

# Brachial Plexus Program



Kim Bjorklund, MD - Plastic and Reconstructive Surgery

Wilawan Nopkhun, MD - Physical Medicine and Rehabilitation

---

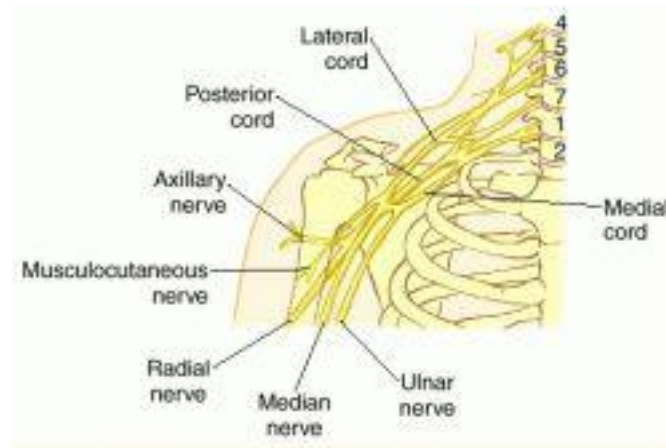


**NATIONWIDE CHILDREN'S**  
*When your child needs a hospital, everything matters.™*

# Brachial Plexus Team

- Comprehensive multidisciplinary approach to brachial plexus and peripheral nerve injuries
- Injuries may be birth-related, traumatic, oncologic among other causes
- Team of experts provides individualized care to each patient and family

# “Brachial Plexus”



- **“Brachial Plexus Birth Injury” (BPBI):**  
*Weakness of the brachial plexus resulting from injury before or during birth process*
- *“Obstetrical” palsy – medico-legal implications*

# Incidence BPBI

- **1-2 per 1000 births**
- **Consistent over time**
- **Right > Left**

## Anatomic location:

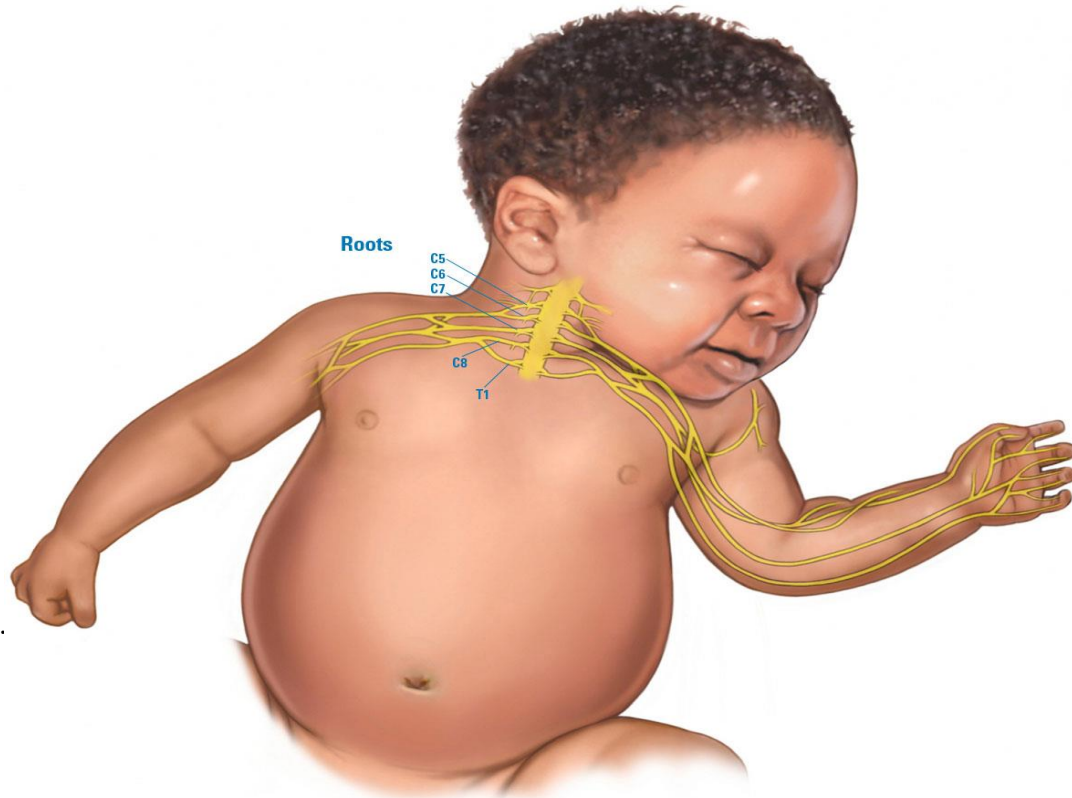
- **50-60% = C5,C6**
- **20-30% = C5,C6,C7**
- **20% = global palsy (C5,C6,C7,C8,T1)**
- **Rare = C8,T1**

