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…”

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
Asymmetric Injury

Upper Trunk (85%)

Lower Roots (15%)
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

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Pathophysiology

Explosive Limb Growth

Asymmetric Injury

Scapular Deformity (SHEAR)

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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

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.

• Co-contraction is more common cause of “biceps weakness” than actual nerve injury to the biceps nerve.
BoTox (Instead of Nerve Graft)

• Co-contracture of biceps and triceps
• Effective for triceps (releases biceps)
• Less useful in Latissimus, Teres major, pectoralis, subscapularis
Botox for Biceps/Triceps Co-contraction

Biceps/ Triceps Co- Contraction

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

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

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

• Many OBPI patients have shoulder bony and joint deformities due to muscle imbalances:

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

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3D CT Scans Pre- and Postoperatively

BEFORE TRIANGLE TILT

AFTER TRIANGLE TILT SURGERY
# Quality of Life Improvement after Triangle Tilt (TT) Surgery

<table>
<thead>
<tr>
<th>PODCI Parameter</th>
<th>Non-TT Mean (SD)</th>
<th>TT Mean (SD)</th>
<th>Change</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Extremity</td>
<td>54.1 (23.6)</td>
<td>73.2 (21.7)</td>
<td>+19.1</td>
<td>0.0033</td>
</tr>
<tr>
<td>Basic Mobility</td>
<td>50.7 (11.5)</td>
<td>77.6 (5.2)</td>
<td>+26.9</td>
<td>&lt;0.0001</td>
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<td>Sports/Physical</td>
<td>54.8 (14.3)</td>
<td>70.8 (11.3)</td>
<td>+16.0</td>
<td>0.013</td>
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<tr>
<td>Pain/Comfort</td>
<td>61.3 (19.6)</td>
<td>66.9 (17.7)</td>
<td>+5.6</td>
<td>0.3592</td>
</tr>
<tr>
<td>Happiness</td>
<td>52.2 (20.3)</td>
<td>57.7 (17.4)</td>
<td>+5.5</td>
<td>0.3514</td>
</tr>
<tr>
<td>Global Functioning</td>
<td>52.38 (13)</td>
<td>70.36 (11)</td>
<td>+18.0</td>
<td>0.0048</td>
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Dr. Nath’s Management:
Numbers are Estimates Based on Experience and Literature Search

Nerve Injury (100%) Complete Recovery
(50%)

Nerve Complications (2.5%)

Muscle Complications (45%) Mod Quad

Bony Complications (35%) Triangle Tilt

Joint Deformity (35%)

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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**
Case Study 1

Contractures of Shoulder

After Mod Quad Surgery

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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

After Modified quad and Triangle tilt surgeries
Conclusions

• Nerve repair in children may not be required as frequently
• Muscle and bony surgeries simpler, effective
• Prognosis excellent with appropriate surgical management
OBSTETRIC BRACHIAL PLEXUS INJURIES
- ERB’S PALSY -

Illustrated by Marjon Fatemizadeh - AUCoN

The Nath Method of Diagnosis and Treatment
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Questions / Suggestions

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