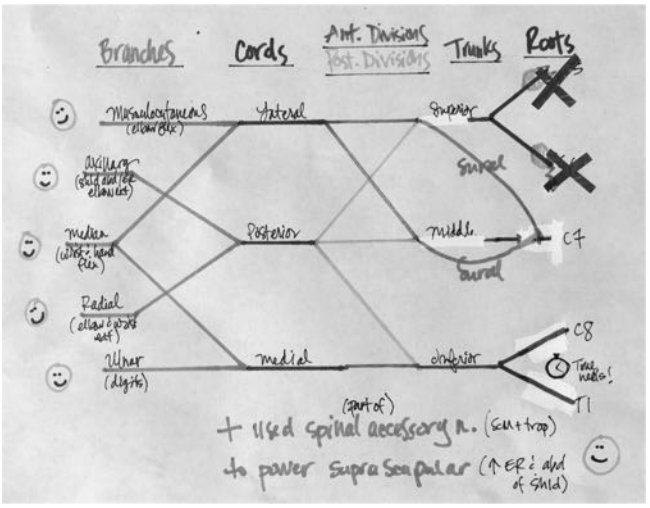
Nerve graft & nerve transfer



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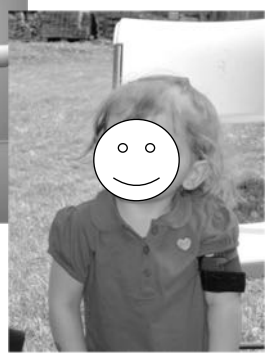
Kristen Post-Op

Post op

Stuck!

- Mallet 11-30-11

Motion	Grade Level
Global Abduction	II
Global External Rotation	I
Hand to Neck (IR)	I
Hand to Spine (ER)	I
Hand to Mouth	I
Total score (0-25)	7

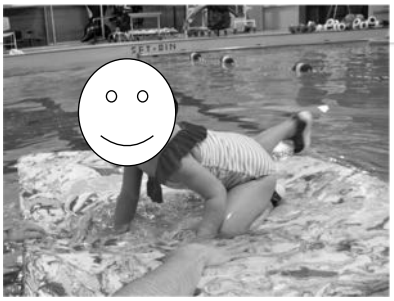


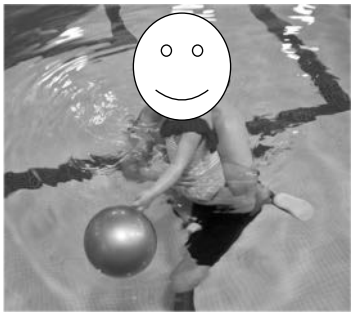
- Toronto

Joint	Numerical Score
Elbow flexion (0-2)	0
Elbow extension (0-2)	0.6
Wrist extension (0-2)	0
Finger extension (0-2)	0
Thumb extension (0-2)	0
Total score (0-10)	0.6

Changing gears

- Began aquatic therapy
- Botox treatments
  - 1/19/12 – Pecs
  - 11/7/12 - Triceps





Videos 1 and 2

Measurable Improvement!

- 4/17/12

AMS
Shoulder Abduction: 0
Shoulder Adduction: 6
Shoulder Flexion: 2
Shoulder External Rotation: 0
Shoulder Internal Rotation: 6
Elbow Flexion: 1
Elbow Extension: 7
Forearm Pronation: 7
Forearm Supination: 0
Wrist Flexion: 5
Wrist Extension: 0
Finger Flexion: 1
Finger Extension: 0
Thumb Flexion: 0
Thumb Extension: 0

TORONTO
Elbow flexion (0-2): 0.3
Elbow extension (0-2): 2
Wrist extension (0-2): 1.3
Finger extension (0-2): 0
Thumb extension (0-2): 0
Toronto Score Total (0-10): 3.6

MALLET
Global Abduction: 2

PROM
Pronation Passive: full
Shoulder ER Passive: 70

Joint Mobilization

- Glenohumeral joint integrity
  - Poor infraspinatus function (due to initial nerve damage)
  - Tightening/shortening of the subscapula from consistent internal rotation positioning
- Scapulohumeral rhythm
  - Poor function of scapular stabilizers

Not quite enough…

- 3/22/13

TORONTO
Elbow flexion (0-2): 0.6
Elbow extension (0-2): 2
Wrist extension (0-2): 1.3
Finger extension (0-2): 0
Thumb extension (0-2): 0
Toronto Score Total (0-10): 3.9

