

# ***Surgical Concepts and Techniques in Pediatric Brachial Plexus Injury***

***Rahul Nath, MD***



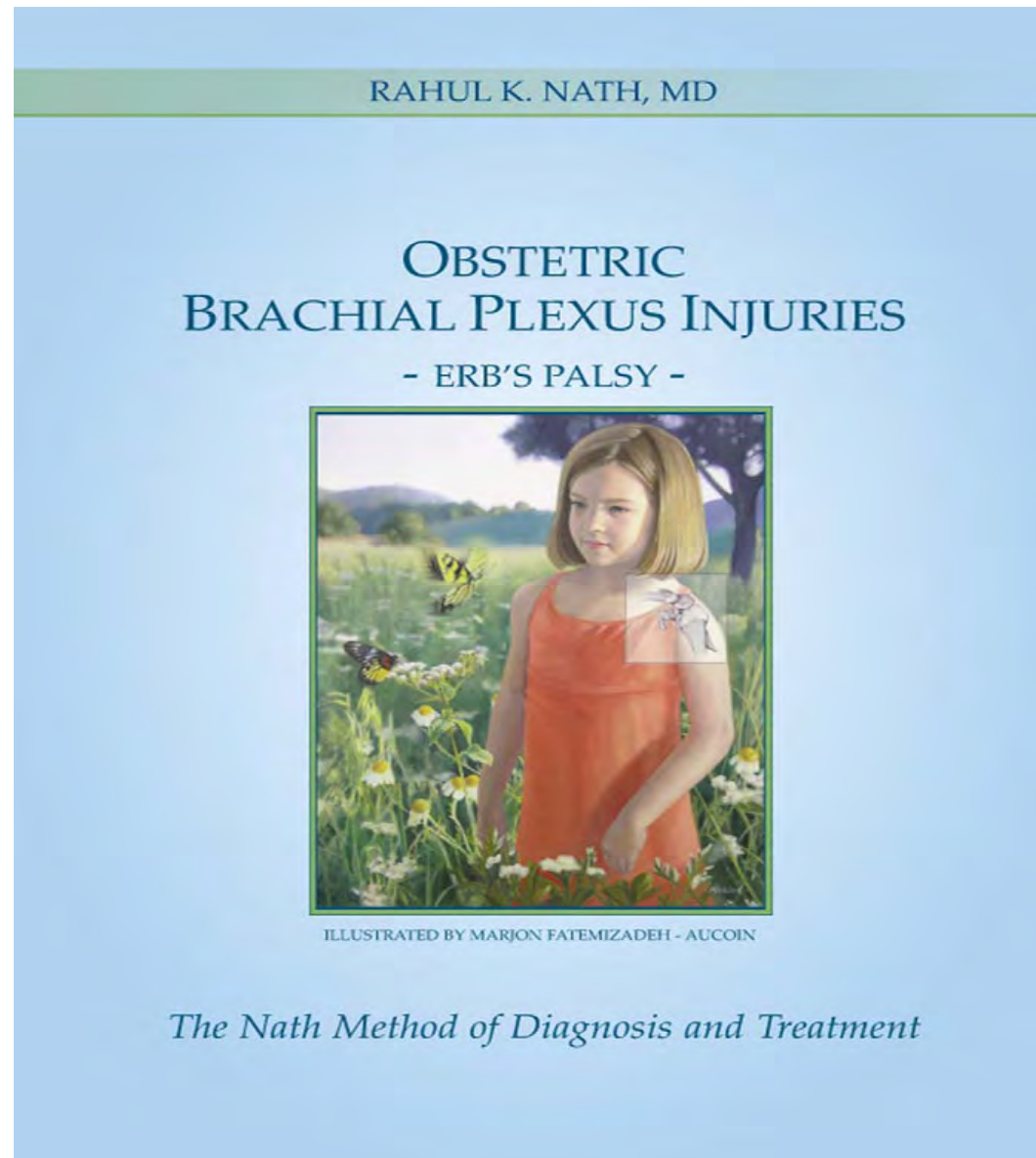
# Disclaimer

This presentation is intended as an informational resource only for therapists working with peripheral nerve injuries. This is a general outline of Dr. Nath's management protocols; other specialists may have different protocols. Many other surgeries or therapy management may be indicated in more complex or less complex cases. No attempt to provide specific medical advice is intended. It is not intended to infer that surgery is always the best choice for a particular nerve injury. You should always contact a specialist directly for diagnosis and treatment of your specific problem, and a second opinion is always a good idea.

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***Management Protocols are  
Based on Book:***

***The Nath Method of  
Diagnosis and Treatment***



***“Nerve injury in the brachial plexus of the newborn results in fibrosis of the muscles and eventual bony deformity...”***

**Whitman R: The treatment of congenital and acquired luxations at the shoulder in childhood. *Ann Surg* 1905, 42(1):110-115.**

