Congenital Muscular Torticollis
Evaluation, Collaboration, and
Clinical Practice Guidelines

Presented August 2018 by:
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Driven by Excellence
in Treatment, Teaching & Research
Schedule for Today

• 8:00 – 8:30 Course overview and introduction to APPT’s CMT CPG
• 8:30– 9:30 Medical management of infant suspected for CMT: examination, differential diagnosis and referral process
• 9:30 – 10:00 Evaluation and management of secondary plagiocephaly
• **10 min BREAK**
• 10:10- 11:30 Therapeutic Management: Initial examination and ROM measurement lab
• **11:30 – 12:15 LUNCH**
• 12:15 – 1:30 Therapeutic Management: Evidence based intervention with positioning and handling labs
• 1:30 – 2:00 Consideration of alternative interventions, discharge and follow up
• **10 min break**
• 2:10 – 3:00 – Group breakouts for case discussions
• 3:00 – 4:00 Group discussion: coordination of care and avoiding delays in referral and intervention
Course Objectives
Upon completion of this course you will

• Know 3 subtypes of CMT, be able to determine severity level, and correctly use this information to develop a plan of care and for family education
• Understand medical work up and diagnostic process recommended for the infant presenting with CMT
• Understand the association between CMT and plagiocephaly, and when and how to manage this secondary impairment
• Know the multidisciplinary team members involved in the care of infant with CMT, and understand each team member’s role
• Know where to find the APPT’s Congenital Muscular Torticollis evidence based Clinical Practice Guideline (2018), and understand how it directs therapeutic management of the infant with CMT
• Be able to develop a therapeutic plan of care with evidence supported interventions
• Be confident measuring head and neck ROM and performing age appropriate stretching exercises in the infant with CMT
• Know when to discharge an infant with CMT from active therapy as well as recommended follow up care
Course Overview and Introduction
Definition of Congenital Muscular Torticollis (CMT)

A postural deformity evident at or shortly after birth characterized by lateral flexion of the head to one side, with cervical rotation to the opposite side due to unilateral shortening or fibrosis of the sternocleidomastoid muscle (SCM).
Three Subtypes of CMT

1. Postural CMT: presents as infant’s postural preference, but without muscle or PROM restrictions

2. Muscular CMT: presents with SCM tightness and PROM limitations

3. SCM mass: presents with a fibrotic thickening of the SCM and PROM limitations
Historical Perspective

- **1950’s** → Physician led studies
- **1970/80’s** - Studies of conservative care/passive stretching
- **1997** - Karmel-Ross – *Physical and Occupational Therapy in Pediatrics*
- **2001/2007** - WHO ICF
- **2009** - Cincinnati Children’s Hospital - Congenital Muscular Torticollis Evidence Based Care Recommendations
- **2013/2018** - APTA’s SOP CMT Evidence-Based Clinical Practice Guideline in Pediatric Physical Therapy
## Importance of Early Identification and Intervention

<table>
<thead>
<tr>
<th>Age at initiation of intervention</th>
<th>Length of intervention/episode of care</th>
<th>Percentage of infants with cervical ROM WNL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 month of age</td>
<td>1.5 months</td>
<td>98 %</td>
</tr>
<tr>
<td>1 – 3 months of age</td>
<td>6 months</td>
<td>89 %</td>
</tr>
<tr>
<td>3 – 6 months of age</td>
<td>7 months</td>
<td>62 %</td>
</tr>
<tr>
<td>&gt; 6 months of age</td>
<td>10 months</td>
<td>&lt; 20%</td>
</tr>
</tbody>
</table>

PURPOSE of a CPG

- Define and classify common CMT impairments
- Identify appropriate outcome measures for CMT PT interventions
- Identify interventions supported by current best evidence
- Create a reference publication for PT’s that can guide clinical practice
- Identify areas of research that are needed to improve the evidence base for PT management of CMT

Physical Therapy Management of Congenital Muscular Torticollis: An Evidence-Based Clinical Practice Guideline

FROM THE SECTION ON PEDIATRICS OF THE AMERICAN PHYSICAL THERAPY ASSOCIATION

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2013: 16 ACTION STATEMENTS

FOUR CATEGORIES

• Identification and Referral of Infants with CMT
• Physical Therapy Examination of Infants with CMT
• Physical Therapy Intervention for Infants with CMT
• Physical Therapy Discharge and Follow-up of Infants with CMT

• Planned publication Fall 2018 in *Pediatric Physical Therapy*

• 20 new research studies, 14 informing prognosis, and 6 informing intervention.