MALLET
Global Abduction: 2
Global External Rotation: 1
Hand to Neck (ER): 2
Hand to Spine (IR): 1
Hand to Mouth: 1
Internal Rotation: 4
Mallet Classification Total Score (0-30): 11

ROM
Pronation Active: 90
Pronation Passive: 90
Supination Active: 0
Supination Passive: 90
Shoulder ER Active: <0
Shoulder ER Passive: 5

AMS
Shoulder Abduction: 2
Shoulder Adduction: 7
Shoulder Flexion: 2
Shoulder External Rotation: 0
Shoulder Internal Rotation: 7
Elbow Flexion: 2
Elbow Extension: 7
Forearm Pronation: 7
Forearm Supination: 0
Wrist Flexion: 1
Wrist Extension: 5
Finger Flexion: 7
Finger Extension: 0
Thumb Flexion: 7
Thumb Extension: 0

Internal Rotation Contractures

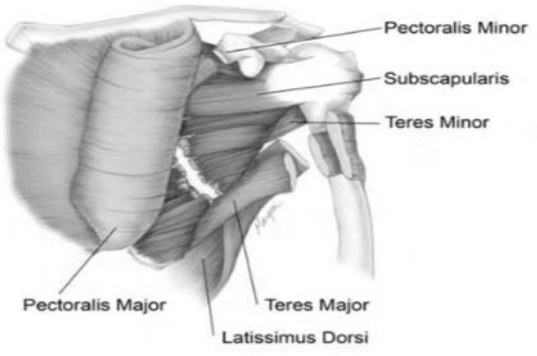
- Contracture rate up to 39% based on severity of initial injury
  - Duijnisveld, et al., 2017
  - Pondaag, et al., 2005
  - Hoeksma, et al., 2003
- Conservative treatment first
  - Stretching, joint mobilizations, antagonist strengthening
  - Botulinum Toxin A
  - Serial casting

2nd Surgery @ 2½ years 4/3/13: Release & tendon transfer

- Sever-L'Episcopo Procedure
- Failure in recovery of adequate left shoulder abduction and external rotation, development of left shoulder internal rotation contracture
- Latissimus and teres major conjoined tendon released from humerus
- Tendons then sutured into the posterior superior rotator cuff through the interval between the triceps and the deltoid

Surgical Release

SURGICAL RELEASE OF:
Pectoralis Minor, Pectoralis Major,
Teres Major, Latissimus Dorsi,
and partial release of the Subscapularis



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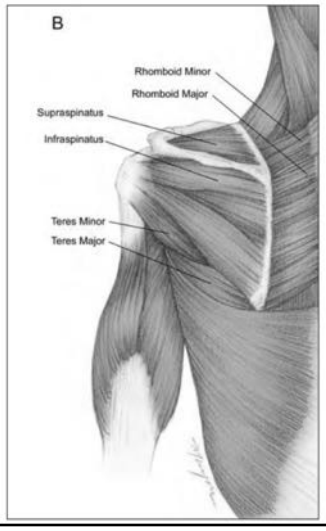
Surgical Tendon Transfer



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Life is never simple…

Therapy Priorities

- Building of core stability followed by facilitation of rotational skills
- Consideration of lower extremity function
- Preparation for function: decreasing tightness in non-affected muscles
- Facilitation of Bilateral Scapular Stability
- Facilitation of Shoulder Function