# Pediatric Plexus Injury vs. Adult Plexus Injury

***Growth Issues***

***More secondary surgery***

***No Growth Issues***

***Less secondary surgery***

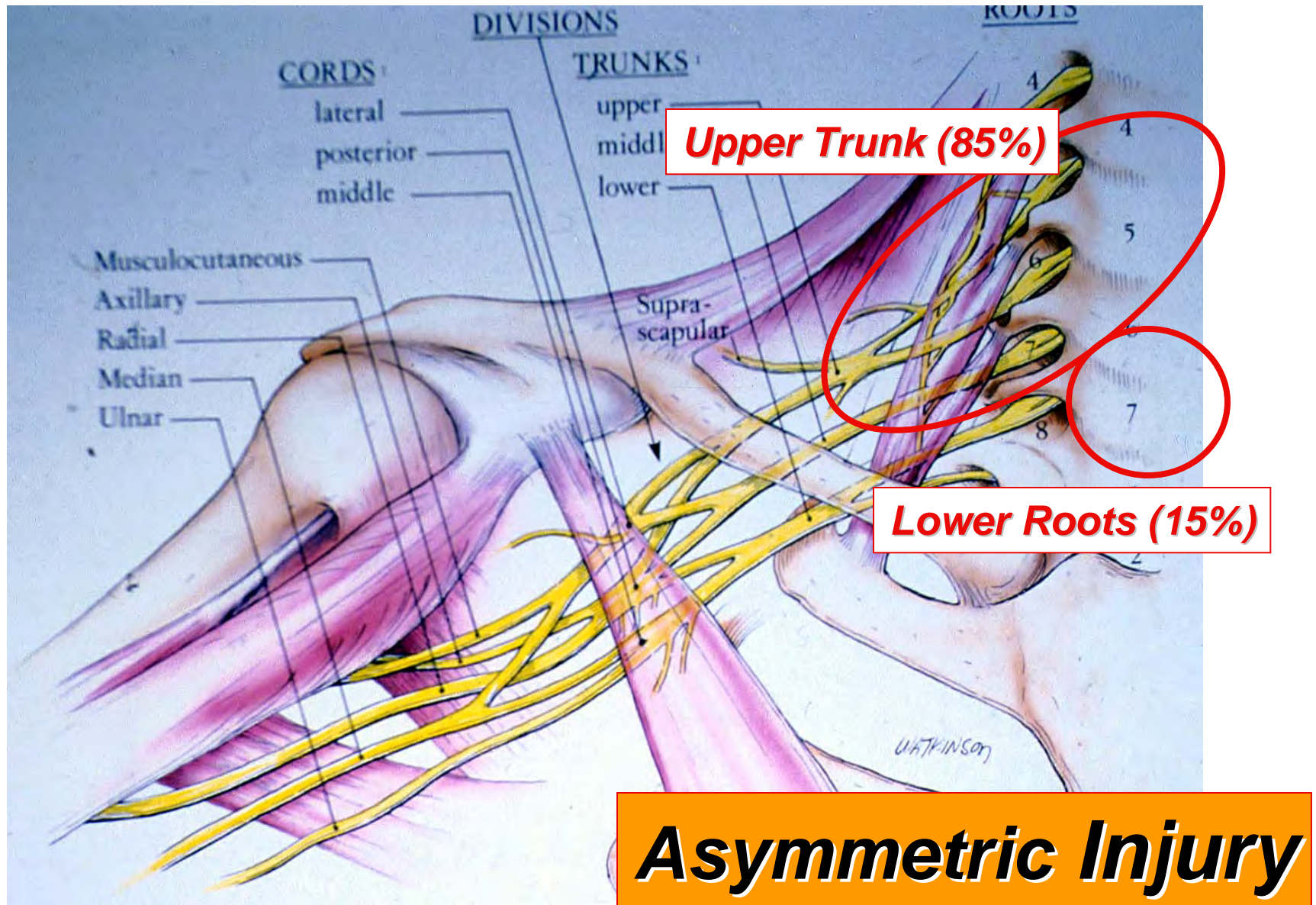
# ***Contents***

- ***ANATOMY***
- ***BRACHIAL PLEXUS INJURY***
- ***BRACHIAL PLEXUS INJURY OUTCOMES***
- ***BRACHIAL PLEXUS SURGERY***
- ***CASE STUDIES***

# Contents

- **ANATOMY:**
  - *5 roots of the brachial plexus: C5-T1*
  - *Upper roots are C5,6*
  - *C5 = Shoulder function and growth*
  - *C6 = Biceps function and arm growth*

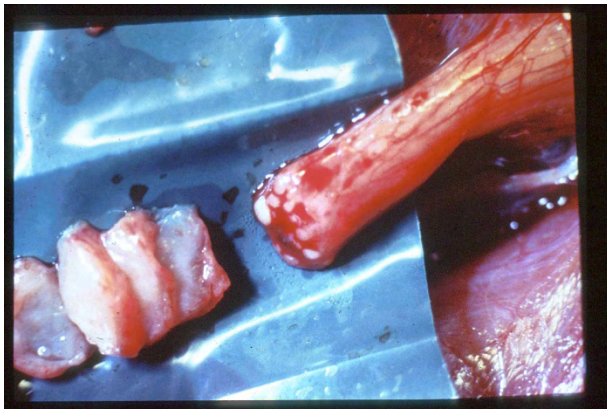






# *Contents*

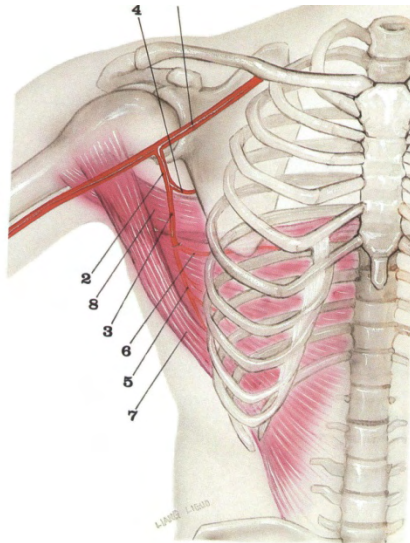
- *BRACHIAL PLEXUS INJURY*
  - Upper roots are more frequently injured than lower ones: ASYMMETRIC INJURY
  - Because injury tends to be ASYMMETRIC, muscle growth is also ASYMMETRIC and leads to MUSCLE IMBALANCES



***Asymmetric  
Nerve Injury***



***Muscle  
Imbalances***



***Shoulder  
Dislocation***

**Birth to 36 months: Girls**  
Length for age percentiles

The chart displays weight and length percentiles for girls from birth to 36 months. The y-axis represents weight in kg (0 to 16) and lb (0 to 35). The x-axis represents age in months (0 to 36). The chart includes curves for the 5th, 10th, 25th, 50th, 75th, 90th, 95th, and 100th percentiles for both weight and length. A red circle highlights the 50th percentile curves for weight and length.