*(Gilbert, 1991)*

---

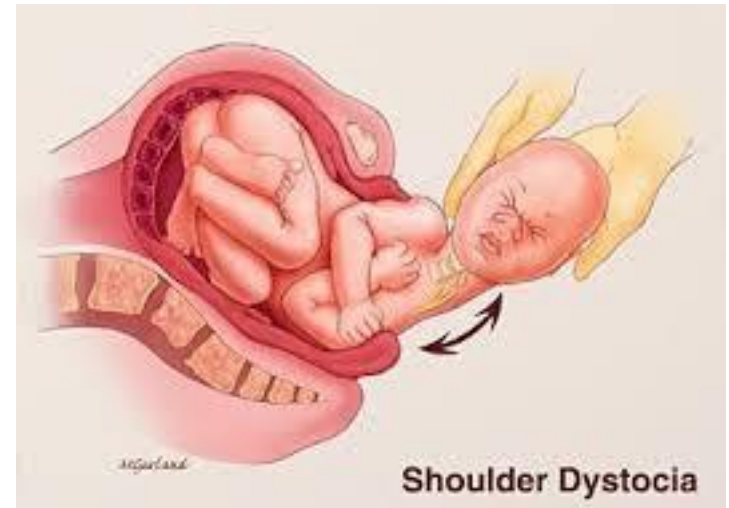
# Etiology

- Neonatal brachial plexus injury occurs from traction on the plexus, resulting in stretch injury or avulsion



# Risk factors

- Shoulder dystocia (100x risk)
  - Large birth weight ( $>4.5\text{kg}$  = 14x risk)
  - Forceps delivery (9x risk)
  - Prolonged labour
  - Multiparity
  - Gestational diabetes
- 
- Clavicle fractures may also be present
  - Humerus fractures if present are contralateral



# Diagnosis

- **Typical presentation:**
- Abnormal posture & motion arm – classic “Waiter’s tip” posture
- Asymmetric reflexes (Moro, tonic neck)



NATIONWIDE CHILDREN'S  
*When your child needs a hospital, everything matters.™*



# Differential Diagnosis

- Clavicle or humerus fracture
- C-spine injury
- CP, other neurologic conditions





# Investigations

- CXR
- U/S – diaphragm & shoulder
- Electrodiagnostics – EMG & Nerve conduction
- MRI
- **CLINICAL ASSESSMENT**

# Physical Exam

- General appearance – syndromic, CP
- Horner's, Diaphragm symmetry
- Position of arm at rest
- Active/passive ROM shoulder, elbow, wrist, fingers
- Reflexes: Moro, Tonic neck – disappear after approximately 6 months of age
- Torticollis
- Sensation – pinch test



# Moro reflex



# Tonic neck

- “Fencing” posture



# Assessment scales

- **Active Movement Scale (“AMS”) = Infants**
- From Hospital for Sick Children, Toronto, Ontario
- Evaluates spontaneous movement & joint movement
- 15 motions tested with gravity eliminated and then against gravity
- Each motion scored 0-7

Curtis, et al., 2002

---

# AMS

---

With gravity eliminated:

No contraction 0

Contraction without movement 1

Movement  $< \frac{1}{2}$  of ROM 2

Movement  $> \frac{1}{2}$  of ROM 3

Full movement 4

Against gravity:

Movement  $< \frac{1}{2}$  of ROM 5

Movement  $> \frac{1}{2}$  of ROM 6

Full movement 7




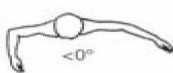

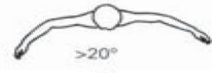












---

Clarke HM, Curtis CG. An approach to obstetrical brachial plexus injuries. Hand Clin. 1995, 11: 563–80. ROM - Range of Motion

---

# Assessment scales

- **Modified Mallet – children (>3 years)**
- Evaluates shoulder function
- Must be able to follow commands