Shoulder Function

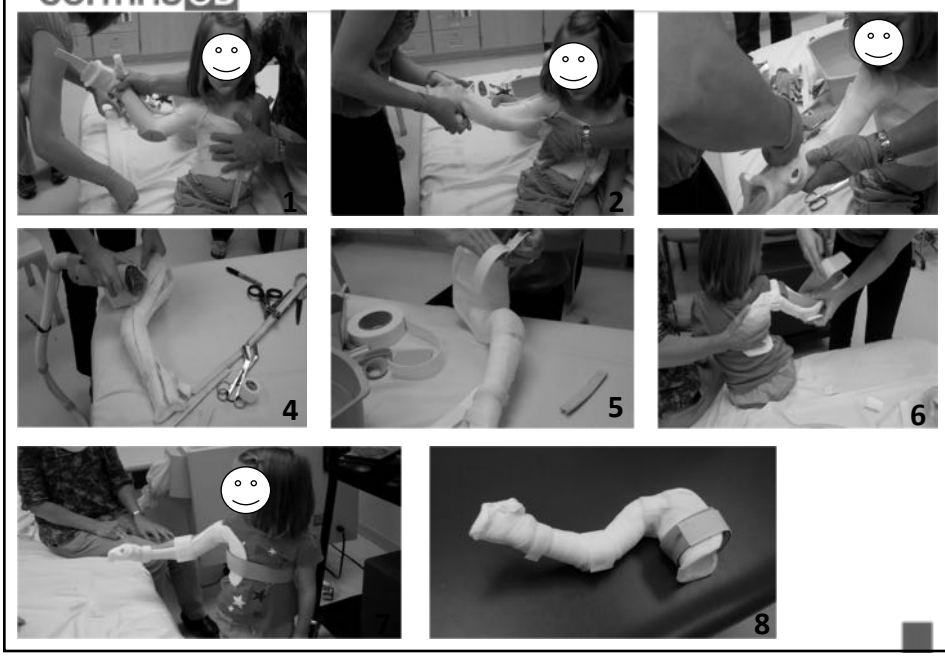
- Build symmetry – lengthen unaffected muscles, strengthening the weak muscles
- Body position – inhibit any compensatory patterns
  - Check early and often
  - New motor pathways that may be now available to the child will be inhibited by old patterns if not discouraged
  - Similar to developmental apraxia/DCD
  - Don't use activities which reinforce old patterns

Facilitation of Overall Function

- Although we are concerned with the affected extremity function, integration of the extremity into bilateral activities of daily living is crucial
  - Start with balance responses
  - Bilateral midline activities
  - Bilateral reaching
- Only when the child has integrated the extremity into their body schema do we isolate out the affected extremity for reaching and use as a assist in function.

Therapy focus

- Aggressive PROM with emphasis on home adherence despite behavioral resistance
- Weightbearing
- NMES
- AROM & strengthening
- Functional use of LUE
  - Very difficult due to lack of grasp/release
- Night splinting to prevent return of IR contracture



Functional strengthening

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Self-Care- Video 3

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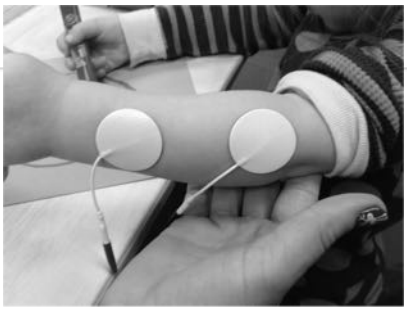
Gains in AROM → gains in function

Video 4



- Continued emphasis on shoulder stretch
- Participation in functional activities
- Time to work on grasp and release!

PARTICIPATION!

- When obsessing over the shoulder and hand, don't forget the elbow!
- Elbow contracture rate: 48%>10º (Sheffler, 2012)
- Limb length discrepancies: 95% of length of unaffected limb (Bae, Ferretti, & Waters, 2008)
- Serial splinting and/or casting

- And don't forget about that forearm!
- Rate of supination contractures: 10-23% (Yam, et al., 2009)
- Pronation contractures: 4-5% (Liggio, et al. 1999)
- Forearm contractures are very difficult to correct conservatively

Serial casting for Pronation

2-piece static-progressive brace

Progress 8/19/14

TORONTO
Elbow flexion (0-2): 1.3
Elbow extension (0-2): 1.3
Wrist extension (0-2): 1.3
Finger extension (0-2): 0.3
Thumb extension (0-2): 0.3
Toronto Score Total (0-10): 4.5

MALLET
Global Abduction: 3
Global External Rotation: 4
Hand to Neck (ER): 2
Hand to Spine (IR): 2
Hand to Mouth: 1
Internal Rotation: 2
Mallet Classification Total Score (0-30): 14

ROM
Pronation Active: 0
Pronation Passive: 90
Supination Active: 0
Supination Passive: 90
Shoulder ER Active: 20
Shoulder ER Passive: 90

AMS
Shoulder Abduction: 2
Shoulder Adduction: 7
Shoulder Flexion: 2
Shoulder External Rotation: 3
Shoulder Internal Rotation: 6
Elbow Flexion: 3
Elbow Extension: 3
Forearm Pronation: 0
Forearm Supination: 0
Wrist Flexion: 1
Wrist Extension: 5
Finger Flexion: 3
Finger Extension: 1
Thumb Flexion: 6
Thumb Extension: 1