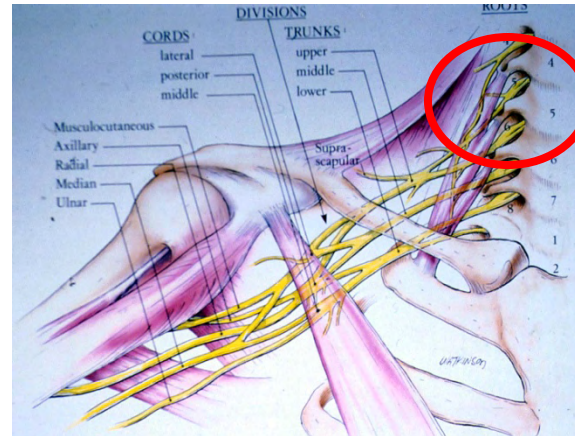
**Legend:**

- W (kg)
- W (lb)
- L (cm)
- L (in)

**Table:**

Percentile	Weight (kg)	Weight (lb)	Length (cm)	Length (in)	Comment
100	16.0	35.3	91.4	36.0	
95	15.0	33.1	89.1	35.1	
90	14.0	30.9	86.9	34.2	
75	12.5	27.5	84.1	33.1	
50	10.0	22.0	80.0	31.5	
25	8.0	17.6	75.0	29.5	
10	6.0	13.2	70.0	27.6	
5	5.0	11.0	67.0	26.4	

**Source:** WHO Child Growth Standards: International Survey of Body Growth (2006)



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## Asymmetric Injury

May 25, 2012

May 25, 2012

# ***Plexus Injury Types***

- ***Stretch (Neuropraxia)***
- ***Tear (Rupture/ Avulsion)***

# *Contents*

- *Outcomes*

- *Nerve injury = Muscle weakness*
- *Asymmetric nerve injury = Muscle imbalances*
- *Muscle imbalances = Shoulder dislocation*

# ***Brachial Plexus Injury Outcomes Based on Literature***

- 1. Muscle Weakness***
- 2. Contracture Formation***
- 3. Shoulder Dislocation***