Modified Mallet classification (Grade I = no function, Grade V = normal function)						
	Not Testable	Grade I	Grade II	Grade III	Grade IV	Grade V
Global Abduction	Not Testable	No function	 <30°	 30° to 90°	 >90°	Normal
Global External Rotation	Not Testable	No function	 <0°	 0° to 20°	 >20°	Normal
Hand to neck	Not Testable	No function	 Not possible	 Difficult	 Easy	Normal
Hand to spine	Not Testable	No function	 Not possible	 S1	 T12	Normal
Hand to mouth	Not Testable	No function	 Marked trumpet sign	 Partial trumpet sign	 <40° of abduction	Normal
Internal rotation	Not Testable	No function	 Cannot Touch	 Can touch with wrist flexion	 Palm on belly No wrist flexion	Normal

# Critical clinical findings

- **Horner's?**
- **Diaphragm asymmetry?**
- **Shoulder – is it dislocated?**
- **Biceps function?**
- **Sensation?**



# Natural History

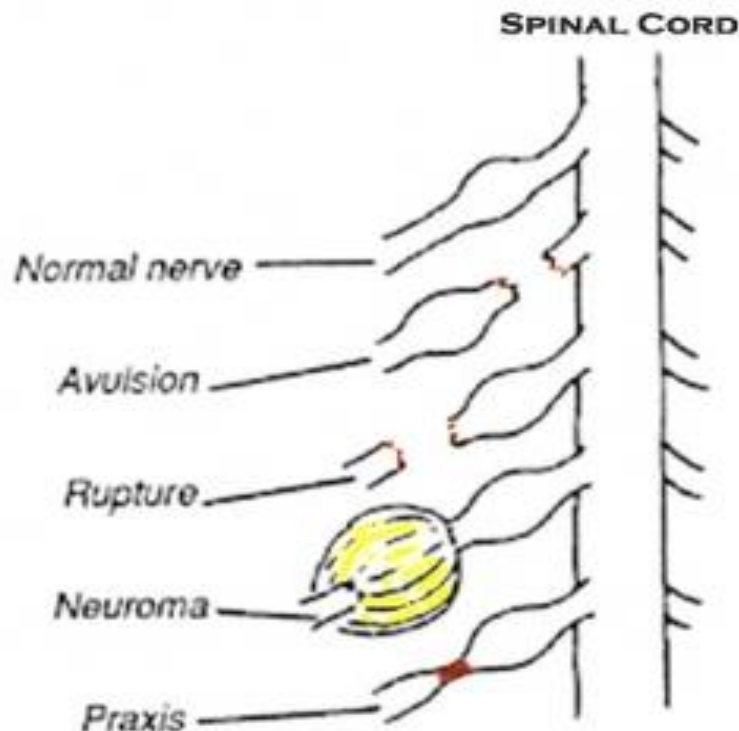
- Injury TYPE

- LOCATION

Upper roots

Lower

Total (all roots)



NATIONWIDE CHILDREN'S  
When your child needs a hospital, everything matters.™

# Natural History

- Full recovery of antigravity biceps at 2 months = complete recovery all arm function in the first 2 years
- 60% infants with NBPP have spontaneous recovery by 2 months
- 20-30% infants with NBPP have incomplete spontaneous recovery
- Infants with total palsy & no recovery by 2 months = poor prognosis for spontaneous recovery

# Management

- Options:
- Non-surgical
- Neurolysis
- Nerve grafting
- Nerve transfers
- Tendon transfers