• Summary of practice recommendations that are supported with current, peer reviewed published literature.
17 Action Statements in 4 categories:

- Education, Identification and Referral (3)
- PT Examination and Evaluation (10)
- PT Intervention (3)
- PT Discontinuation, Reassessment and Discharge

Referral Path Flowchart

Classification of CMT Severity Flowchart

Recommendations for implementation and QI

Research recommendations

https://pediatricicapta.org/clinical-practice-guidelines/
2018 Algorithm for Early Identification of Congenital Muscular Torticollis and Referral to Physical Therapy

Pre/postnatal education for all parents on symmetrical positioning and supervised tummy time while awake.

High Risk Characteristics of CMT at Birth

- Birth history includes:
  - Birth trauma
  - Premature
  - Body length > 51.3 cm

- If present at birth:
  - SCM mass
  - Cervical ROM limitations
  - Facial asymmetry
  - Cranial deformation

Observe or evaluate this newborn infant to determine risk for CMT. Can be noted by any of the following: MD, RN, Midwife, PT, Parent.

If unremitting birth history & physical exam, infant's physician observes during each well baby check-up for later onset:

Pediatric Physical Therapist

Physical screens conducted by MD and/or PT during examination of newborn at risk or diagnosed with CMT need to rule out extramacular causes of SCM tightness. Consult reports from referred specialists should be sent to both MD & PT.

Abnormal visual screen: refer to Ophthalmology

Non-muscular asymmetry: refer for additional imaging

Abnormal orthopedic screen: refer to Orthopedics

Abnormal neurologic screen: refer to Neurology

Follow up clearance from specialists for contraindications, or as appropriate, continue with physical therapy examination.

Infant's Physician

Continue with PT interventions as appropriate. See Figure 2

*Note: This is Figure 1 from: Kaplan SL, Couturier CT, Sargent B. The 2018 Physical Therapy Management of Congenital Muscular Torticollis: Evidence-Based Clinical Practice Guidelines. Pediatr Phys Ther. 2018;30(4). You are strongly encouraged to read the complete guideline, freely available at APTA Academy of Pediatric Physical Therapy website. https://pediatricapt.org/
MEDICAL MANAGEMENT OF CMT
PHYSICIAN PERSPECTIVE
Congenital Muscular Torticollis (CMT)

• Torticollis: abnormal posture of the head and neck
• CMT = “prenatally” acquired torticollis
  – typically develops by age 1-4 weeks
• 3 types of CMT
  – Postural: normal ROM
  – Muscular: limited ROM
  – SCM Mass: limited ROM and fibrosis
CMT with limited ROM

– Due to uneven strength or length in the sternocleidomastoid (SCM) muscles
– Left sided torticollis = left SCM
  • left ear to left shoulder and usually chin the right shoulder, decreased lateral rotation to the left
– Right sided torticollis = right SCM
  • right ear to right shoulder and usually chin the left shoulder, decreased lateral rotation to the right

• If the chin is to the ipsilateral shoulder consider imaging
Pathology of CMT

• Fetal head descent/abnormal intrauterine position, in the 3rd trimester, results in SCM ischemia/compartment syndrome
• Muscle becomes fibrous and can have a palpable mass of myoblasts, fibroblasts, myofibroblasts and mesenchyme-like stem cells
  – Mass maximum size by 4 weeks of age
Incidence and Risk Factors for CMT

• Estimated that anywhere from 0.3-16% of newborns have evidence of torticollis

• Increased risk with
  – Fetus being “stuck” in one position for more than 6 weeks
  – Difficult labor/instrumented delivery
  – Oligohydramnios
  – Long birth length
  – Breech presentation
  – First born
  – Male
Associated Conditions

Facial asymmetry

- Mandibular inclination
  - Breastfeeding problems
- Ear asymmetry
  - Contralateral anterior and flattened
  - Ipsilateral smaller and cupped
- Eye asymmetry
  - Ipsilateral higher and smaller
- Seen in approximately 15% of infants with CMT
- Less severe facial asymmetry can be seen in infants with symmetric neck ROM.
Associated Conditions

Plagiocephaly

• Flattening of the skull
  – Contralateral to the torticollis
• Seen in 24% of infants with CMT, but 90% of infants with plagiocephaly will have asymmetric head rotation
• rule out craniosynostosis
  – premature closure of one more of the cranial sutures
Associated condition
other orthopedic