Constraint Induced Movement Therapy (CIMT)

- Well-supported intervention for BPBI
- Multiple protocols
- Kristen's schedule
  - Off for school and sports
  - On all waking hours at home
  - 5-8 hrs./day for 6-8 weeks

Self-Feeding

Videos 5 and 6

Functional hand use at home

Videos 7 and 8

CONTINUED

Pronation and Grasp & Release

Videos 9, 10, and 11

CONTINUED

Adapt when needed – function first

Videos 12 and 13

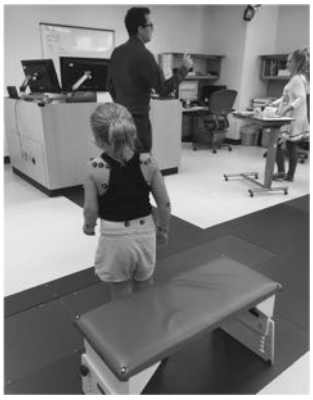
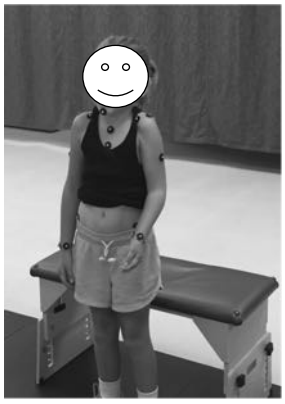
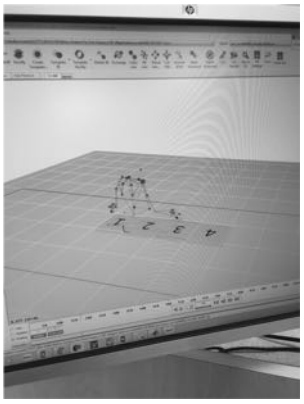
Nothing stops her!

Video 14

- Hand dominance is not straightforward for kids with BPBI

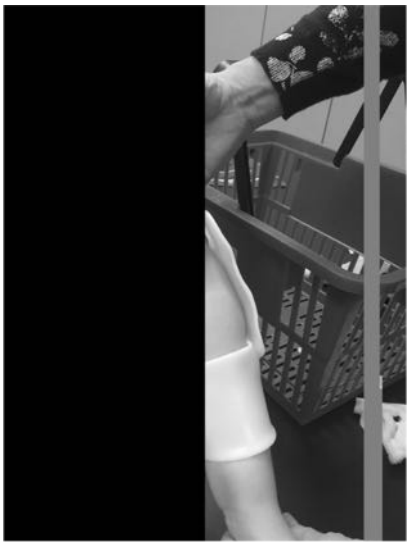
Virtual Reality & Robotics

Motion Analysis Lab

Collaboration with UC Engineering & Design Students

That darn elbow!



What else can improve function?

- 12/19/17
- Toronto

Joint	Numerical Score
Elbow flexion (0-2)	1.6
Elbow extension (0-2)	0.6
Wrist extension (0-2)	1
Finger extension (0-2)	0.3
Thumb extension (0-2)	0
Total score (0-10)	3.5

- Mallet

Motion	Grade Level
Global Abduction	3
Global External Rotation	2
Hand to Neck (IR)	2
Hand to Spine (ER)	2
Hand to Mouth	3
Total score (0-25)	15

ROM
Pronation Active: -90
Pronation Passive: 0
Supination Active: 90
Supination Passive: 90
Shoulder ER Active: 50
Shoulder ER Passive: 90

AMS
Shoulder Abduction: 2
Shoulder Adduction: 7
Shoulder Flexion: 2
Shoulder External Rotation: 6
Shoulder Internal Rotation: 3
Elbow Flexion: 7
Elbow Extension: 2
Forearm Pronation: 0
Forearm Supination: 7
Wrist Flexion: 0
Wrist Extension: 3
Finger Flexion: 1
Finger Extension: 2
Thumb Flexion: 2
Thumb Extension: 2

3rd surgery @ 7 years: Forearm osteotomy & Tendon re-routing

- Supination contracture
- Distal fragment of radius rotated until it rests in ~20º pronation
- Distal limb of the biceps tendon is brought around the radius to provide a pronation moment
- Rerouted biceps tendon is repaired to the proximal stump of the biceps tendon
- Radius fixed with plate and screws