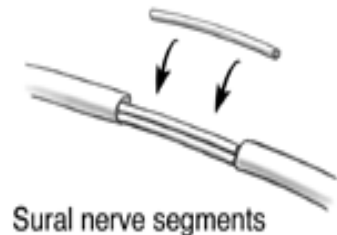
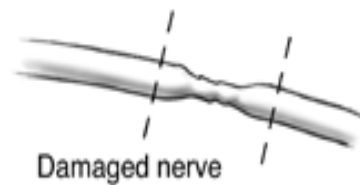
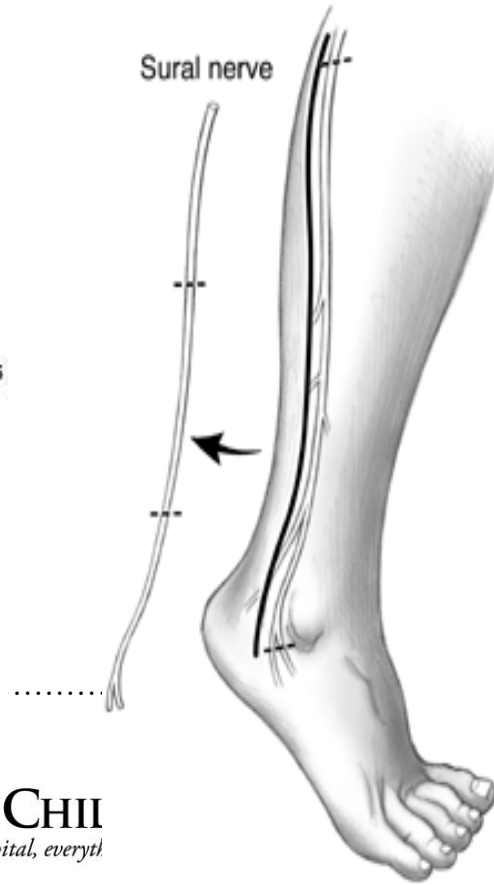
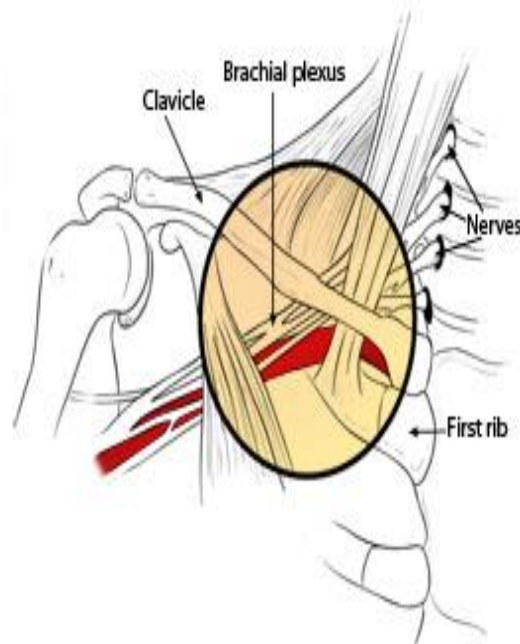
# Non-surgical management