• Metatarsus Adductus
• Developmental dysplasia of the hip (DDH)
  – Seen in up to 2-29% of infants with CMT
  – Differing opinions on whether or not to screen
  – <4-6 months ultrasound
  – ≥4-6 months radiographs
Differential Diagnosis for torticollis in infants

• >80 causes described in the literature
  – Benign paroxysmal torticollis
  – GI issues
  – Ocular issues
  – Bony issues
  – Central Nervous System Pathology
  – Peripheral Nervous System Pathology
  – Infection or tumor
Benign Paroxysmal Torticollis of Infancy

• Presentation:
  • starts around age 2 weeks- 4 months
  • involves both sides
  • Posturing lasts hours to days
  • Episodes can have associated emesis and pallor, ataxia and drowsiness (migraine-like)

• Prognosis: self limiting, usually resolves by age 2-3 yrs
GI issues: Sandifer Syndrome

- Incidence: <1% of infants with GERD
- Presentation: paroxysmal
- Etiology: gastroesophageal reflux with neck torsional spasm and truncal posturing
- Treatment: PPI or H-2 blocker, positioning, may need fundoplication
Ocular Torticollis

- Abnormal posturing attempts to improve vision
- CN IV Palsy
  - Etiology: weakness or paralysis of the superior oblique muscle
  - Presentation: superior eye deviation when moving eyes laterally
    - Head position will vary depending on where the nerve was injured
    - Head position improves when you cover eyes
  - Treatment: prisms, may need surgery
- Lateral Rectus Palsy
- Nystagmus
  - spasmus nutans (nystagmus, head nod, abnormal head position)
Bony Causes of Torticollis

• Klippel-Feil Syndrome
  – Fusion of two or more cervical levels
  – Restricted motion, shortened neck, low hairline
  – Can have associated anomalies

• Atlantoaxial Rotatory Subluxation (AARS)
  – Fixed rotation of the joint
  – SCM spasms on the side of the chin
CNS & PNS Causes of Torticollis in Infants

• Brain tumor (posterior fossa)
  – Head tilt can be compensatory for visual changes or traction/irritation to CN and other structures

• Damage to the basal ganglia causing dystonia

• Spinal tumor

• Cervical syrinx

• Brachial plexus palsy
  – Up to 43% of infants with torticollis
  – Torticollis ipsilateral to palsy
  – Not related to the severity of the palsy
History

- **Age identified**
  - CMT typically develops by age 1-4 weeks
- **Progression**
- **Continuous or intermittent**
- **Associated symptoms**
- **Infant positioning devices**
- **Treatments**
- **Birth Hx:** screen for risk factors
- **Family Hx:** skeletal, nervous system issues
Physical Examination

• General
• **Head shape**
• **Eyes and mouth**
• **Facial asymmetry**
• **Neck/Spine**
• Hips
• Feet
• **Neuro**
PE: Head shape

- Size
- Fontanelles
  - diamond or triangle
- Sutures
  - overlapping
- Bulging
- Flattening
  - Contralateral occipital flattening (CMT)
  - Ipsilateral facial flattening (CMT)
PE: Eyes and Mouth

- **Alignment**
  - Ipsilateral eye down (CMT)

- **Shape/symmetry**
  - Harlequin

- **Tracking/strabismus**
  - Cover the eyes

- **Ipsilateral downward displacement of the mouth (CMT)**

- **Mandibular inclination**
PE: Neck & Spime

- Lateral rotation in the direction of the involved SCM is restricted (CMT)
- Inferior 1/3rd can have a fibrotic mass 1-3 cm (as it shrinks the SCM gets tighter) (CMT)
- Mass usually resolves between 2-8 months (CMT)
- Cock Robin position with tilt and contralateral rotation as well as flexion
  - SCM spasticity on the side to which the chin is rotated (AARS)
- Screen TL spine for scoliosis
PE: Hips and Feet

- Galeazzi
- Ortalani
- Barlow
- Calcaneal bisection
PE: Neuro

- Strength
- Tone
- Coordination
  - Ataxia
- Reflexes
  - Muscle stretch
  - Primitive
When to Screen

Start At Birth
- 3.92% - only infants with SCM mass or thickening
- 16% - any asymmetry of ROM

Some are not clinically apparent until several weeks to months after birth

Items to Screen

- Positional preference
- Reduced cervical range of motion
- Sternocleidomastoid masses
- Facial asymmetry

- Refer to pediatrician and/or physical therapist
Benefits of Early Intervention

• Early parental education to facilitate symmetrical development
• Greater infant cooperation with intervention (compared to infant with head control)
• Less intervention required to reach full range of motion
• Greater likelihood of gaining full range of motion
• Early diagnosis if other cause of asymmetry