Forearm Osteotomy

Pronated skills

Videos 15 and 16

Time to work on digit control and use

Videos 17 and 18

CONTINUED

Breaking old habits

CONTINUED

Kristen's Toronto Progression

Select Flowsheets to View

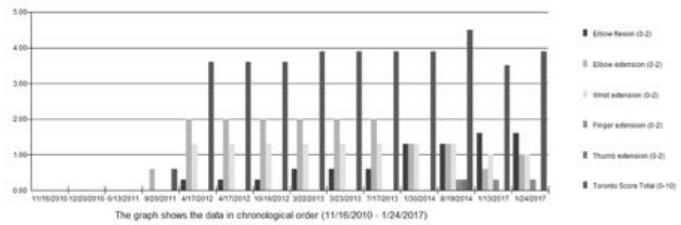
OTPT TORONTO SCORE [970]

Toronto Score	11/16/2010	12/20/2010	6/13/2011	9/20/2011	4/17/2012	4/17/2012	10/16/2012	3/22/2013	3/23/2013	7/17/2013	1/30/2014	8/19/2014	1/13/2017	1/24/2017
Elbow flexion (0-2)	0	0	0	0	0.3	0.3	0.3	0.6	0.6	0.6	1.3	1.3	1.6	1.6
Elbow extension (0-2)	0	0	0	0.6	2	2	2	2	2	2	1.3	1.3	0.6	1
Wrist extension (0-2)	0	0	0	0	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1	1
Finger extension (0-2)	0	0	0	0	0	0	0	0	0	0	0	0.3	0.3	0.3
Thumb extension (0-2)	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0
Toronto Score Total (0-10)	0	0	0	0.6	3.6	3.6	3.6	3.9	3.9	3.9	3.9	4.5	3.5	3.9

Select Flowsheets to View
OTPT TORONTO SCORE [970]

Load More

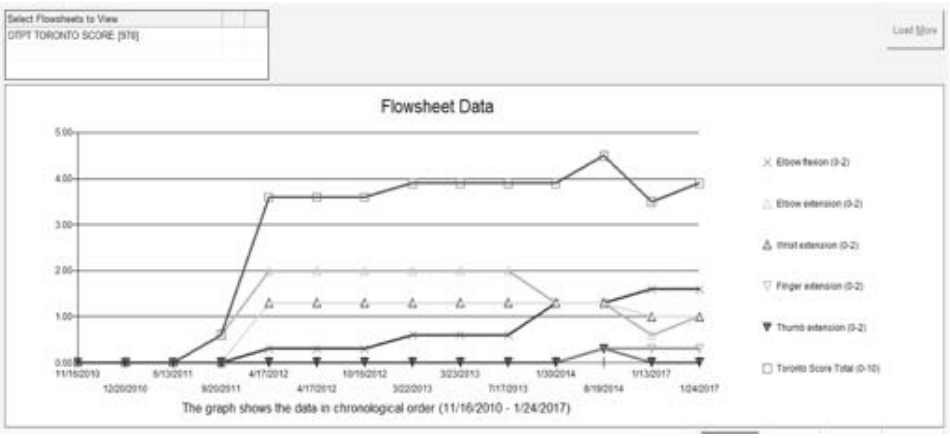
Flowsheet Data



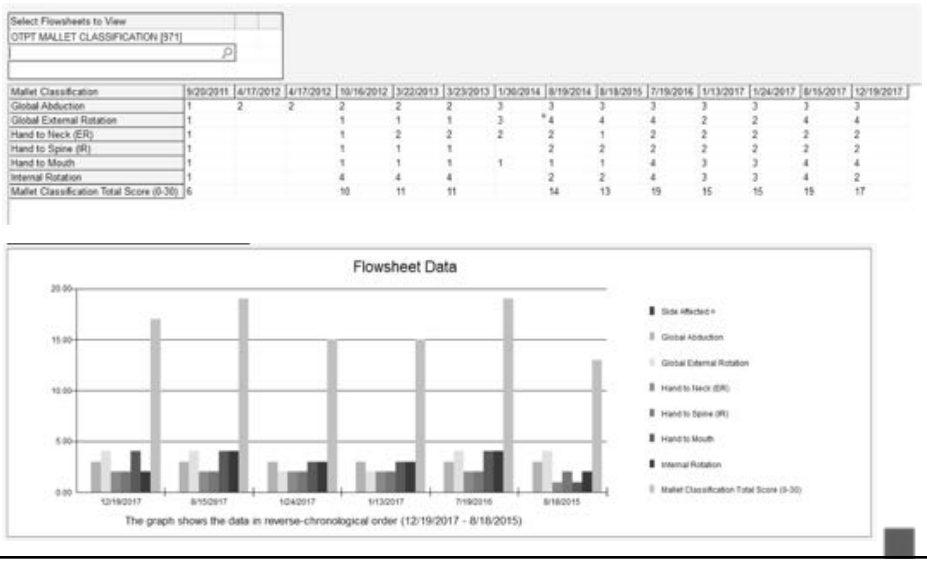
The graph shows the data in chronological order (11/16/2010 - 1/24/2017)