- OT
- ROM, stretching
- Splinting/bracing
- Botox injections

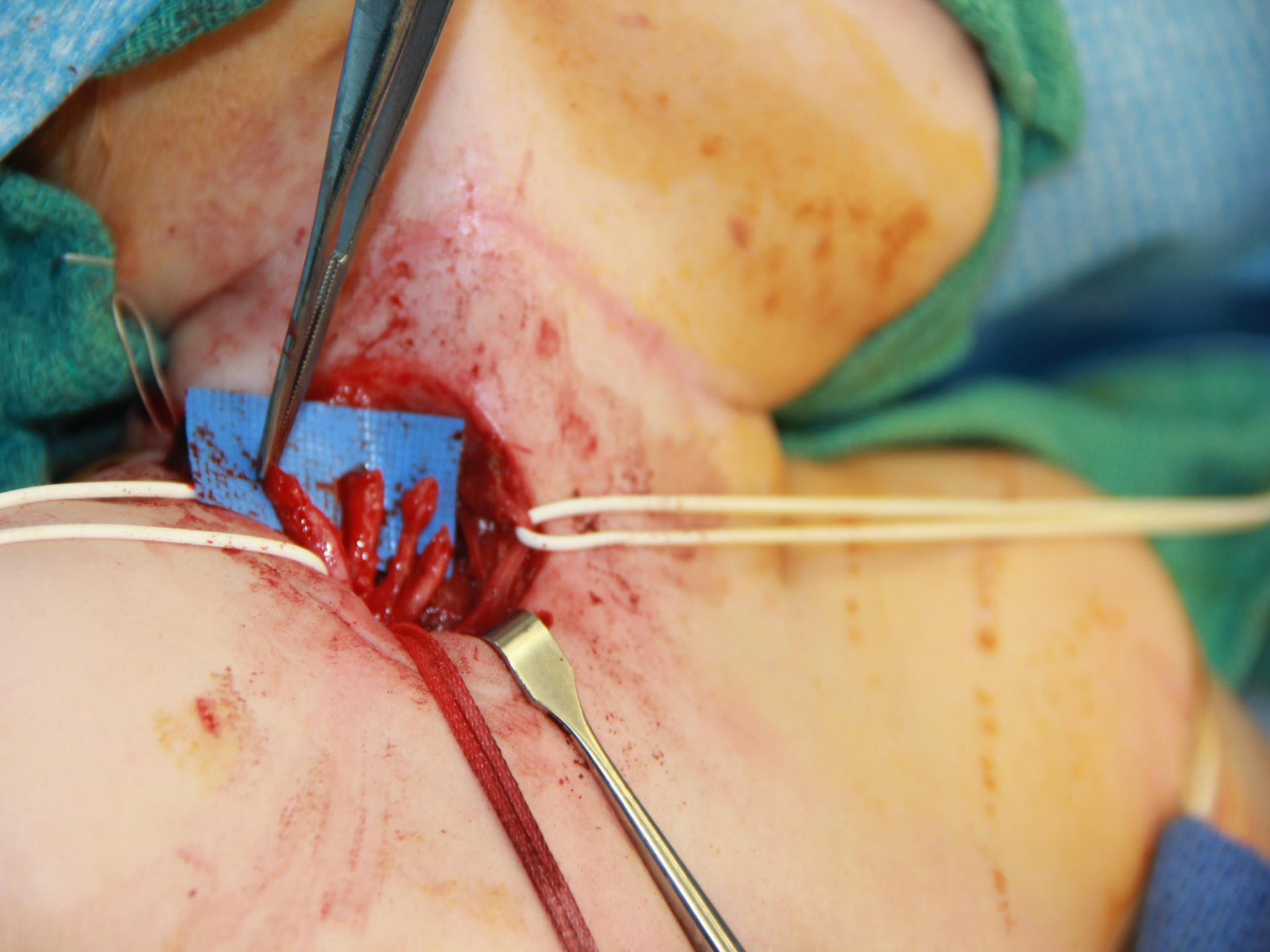


# Surgery

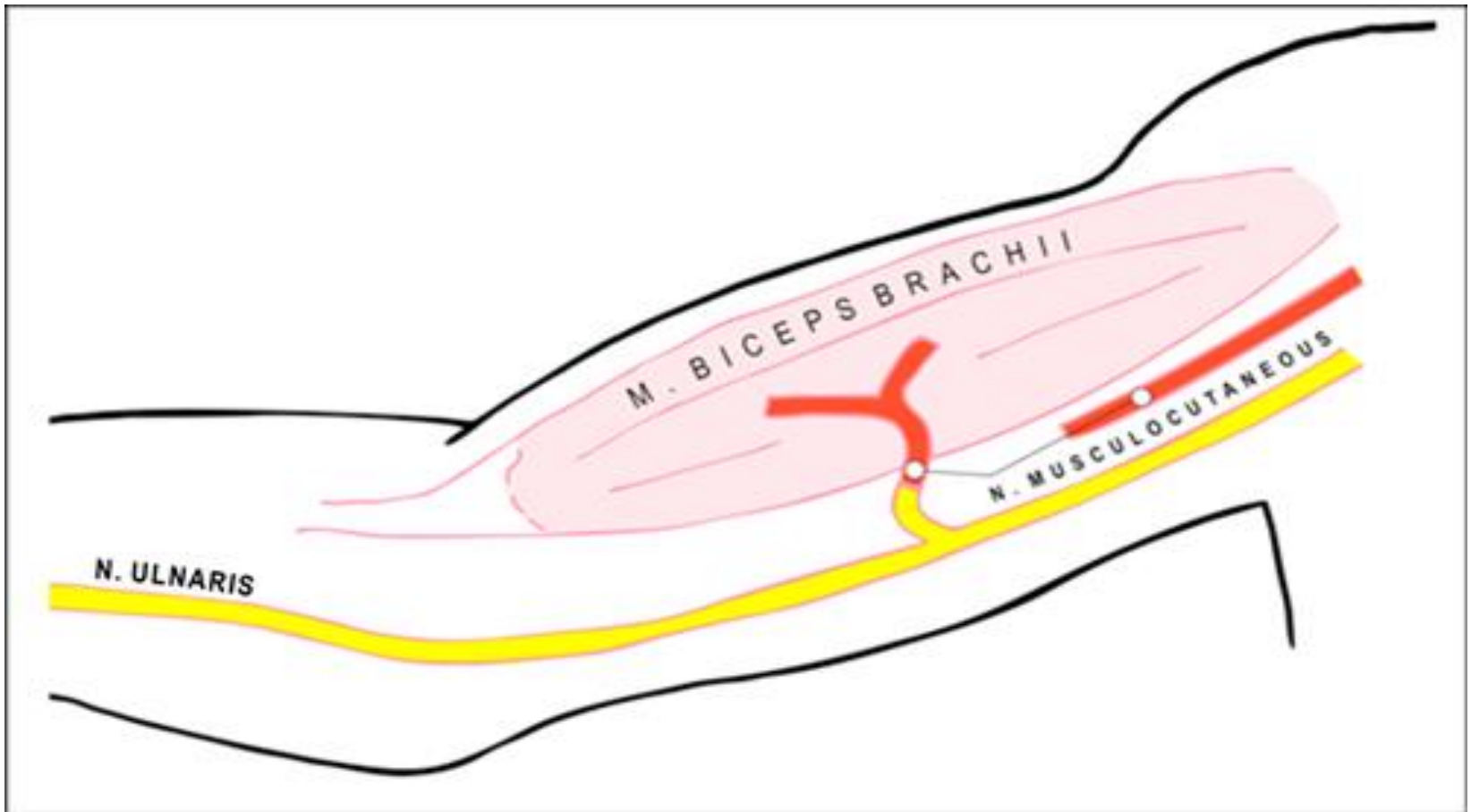
- **Nerve grafting:**
- Exploration brachial plexus, resect neuroma/scar, bilateral sural nerve harvest, cable grafts