Age at Beginning of PT Correlates with Duration of Treatment

- Intervention started earlier is more quickly effective
- If started before 1 month of age, 98% achieve near normal range within 1.5 months
- After 1 month, prolongs to 6 months
- After 6 months, may require 9-10 months
  - Fewer infants achieve near normal range
- After 12 months, none achieved good ROM in 10 months (n=8)

### Severity Grading

<table>
<thead>
<tr>
<th>Grade</th>
<th>Name</th>
<th>Age at Presentation</th>
<th>Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Early Mild</td>
<td>0-6 months</td>
<td>&lt; 15° rotation</td>
</tr>
<tr>
<td>2</td>
<td>Early Moderate</td>
<td>0-6 months</td>
<td>15-30° rotation</td>
</tr>
<tr>
<td>3</td>
<td>Early Severe</td>
<td>0-6 months</td>
<td>&gt; 30° rotation</td>
</tr>
<tr>
<td>4</td>
<td>Late Mild</td>
<td>7-9 months</td>
<td>&lt; 15° rotation or only postural preference</td>
</tr>
<tr>
<td>5</td>
<td>Late Moderate</td>
<td>10-12 months</td>
<td>&lt; 15° rotation or only postural preference</td>
</tr>
<tr>
<td>6</td>
<td>Late Severe</td>
<td>7-12 months</td>
<td>&gt; 15° rotation</td>
</tr>
<tr>
<td>7</td>
<td>Late Extreme</td>
<td>&gt; 7 months</td>
<td>SCM mass</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td>&gt; 12 months</td>
<td>&gt; 30° rotation</td>
</tr>
</tbody>
</table>

Outcomes of Manual Stretching

- 821 patients with congenital muscular torticollis
- Presented before 12 months
- Treated with manual stretching
- 3 groups – SCM tumor, muscular torticollis, postural
- Predictors of outcome:
  - group
  - initial deficit in rotation
  - age at presentation

<table>
<thead>
<tr>
<th>Clinical Group (N = 821)</th>
<th>Rotation Deficit *</th>
<th>Median Duration of Treatment (mo)</th>
<th>Overall Score *</th>
<th>Surgical Treatment *</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤15°</td>
<td>&gt;15°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sternomastoid tumor (n = 452)</td>
<td>27.7%</td>
<td>72.3%</td>
<td>3.7</td>
<td>87.8%</td>
</tr>
<tr>
<td>Muscular torticollis (n = 276)</td>
<td>68.1%</td>
<td>31.9%</td>
<td>2.5</td>
<td>93.8%</td>
</tr>
<tr>
<td>Postural torticollis (n = 93)</td>
<td>95.7%</td>
<td>4.3%</td>
<td>1.4</td>
<td>98.9%</td>
</tr>
</tbody>
</table>

*The values are given as the percentage of patients.

<table>
<thead>
<tr>
<th></th>
<th>Excellent or Good (N = 779)</th>
<th>Fair or Poor (N = 42)</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Postural torticollis</td>
<td>93 (11.9%)</td>
<td>0 (0.0%)</td>
<td>0.0018†</td>
</tr>
<tr>
<td>Muscular torticollis</td>
<td>268 (34.4%)</td>
<td>8 (19.0%)</td>
<td></td>
</tr>
<tr>
<td>Sternomastoid tumor</td>
<td>418 (53.7%)</td>
<td>34 (81.0%)</td>
<td></td>
</tr>
<tr>
<td><strong>Rotation deficit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤15°</td>
<td>397 (51.0%)</td>
<td>5 (11.9%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>&gt;15°</td>
<td>382 (49.0%)</td>
<td>37 (88.1%)</td>
<td></td>
</tr>
<tr>
<td><strong>Age at presentation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;29 days</td>
<td>188 (24.1%)</td>
<td>5 (11.9%)</td>
<td>0.0010</td>
</tr>
<tr>
<td>29-90 days</td>
<td>333 (42.7%)</td>
<td>30 (71.4%)</td>
<td></td>
</tr>
<tr>
<td>91-365 days</td>
<td>258 (33.1%)</td>
<td>7 (16.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>Lateral bending deficit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5° or 6-10°</td>
<td>461 (59.2%)</td>
<td>11 (26.2%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>11-15° or &gt;15°</td>
<td>318 (40.8%)</td>
<td>31 (73.8%)</td>
<td></td>
</tr>
<tr>
<td><strong>Craniofacial asymmetry†</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal or mild</td>
<td>579 (75.5%)</td>
<td>25 (59.5%)</td>
<td>0.0210</td>
</tr>
<tr>
<td>Moderate or severe</td>
<td>188 (24.5%)</td>
<td>17 (40.5%)</td>
<td></td>
</tr>
<tr>
<td><strong>Head tilt§</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal or mild</td>
<td>709 (91.2%)</td>
<td>7 (16.7%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Moderate or severe</td>
<td>68 (8.8%)</td>
<td>35 (83.3%)</td>
<td></td>
</tr>
</tbody>
</table>
SCM Rupture