CONTINUED

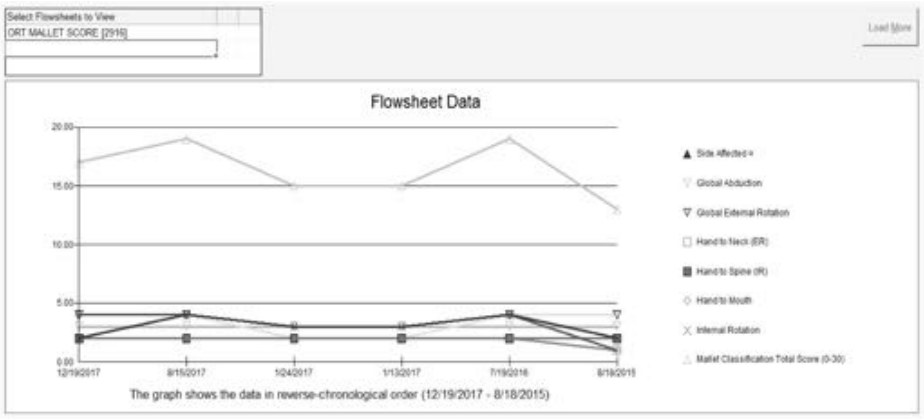
Kristen's Toronto Progression



Kristen's Mallet Progression



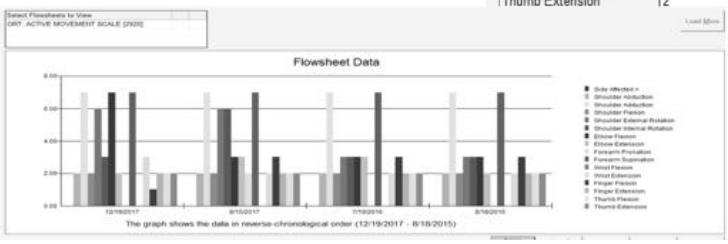
Kristen's Mallet Progression



Kristen's AMS Progression

Select Flowsheets to View
ORT: ACTIVE MOVEMENT SCALE [2920]

Active Movement Scale	12/19/2017	8/15/2017	7/19/2016	8/18/2015
Side Affected	Left	Left	Left	
Shoulder Abduction	2	2	2	2
Shoulder Adduction	7	7	7	7
Shoulder Flexion	2	2	2	2
Shoulder External Rotation	6	6	3	3
Shoulder Internal Rotation	3	6	3	3
Elbow Flexion	7	3	3	3
Elbow Extension	2	3	3	2
Forearm Pronation	0	2	0	0
Forearm Supination	7	7	7	7
Wrist Flexion	0	0	0	0
Wrist Extension	3	2	2	2
Finger Flexion	1	3	3	3
Finger Extension	2	2	2	2
Thumb Flexion	2	2	2	2
Thumb Extension	2	2	2	2



Mom's perspective

- Video

The big picture

- Strive for "normal," but don't expect it
- Tools are not silver bullets
- Obsessing over range in one joint can be costly
  - Takes range from other joints
  - Generally results in compensatory patterns
- Functional activities are far more effective at achieving range and strength gains than are rote exercises
- Ultimate goal is to PARTICIPATE and find enjoyable activities which demand BUE use

CONTINUED

Participation is KEY

CONTINUED

Special thanks to Kristen
and her fabulous Mom, Nedra
who play along with
all my crazy OT ideas