# *1. Muscle Weakness: Affecting Shoulder and Biceps*



***6 Month- old child with 0/5 Biceps and 0/5 Shoulder***

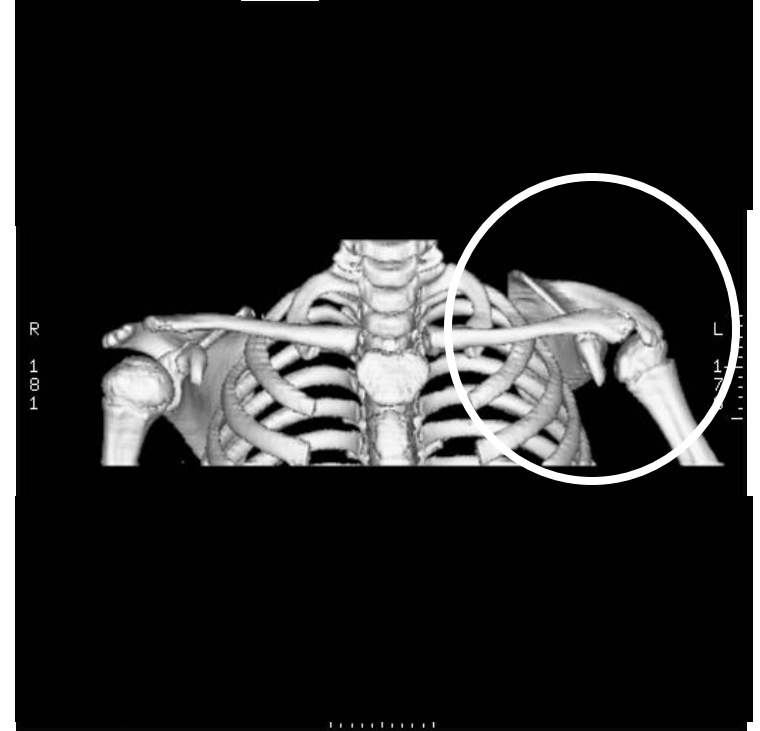


## *2. Muscle Imbalances: Shoulder Internal Rotators and Adductors become stronger than External Rotators*



***5 year old child with Contractures:  
Restricted Shoulder Abduction***

### *3. Muscle Imbalances are associated with Elevated Scapula and Subluxed Shoulder Joint*



***Note: 3D CT Scan shows Left SHEAR Deformity***

# Contents

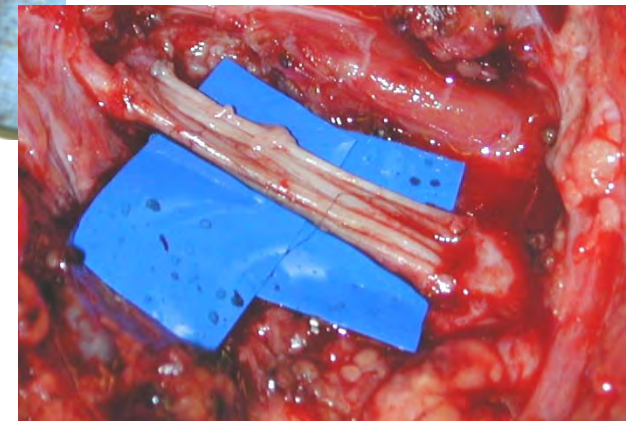
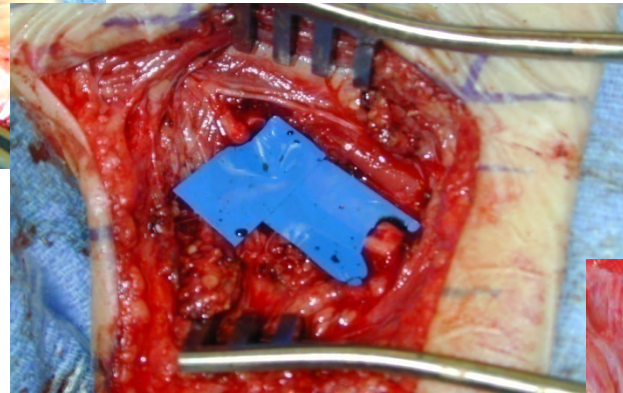
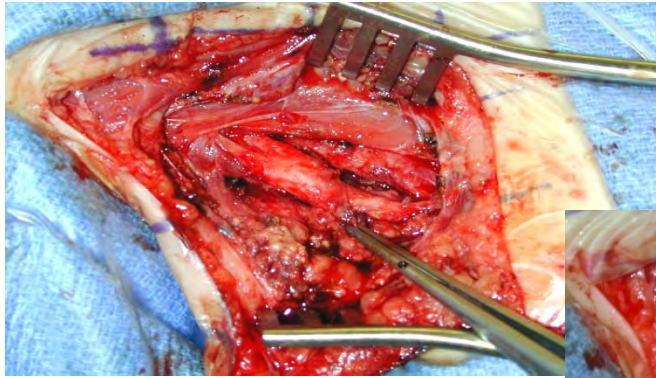
- *Surgery*

- *Nerve injury tends to be stretch, not tear or avulsion = Infrequent need for nerve graft*
- *Muscle imbalances are common = Modified quad surgery*
- *Shoulder joint dislocation is common = Triangle tilt surgery*

# ***Brachial Plexus Surgery***

- 1. Nerve Graft/ Repair (Unusual)***
- 2. Contracture Release (Mod quad surgery is common)***
- 3. Bone/ Joint Surgery (Triangle tilt surgery is common)***

# *1. Nerve Graft*



# ***Outcome Research: Be cautious about nerve grafting***

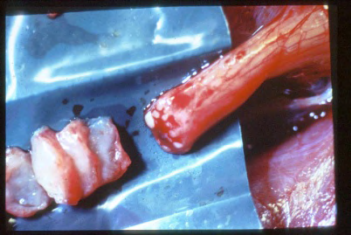
- Nath RK. Nerve grafting worsens shoulder bony deformities in obstetric brachial plexus injury. *J Bone Joint Surg (Br.)* 2009.
- Strömbeck C, Krumlinde-Sundholm L, Forssberg H. Functional outcome at 5 years in children with obstetrical brachial plexus palsy with and without microsurgical reconstruction. *Dev Med Child Neurol.* Mar 2000;42(3):148-157.





## ***Patient After Nerve Grafting: Residual Shoulder Problems are Common***



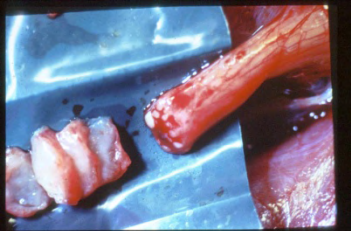


# ***Biceps/ Triceps Co- contraction***

- In a study of **482** children with brachial plexus palsies, **2.5%** of children developed biceps-triceps cocontractions.
  - Rollnik JD, Hierner R, Schubert M, et al. Botulinum toxin treatment of cocontractions after birth-related brachial plexus lesions. *Neurology*. Jul 12 2000;55(1):112-114.
- Co- contraction is more common cause of “biceps weakness” than actual nerve injury to the biceps nerve

# ***BoTox (Instead of Nerve Graft)***

- ***Co-contraction of biceps and triceps***
- ***Effective for triceps (releases biceps)***
- ***Less useful in Latissimus, Teres major, pectoralis, subscapularis***



# *Botox for Biceps/ Triceps Co-contraction*

- Basciani M, Intiso D. Botulinum toxin type-A and plaster cast treatment in children with upper brachial plexus palsy. *Pediatr Rehabil.* Apr-Jun 2006;9(2):165-170.
- DeMatteo C, Bain JR, Galea V, Gjertsen D. Botulinum toxin as an adjunct to motor learning therapy and surgery for obstetrical brachial plexus injury. *Dev Med Child Neurol.* Apr 2006;48(4):245-252.
- Desiato MT, Risina B. The role of botulinum toxin in the neuro-rehabilitation of young patients with brachial plexus birth palsy. *Pediatr Rehabil.* Jan-Mar 2001;4(1):29-36.
- Heise CO, Lorenzetti L, Marchese AJ, Gherpelli JL. Motor conduction studies for prognostic assessment of obstetrical plexopathy. *Muscle Nerve.* Oct 2004;30(4):451-455.
- Hierner R, Rollnik JD, Berger AC, Dengler R. Botulinum toxin type a for the treatment of biceps/triceps co-contraction in obstetrical brachial plexus lesions. Preliminary results after a follow-up of 18 months. *Eur J Plast Surg.* 2001;24(1):2-6.
- Rollnik JD, Hierner R, Schubert M, et al. Botulinum toxin treatment of cocontractions after birth-related brachial plexus lesions. *Neurology.* Jul 12 2000;55(1):112-114.