- 455 patients with SCM mass
- Unintentional snapping in 9.2% during manual stretching
- Gentle stretching only
- Audible snap with sudden increase in ROM
- Visible bruising in some
- Occurred in more severe cases
- In 3.5 year follow-up, did not have worse outcome

### Pretreatment Data

**TABLE 2. Baseline Pretreatment Data - Comparison of Patients Who Had Snapping and Patients Who Did Not Have Snapping**

<table>
<thead>
<tr>
<th>Pretreatment Data</th>
<th>Snapping (n = 41)</th>
<th>Nonsnapping (n = 404)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age at initial assessment (days)</td>
<td>28</td>
<td>41</td>
<td>p &lt; 0.05</td>
</tr>
<tr>
<td>(range)</td>
<td>(10–69)</td>
<td>(10–299)</td>
<td></td>
</tr>
<tr>
<td>Deficit in passive rotation of neck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I = 0°</td>
<td>0%</td>
<td>6.1%</td>
<td></td>
</tr>
<tr>
<td>Group II 1–15°</td>
<td>15%</td>
<td>26.9%</td>
<td></td>
</tr>
<tr>
<td>Group III 15–30°</td>
<td>42.5%</td>
<td>45%</td>
<td></td>
</tr>
<tr>
<td>Group IV &gt; 30°</td>
<td>42.5%</td>
<td>22%</td>
<td>p = 0.0009</td>
</tr>
<tr>
<td>Incidence of hip dysplasia (Overall)</td>
<td>17.5%</td>
<td>6.9%</td>
<td>p = 0.0124</td>
</tr>
<tr>
<td>Largest transverse diameter of sternomastoid tumor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5–1.5 cm</td>
<td>12.5%</td>
<td>27.7%</td>
<td>p = 0.005</td>
</tr>
<tr>
<td>2.0–3.0 cm</td>
<td>87.5%</td>
<td>72.3%</td>
<td></td>
</tr>
<tr>
<td>Longitudinal involvement of whole length of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sternocleidomastoid muscle</td>
<td>35%</td>
<td>12.7%</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>

Results

TABLE 3. Results of Treatment and Final Assessment

<table>
<thead>
<tr>
<th>Results</th>
<th>Snapping (n = 41)</th>
<th>Nonsnapping (n = 404)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean length of followup (days)</td>
<td>1067</td>
<td>983</td>
<td>p &gt; 0.05</td>
</tr>
<tr>
<td>Mean treatment duration (days)</td>
<td>121</td>
<td>145.6</td>
<td>p &gt; 0.05</td>
</tr>
<tr>
<td>(range)</td>
<td>(33–231)</td>
<td>(15–350)</td>
<td></td>
</tr>
<tr>
<td>Mean time for rotation to return to normal (days)</td>
<td>65</td>
<td>110</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>Mean time of disappearance of the tumor (days)</td>
<td>102</td>
<td>193</td>
<td>p = 0.001</td>
</tr>
<tr>
<td>Operation necessary on followup</td>
<td>2 (5.4%)</td>
<td>29 (7.6%)</td>
<td>p = 1.000</td>
</tr>
<tr>
<td>Overall final score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>excellent</td>
<td>90%</td>
<td>75.9%</td>
<td></td>
</tr>
<tr>
<td>good</td>
<td>5%</td>
<td>15.1%</td>
<td></td>
</tr>
<tr>
<td>fair</td>
<td>0%</td>
<td>2.6%</td>
<td>p = 0.595</td>
</tr>
<tr>
<td>poor</td>
<td>5%</td>
<td>6.7%</td>
<td></td>
</tr>
</tbody>
</table>

Red Flags for Referral

- Poor visual tracking
- Abnormal muscle tone
- Extra-muscular masses in neck
- Little or no progress in asymmetry after 4 to 6 weeks of treatment
- Late onset
- Atypical presentation – tilt and turn to the same side

Possible Referrals

- Pediatrician for further work-up
- PM&R
- Orthopedics vs ENT vs Plastic surgery
- Orthotist for molding or bracing
- Spine
- Orthopedics for hip dysplasia
99.2% of patients were treated successfully without imaging.