# Nerve transfers

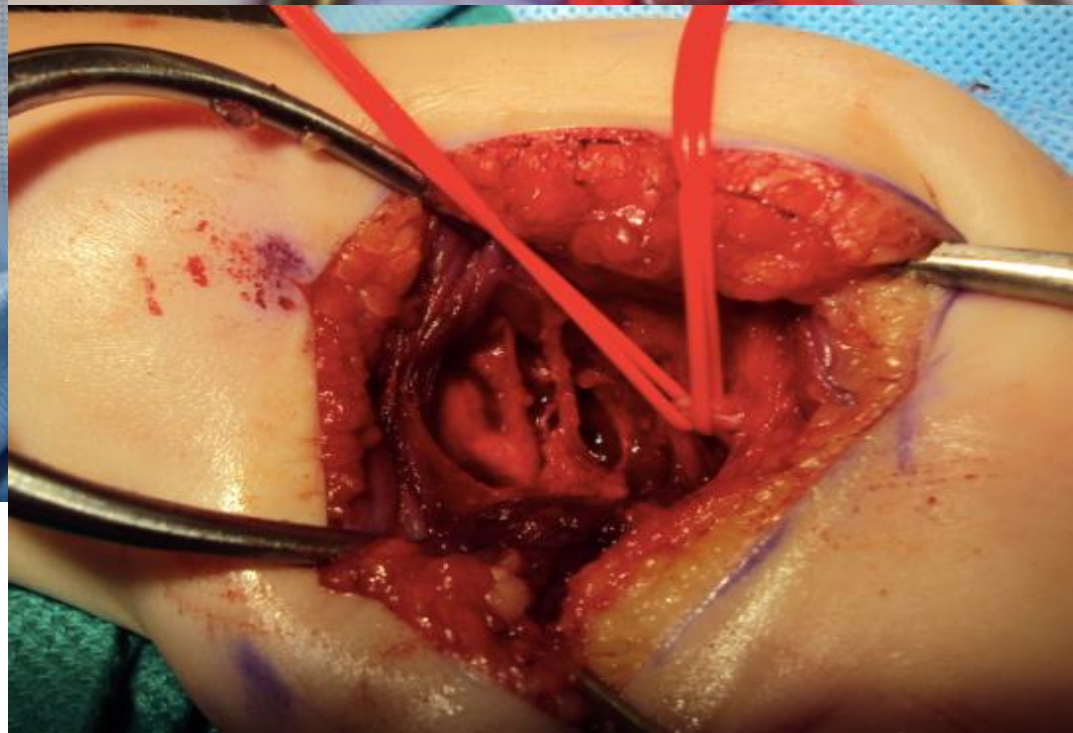
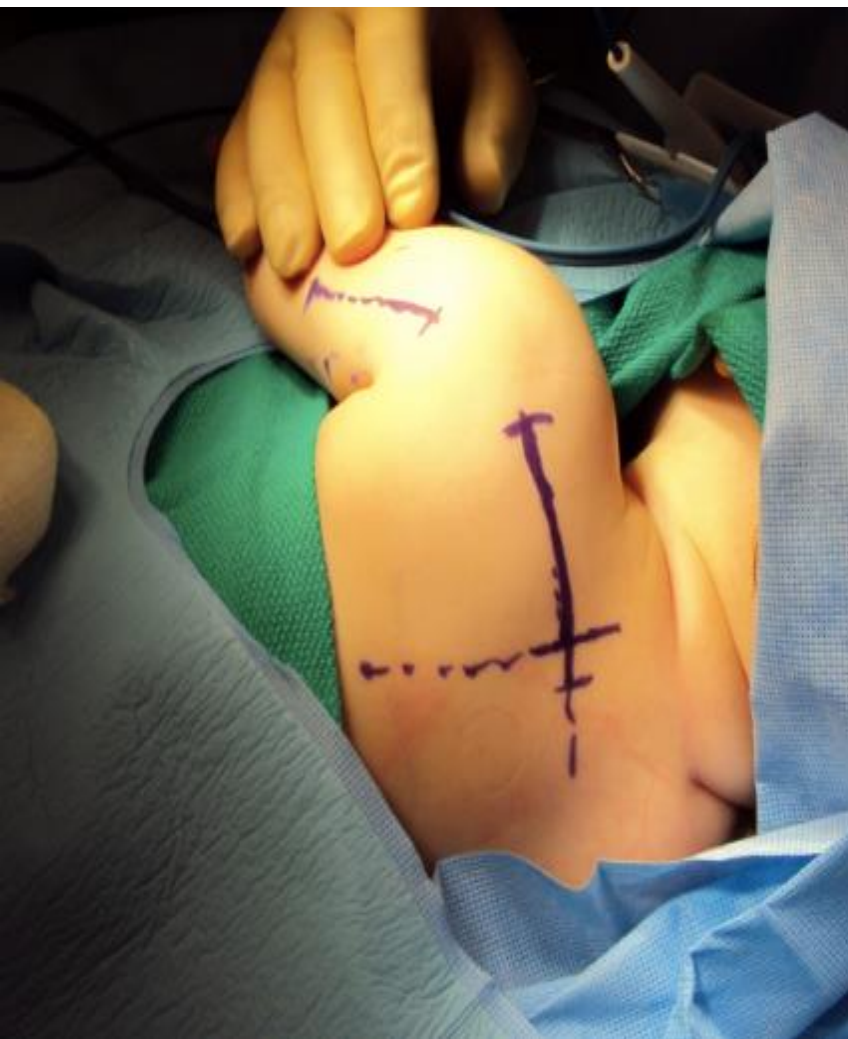