# ***Biceps/ Triceps Co- Contraction***



***6 Month- old child with 0/5 Biceps and 0/5 Shoulder***

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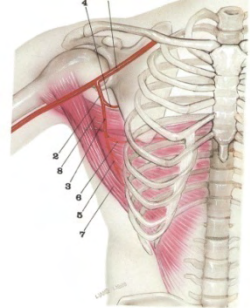
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# ***Biceps/Triceps Co- Contraction***



***Same child 18 months old, NO NERVE GRAFTING,  
Botox to triceps instead***



## 2. Muscle Complications

- A far greater number of children will develop significant contractures in the shoulder. In one study of 62 children, 45% of patients recovering biceps after three weeks developed contractures of the shoulder
  - Hoeksma AF, Wolf H, Oei SL. Obstetrical brachial plexus injuries: incidence, natural course and shoulder contracture. *Clin Rehabil.* Oct 2000;14(5):523-526



# ***Contractures in Axilla/ Chest***



***5 year old child with Contractures:  
Restricted Shoulder Abduction: Modified  
quad surgery is often indicated***



# ***Contractures in Axilla/ Chest***

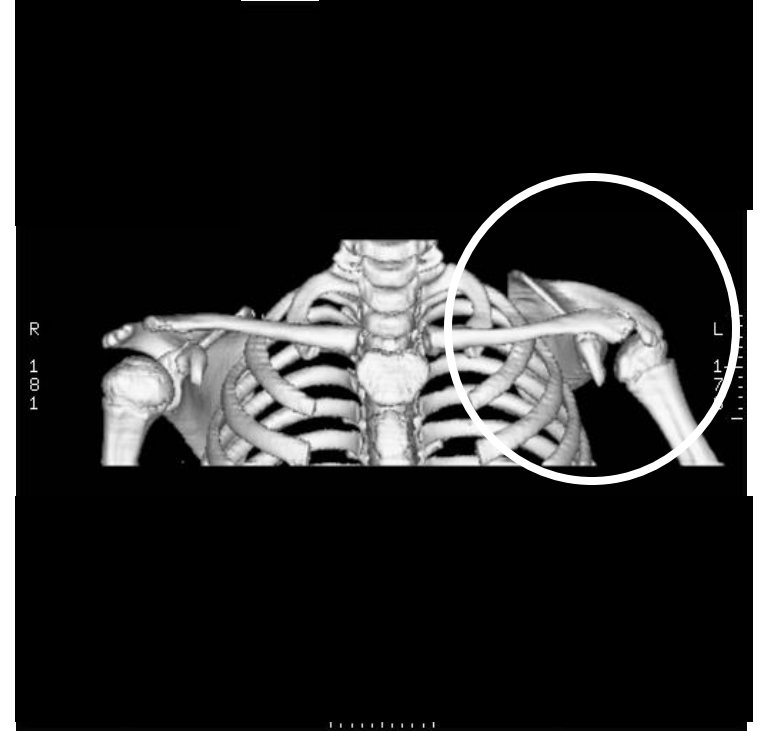


***Same 5 year old child After Contracture Releases  
(Modified quad surgery): Improved Shoulder  
Abduction***

### ***3. Bony Complications: SHEAR (Scapular Hypoplasia, Elevation and Rotation)***

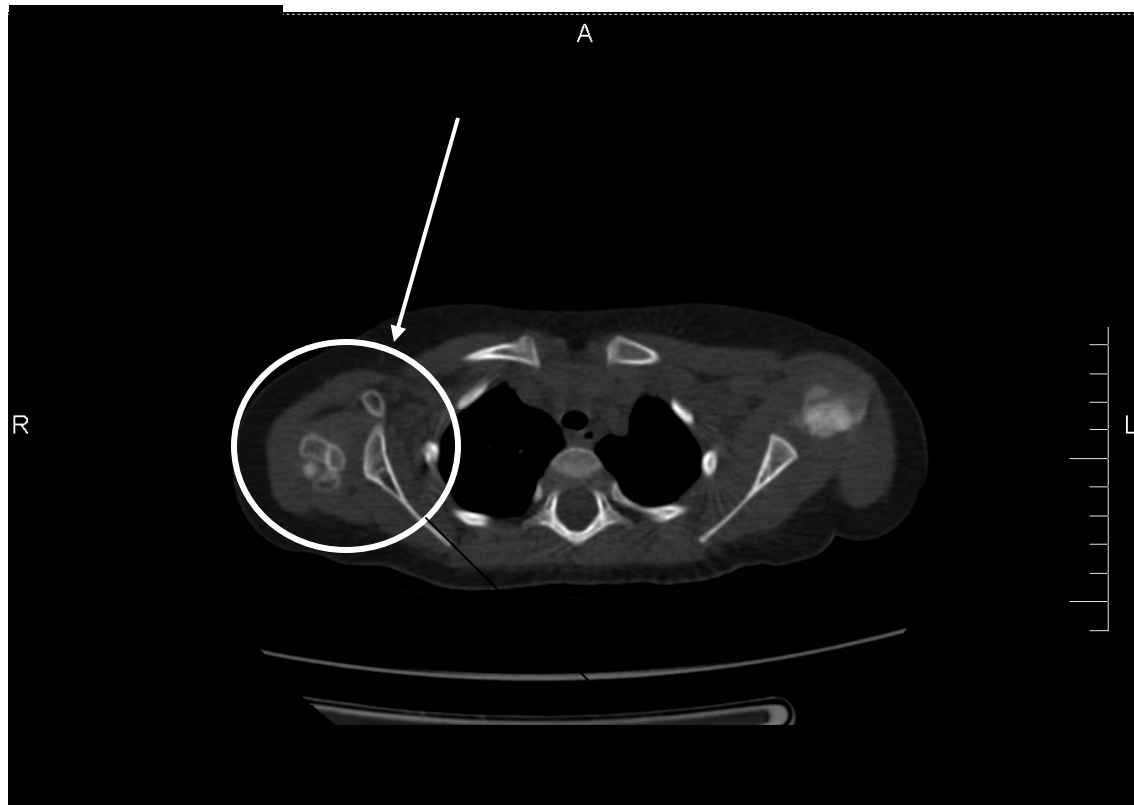
- Many OBPI patients have shoulder bony and joint deformities due to muscle imbalances:
  - Birch R (2003). Late sequelae at the shoulder in obstetric palsy in children. Shoulder Duparc J, editor. Paris, Elsevier. 3: 55-200-E-10.
- Triangle tilt surgery is often indicated