Consider imaging screening only for worrisome findings or history
  - X-ray
  - CT
  - MRI

Consider imaging if torticollis persists after 1 year of treatment.

Other treatments

• Orthoses
• Botulinum toxin injections
• Surgical release
Botulinum toxin

Normal process of acetylcholine release. No BOTOX® present

BOTOX®

Acetylcholine vesicle unable to bind

Cleaved SNAP-25
Botulinum toxin

- Anatomy
- Dose
- Risks
- Procedure
- Effect

- 27 children with CMT
- 6 – 18 months
- Toxin to sternocleidomastoid muscle, upper trapezius, or both
- 20/27 – 74% had improvement in rotation or tilt
- 2/27 – 7% had transient adverse effects
  - mild dysphagia
  - neck weakness
- All received physical therapy and a home exercise program

### TABLE 1
Quantitative cervical rotation measurements before and after botulinum toxin type A injection and degree of change

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cervical Rotation, Degrees</th>
<th>Change, Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>75</td>
</tr>
<tr>
<td>6</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>7</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>8</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>9</td>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>11 (injection 2)</td>
<td>45</td>
<td>70</td>
</tr>
<tr>
<td>13</td>
<td>40</td>
<td>90</td>
</tr>
<tr>
<td>14</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>15 (injection 1)</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>19</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>23 (injection 1)</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>2 (injection 2)</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>26</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>27</td>
<td>75</td>
<td>90</td>
</tr>
</tbody>
</table>

### TABLE 2
Quantitative active head tilt measurements before and after botulinum toxin type A injection and degree of change

<table>
<thead>
<tr>
<th>Subject</th>
<th>Head Tilt, Degrees</th>
<th>Change, Degrees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>45</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>14</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>19</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>23 (injection 2)</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>24</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>26</td>
<td>45</td>
<td>0</td>
</tr>
</tbody>
</table>
Botox is transient, are results?

- 15 children
- 3 to 17 months
- Age at botox 7.6 months
- Follow-up 11-33 months
- 1 child had surgery

**Table 3. Changes in Passive Range of Motion During Treatment**

<table>
<thead>
<tr>
<th></th>
<th>Prephysio (Initial)</th>
<th>PreBotox</th>
<th>PostBotox (Final)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lateral rotation (degrees)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>67.8</td>
<td>76.4</td>
<td>88.3</td>
</tr>
<tr>
<td>Range</td>
<td>45–80</td>
<td>45–80*</td>
<td>80–90*</td>
</tr>
<tr>
<td>n = 9</td>
<td>n = 9</td>
<td>n = 14</td>
<td></td>
</tr>
<tr>
<td>Side flexion (degrees)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>32.6</td>
<td>26.5</td>
<td>42.3</td>
</tr>
<tr>
<td>Range</td>
<td>23–45</td>
<td>15–45</td>
<td>20–45</td>
</tr>
<tr>
<td>n = 7</td>
<td>n = 4</td>
<td>n = 11</td>
<td></td>
</tr>
</tbody>
</table>

Because of the level of cooperation of the child and other factors, not every measurement was recorded at each visit.

*P ≤ 0.05.

<table>
<thead>
<tr>
<th>Number of Children Injected</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Not reported</td>
</tr>
<tr>
<td>3</td>
<td>Not reported</td>
</tr>
<tr>
<td>15</td>
<td>One bruising, one sore neck, one with brief fever</td>
</tr>
<tr>
<td>27</td>
<td>One mild dysphagia, one neck weakness – no treatment required</td>
</tr>
</tbody>
</table>

**Duchenne Muscular Dystrophy**

<table>
<thead>
<tr>
<th>Number of Children Injected</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None</td>
</tr>
</tbody>
</table>

**Idiopathic Clubfoot**

<table>
<thead>
<tr>
<th>Number of Children Injected</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>Not reported</td>
</tr>
<tr>
<td>32</td>
<td>Not reported</td>
</tr>
<tr>
<td>51</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>None</td>
</tr>
</tbody>
</table>

**Idiopathic Toe Walking**

<table>
<thead>
<tr>
<th>Number of Children Injected</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>3 with sore calves</td>
</tr>
<tr>
<td>5</td>
<td>Not reported</td>
</tr>
<tr>
<td>10</td>
<td>None</td>
</tr>
</tbody>
</table>