**NATIONWIDE CHILDREN'S**  
*When your child needs a hospital, everything matters.™*

# Common Nerve Transfers:

- SAN to SSN (shoulder)
- Radial to Axillary (shoulder)
- Oberlin Median/Ulnar to MCN (elbow flexion)
- **Other options:**
- ICN to MCN
- Contralateral C7 (usually to lower trunk for hand)
- Medial pectoral, thoracodorsal, phrenic





# Post-op

- Nerve grafting – CXR & U/S (Phrenic N function)
- 1-3 days in hospital
- Swathe & sling 3 weeks, then resume therapy
- Expected recovery – within 1 year transfers, up to 3 years nerve grafting



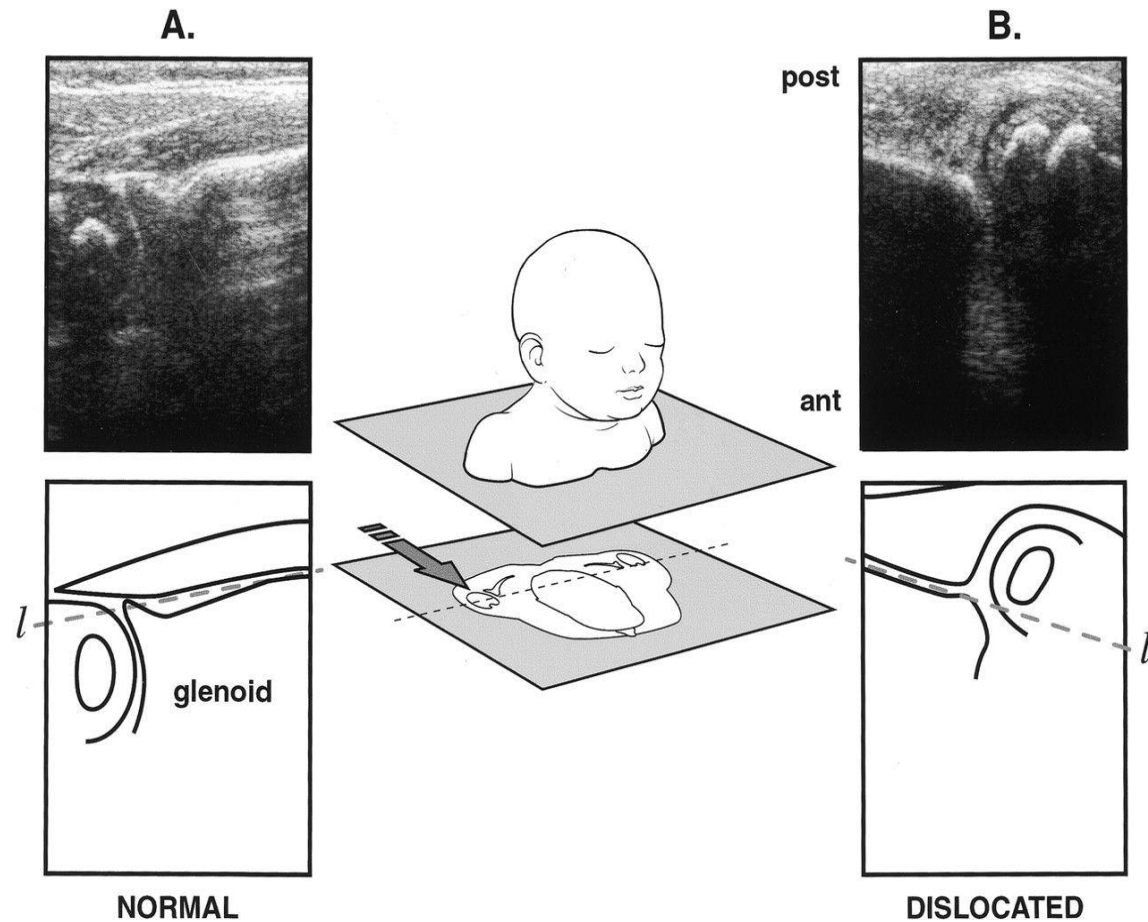
# Shoulder dislocation

- **8-10%** of NBPP infants have posterior shoulder dislocation within 1 year (Dahlin, Ezaki)
- Paralyzed external rotator muscles & normal internal rotators
- Recognize & treat to avoid long term deformity of glenohumeral joint



# Management of shoulder

- U/S for suspected dislocation
- No sedation, no radiation
- MRI for concern of chronic glenohumeral dysplasia



# Management of shoulder

- Reduction to anatomic position (closed, open, arthroscopic)
- +/- Spica casting 4-6 weeks, +/- Botox internal rotator muscles
- Tendon transfers (LD, Teres Major to rotator cuff to act as external rotator ) +/- release Subscapularis, Pec Major to minimize future GH dysplasia
- Derotational humeral osteotomy for longstanding changes of GH joint



# Timing of BPBI Management

- **< 1 month old** = OT/PT, serial clinical exams monthly
- **3 months:** Total palsy = Surgical exploration
- **3 months:** Partial biceps, upper palsy, no signs avulsions = Serial clinical exams until 6 months
- **6-9 months:** Incomplete biceps recovery = Surgery (nerve grafting vs transfers)

# Summary

- BPBI continues to be common
- Critical to establish early diagnosis & refer to multidisciplinary team
- Infants with unchanged global palsy at 3 months require surgical exploration & nerve grafting
- Infants with upper trunk palsy alone can be observed until approximately 6 months for biceps function
- Nerve grafting vs nerve transfers continue to be evaluated
- Evaluate the shoulder for potential posterior dislocation at all ages

# Brachial Plexus Team

- Early evaluation and treatment is essential to best outcomes
- Therapy for flexibility & strength while awaiting recovery is critical
- Offer collaborative, multidisciplinary, evidence-based approach to caring for brachial plexus birth injuries



## Brachial Plexus Program Fast Facts



**5** Services  
Lines Participate

- Plastic and Reconstructive Surgery
- Physical Medicine and Rehabilitation
- Orthopedics
- Occupational Therapy
- Radiology

**100+**  
patients a year



Patients range  
in age from **birth**  
to **young adult**



Average time from referral to  
OT assessment – **within 2 weeks**

## Meet Our Multidisciplinary Team



Kim A. Bjorklund, MD  
*Plastic and  
Reconstructive Surgery*



Wilawan Nopkhun, MD  
*Physical Medicine and  
Rehabilitation*



Kristin Fisher, OTR/L  
*Occupational Therapy*



Kathryn S. Milks, MD  
*Radiology*



James E. Popp, MD  
*Orthopedics*