# ***SHEAR: Dislocated Shoulder***

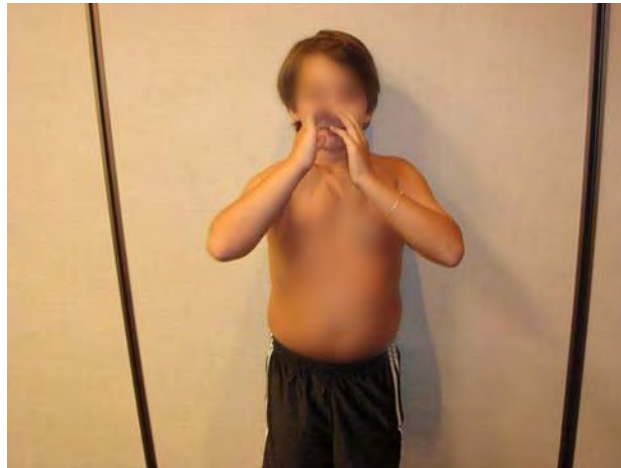


***Note: 3D CT Scan shows Left SHEAR Deformity***

# ***Most Common Result of OBPI is Shoulder Deformity, Pain and Arthritis by Late Teen Years***

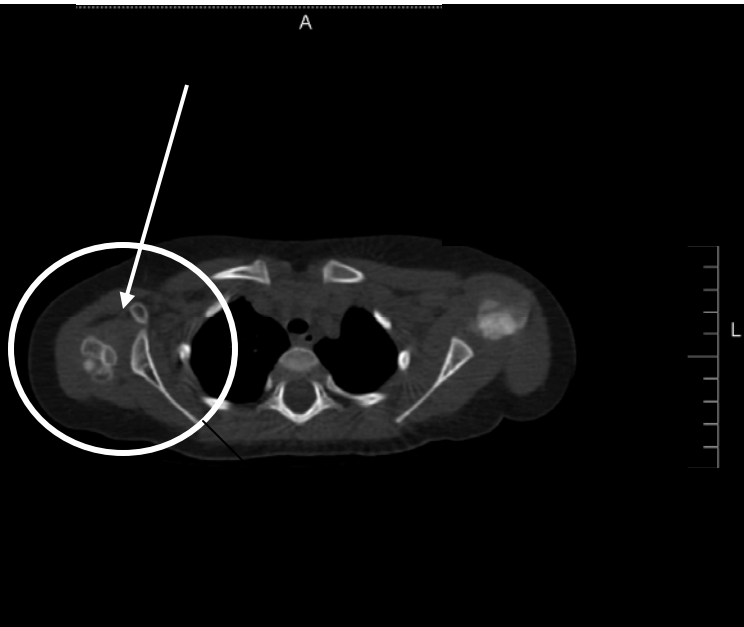


## ***Triangle Tilt Surgery (bottom row) after Failed Humeral Osteotomy (top row)***



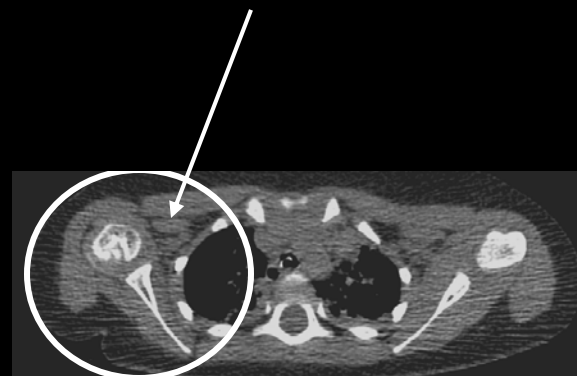
***Shoulder Relocated; normalization of function, increased length; improved growth; decreased pain***