**Lower Limb Lengthening**

<table>
<thead>
<tr>
<th>Number of Children Injected</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>None</td>
</tr>
</tbody>
</table>

**Neonatal Brachial Plexus Palsy**

<table>
<thead>
<tr>
<th>Number of Children Injected</th>
<th>Adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>None</td>
</tr>
<tr>
<td>13</td>
<td>Not reported</td>
</tr>
<tr>
<td>22</td>
<td>None</td>
</tr>
<tr>
<td>8</td>
<td>Not reported</td>
</tr>
<tr>
<td>8</td>
<td>Not reported</td>
</tr>
<tr>
<td>2</td>
<td>Not reported</td>
</tr>
<tr>
<td>19</td>
<td>Not reported</td>
</tr>
<tr>
<td>6</td>
<td>2 with tenderness at injection site</td>
</tr>
<tr>
<td>50</td>
<td>One with excessive weakness shoulder for 10 days</td>
</tr>
<tr>
<td>6</td>
<td>None</td>
</tr>
</tbody>
</table>

SURGICAL RELEASE

- Unipolar release of sternal or clavicular head of SCM
- Bipolar release at muscle’s insertion at mastoid
- Resection of fibrous tumor
- Fascia and other tight structures are also released.

Potential Complications of Release

• Recurrence rate as high as 7%
• Hematoma
• Hollowing at the base of the neck
• Bony prominence of the sternal head of the clavicle
• Reattachment of clavicular head to the clavicle, forming a band
• Damage to facial or spinal accessory nerve

Surgical Outcomes

- 84 patients – 70% failed PT, 30% no PT
- Factors assessed
  - Age at surgery
  - Limitation in rotation
  - Facial asymmetry
  - Head tilt
- Surgery - Unipolar or bipolar release or resection of tumor
- 3-4 months physical therapy with ROM, strengthening, scar treatment
- 3 months adjustable torticollis orthosis
- Follow up 2-13 years (5)

Rotational Outcomes

**TABLE 2. Rotational Deficits (Rotation Group) Preoperative Versus at Final Assessment**

<table>
<thead>
<tr>
<th>Rotation Grouping</th>
<th>Preoperative Assessment (%)</th>
<th>Final Assessment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotation Group I = 0°</td>
<td>0</td>
<td>92.5</td>
</tr>
<tr>
<td>Rotation Group II = 1° to 15°</td>
<td>22.2</td>
<td>5</td>
</tr>
<tr>
<td>Rotation Group III = 16° to 30°</td>
<td>64.2</td>
<td>2.4</td>
</tr>
<tr>
<td>Rotation Group IV = &gt; 30°</td>
<td>13.6</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Craniofacial Asymmetry and Head Tilt

<table>
<thead>
<tr>
<th>Abnormalities</th>
<th>Preoperative Assessment (%)</th>
<th>Final Assessment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craniofacial asymmetry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>9.9</td>
<td>55</td>
</tr>
<tr>
<td>Mild</td>
<td>65.4</td>
<td>41.3</td>
</tr>
<tr>
<td>Moderate</td>
<td>21</td>
<td>3.6</td>
</tr>
<tr>
<td>Severe</td>
<td>3.6</td>
<td>0</td>
</tr>
<tr>
<td>Head tilt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>0</td>
<td>77.5</td>
</tr>
<tr>
<td>Mild</td>
<td>90.1</td>
<td>20</td>
</tr>
<tr>
<td>Moderate</td>
<td>7.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Severe</td>
<td>2.4</td>
<td>0</td>
</tr>
</tbody>
</table>

## Scoring Sheet

<table>
<thead>
<tr>
<th>Overall Results</th>
<th>Excellent (3 points)</th>
<th>Good (2 points)</th>
<th>Fair (1 point)</th>
<th>Poor (0 points)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotational deficits (°)</td>
<td>&lt; 5</td>
<td>6–10</td>
<td>11–15</td>
<td>&gt; 15</td>
</tr>
<tr>
<td>Side flexion deficits (°)</td>
<td>&lt; 5</td>
<td>6–10</td>
<td>11–15</td>
<td>&gt; 15</td>
</tr>
<tr>
<td>Craniofacial asymmetry (no, mild, moderate, severe)</td>
<td>No–mild</td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Scar (no, mild, moderate, severe)</td>
<td>No–mild</td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Band (no, lateral, clavicular, sternal)</td>
<td>No</td>
<td>Lateral</td>
<td>Lateral, clavicular</td>
<td>Clavicular, sternal</td>
</tr>
<tr>
<td>Head tilt (no, mild, moderate, severe)</td>
<td>No</td>
<td>Mild</td>
<td>Moderate</td>
<td>Severe</td>
</tr>
<tr>
<td>Subjective assessment (cosmetic and functional)</td>
<td>Excellent</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>Overall scores</td>
<td>17 to 21</td>
<td>12 to 16</td>
<td>7 to 11</td>
<td>&lt; 7</td>
</tr>
</tbody>
</table>