# ***CT Scan results One Year after Triangle Tilt Surgery***



**A** (Therapy Alone)

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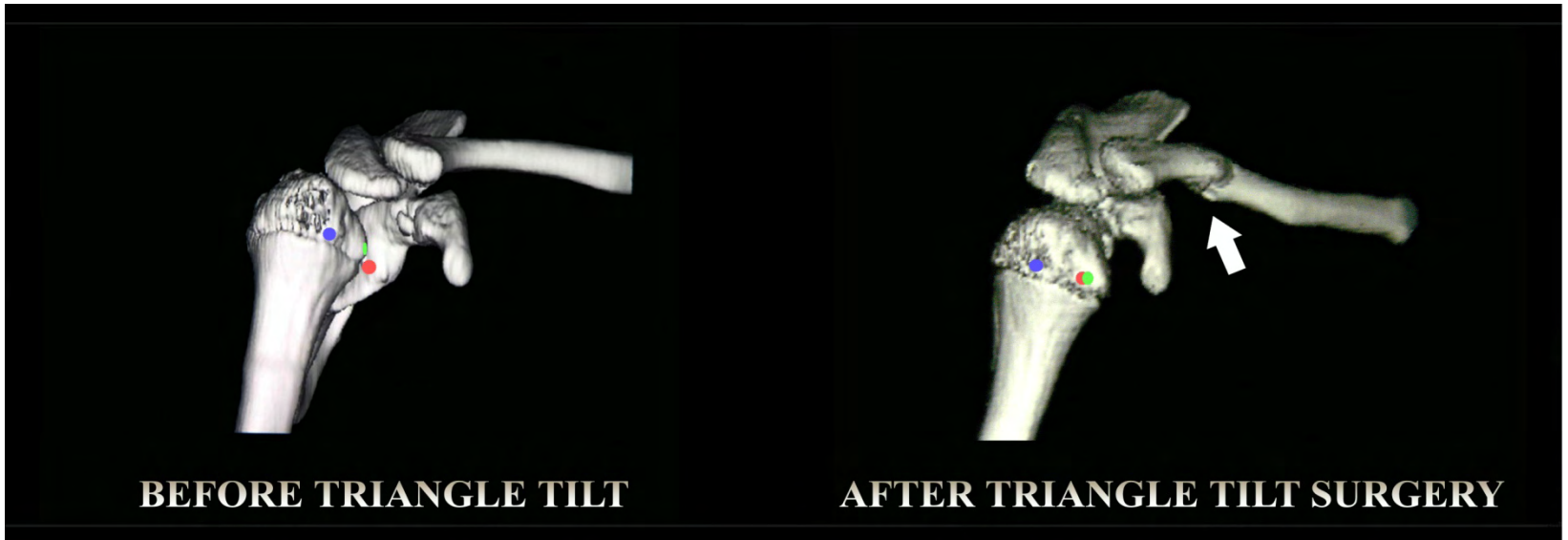


**B** (Same child as A, After Triangle Tilt Surgery)

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# ***3D CT Scans Pre- and Postoperatively***

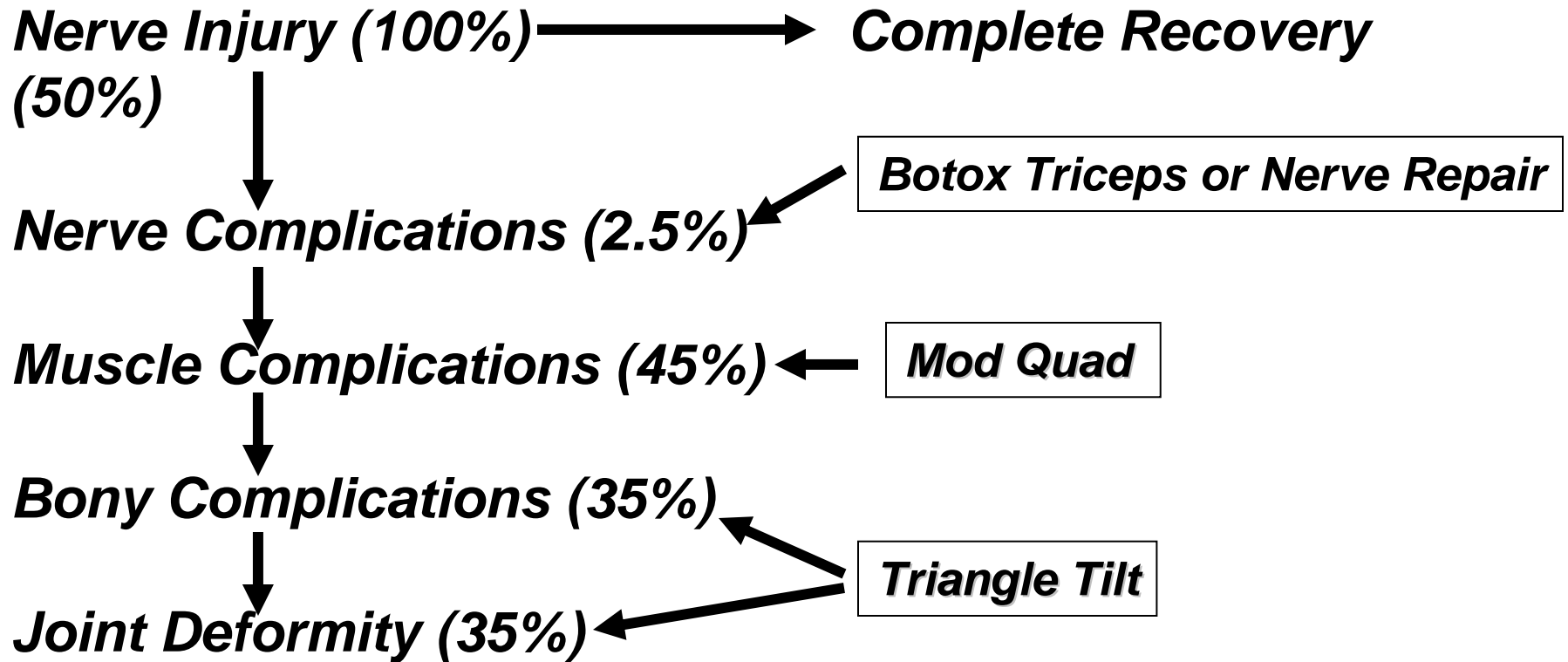




# ***Quality of Life Improvement after Triangle Tilt (TT) Surgery***

<b>PODCI Parameter</b>	<b>Non-TT Mean (SD)</b>	<b>TT Mean (SD)</b>	<b>Change</b>	<b>p-value</b>
Upper Extremity	54.1 (23.6)	73.2 (21.7)	+19.1	0.0033
Basic Mobility	50.7 (11.5)	77.6 (5.2)	+26.9	<0.0001
Sports/Physical	54.8 (14.3)	70.8 (11.3)	+16.0	0.013
Pain/Comfort	61.3 (19.6)	66.9 (17.7)	+5.6	0.3592
Happiness	52.2 (20.3)	57.7 (17.4)	+5.5	0.3514
Global Functioning	52.38 (13)	70.36 (11)	+18.0	0.0048

***Dr. Nath's Management:  
Numbers are Estimates Based on Experience  
and Literature Search***



**This is a general outline of Dr. Nath's management protocols; other specialists may have different protocols. Many other surgeries or therapy management may be indicated in more complex or less complex cases**

# ***Details of Dr. Nath's Management***

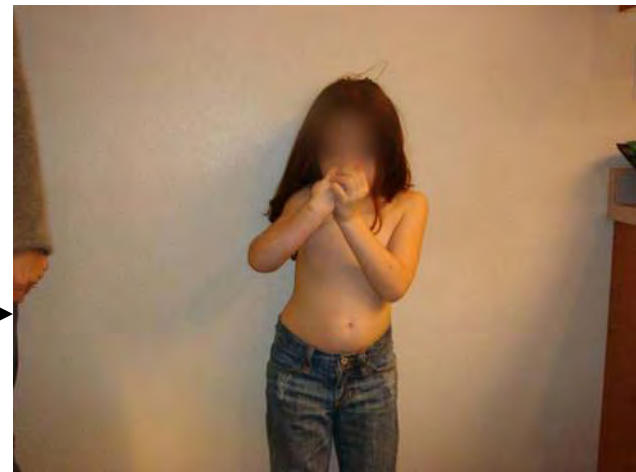
- (1) Paralyzed Biceps: Botox Triceps  
Shoulder
- (2) Contractures: Modified Quad Surgery
- (3) Bony/Joint Deformities: Triangle Tilt  
Surgery

# ***Rationale for Preferred Management***

1. Pathophysiology is the basis for management
2. Literature:
  - Nerve injury tends to recover spontaneously
  - Muscle injury and contractures common
  - Bone deformity follows muscle imbalances
3. Experience

# ***Nerve Graft***

# ***Triangle Tilt***



# ***Case Study 1***

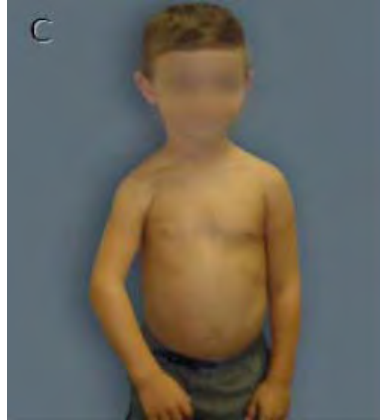


***Contractures of  
Shoulder***

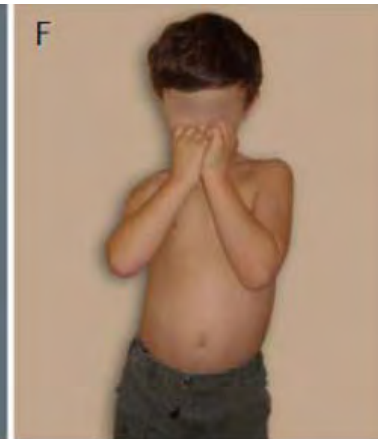
***After Mod Quad Surgery***



***Before***  
***Triangle***  
***Tilt***  
***Surgery***



***After***  
***Triangle***  
***Tilt***  
***Surgery***



# ***Case Study 2***



***8 Months Old, Right OBPI***

# ***Surgical Procedures Performed at Outside Hospital***

1. *NERVE GRAFTING*
2. *MUSCLE TRANSFERS*
3. *SHOULDER JOINT RELEASES*
4. *BICEPS TO TRICEPS  
TRANSFER WITH ALLOGRAFT*
5. *BICEPS TENDON ALLOGRAFT*
6. *HUMERAL OSTEOTOMY*

# ***Case Study 2***



**6 Years old after 6 surgical procedures at outside hospital**

# ***Surgical Procedures by Dr. Nath***

***1. MODIFIED QUAD***

***2. TRIANGLE TILT***

# Case Study 4



**6 Year old child following surgery at outside hospital:**

- 1. Nerve grafting**
- 2. Muscle transfer**
- 3. Shoulder joint surgery**
- 4. Biceps to triceps transfer (cadaver tissue)**
- 5. Biceps tendon cadaver graft**
- 6. Humeral osteotomy**

May 25, 2012



**After Modified quad and Triangle tilt surgeries**

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# *Conclusions*

- Nerve repair in children may not be required as frequently
- Muscle and bony surgeries simpler, effective
- Prognosis excellent with appropriate surgical management

RAHUL K. NATH, MD

OBSTETRIC  
BRACHIAL PLEXUS INJURIES  
- ERB'S PALSY -



ILLUSTRATED BY MARJON FATEMIZADEH - AUCOIN

*The Nath Method of Diagnosis and Treatment*

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# Questions / Suggestions

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## Websites

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[www.drnathwingingscapula.com](http://www.drnathwingingscapula.com)

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