### Outcomes by Age

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Group 1 (≤1 year)</td>
<td>22</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Age group 2 (1–3 years)</td>
<td>19</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Age group 3 (3–10 years)</td>
<td>26</td>
<td>5</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Age Group 4 (&gt;10 years)</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total number (%)</td>
<td>74 (88.1%)</td>
<td>7 (8.3%)</td>
<td>2 (2.4%)</td>
<td>1 (1.2%)</td>
</tr>
</tbody>
</table>

Follow-up

- 3-12 months
- Positional preference
- Structural and movement symmetry of the neck, face, head, trunk, hips, extremities
- Developmental milestones
Facial Asymmetry

- Improvement noted in all age groups but best if surgery done before 5 years old.
- Improvement may vary by part of face.
  - Facial bones grow at different rates
  - Orbits max growth at 1-2 years, maxilla 8-14 years

Kittur, D. The fate of facial asymmetry after surgery for muscular torticollis in early childhood. Journal of Indian Association of Pediatric Surgeons. 2016 Apr-June; 21 (2) 57-60.

Motor Delay


- 173 children with postural torticollis
- 44 with functional asymmetry on Alberta Infantile Motor Scale
- At age 2, 78% with resolved torticollis, 82% resolved asymmetry

Ohman, A. and Beckung, E. Children who had congenital torticollis as infants are not at higher risk for a delay in motor development at preschool age. *PMR* 2013;5, 850-855.

- 81 children with history of CMT vs a control group, aged 3.5 – 5 years
- Movement Assessment Battery for Children
- Mean scores similar in both groups
ORTHOTIC MANAGEMENT OF CMT AND PLAGIOCEPHALY
Referral Process
Team Approach

Pediatrician  
Therapist

Craniofacial Team  
Orthotist
Craniofacial Team

- Otolaryngologist
- Pediatric anesthesiologist
- Neuroradiologist
- Orthotist
- Craniofacial surgeon
- Geneticist
- Orthodontist
- Pediatric neurosurgeon
- Maxillofacial surgeon
- Ophthalmologist
- Plastic surgeon
- Speech / language
- Dentist
- Dysmorphologist
Pediatricians

• Many/most pediatricians are comfortable making a diagnosis for deformational cases and referring to orthotist.

• If patient presents with questionable suture patency, neck muscle involvement or other concerns then referrals are made to the craniofacial team or therapist.
Orthotic Assessment

- Establish relationship with parent and infant
- Share experience and expertise; provide caregiver education
- Establish baseline and goals
- Assess anthropometric measurements
- Determine severity
- Make clinical recommendation(s)
- Clinical report
CMT and sustained supine positioning
Deformational Plagiocephaly

Deformational Plagiocephaly

- **Disease** or physiological disruption that creates an imbalance in the static or dynamic modeling process, resulting in physical impairment of the individual.

- **Deformational plagiocephaly** is a condition characterized by an asymmetrical distortion (flattening of one side) and/or disrupted proportion of the skull.
Synostotic vs Non-Synostotic Deformational Plagiocephaly

- Must confirm that plagiocephaly is **non-synostotic** prior to CRO therapy; CRO contraindicated in synostotic plagiocephaly.
- Always assess from above
- Check ear placement and the shape of the head.
- Synostotic plagiocephaly is shaped like a trapezoid
- Non-synostotic deformational plagiocephaly will look like a parallelogram and is appropriate for CRO treatment

Synostotic: trapezoid shape; ear on affected side posterior; refer to MD!

Non-synostotic: parallelogram shape; ear on affected side anterior – CRO appropriate!
Asymmetrical Brachycephaly

http://www.paediatricpearls.co.uk/wp-content/uploads/plagiocephaly-mothersstale-1.jpg
http://www.londonorthotics.co.uk/media/22875/charlie-monks-before.jpg
Deformational Scaphocephaly

Normal

Plagiocephaly

Brachycephaly

Scaphocephaly
What is a Cranial Remolding Orthosis?

A Class II medical device:

- Designed for infants
- That decreases cranial asymmetry and/or disproportion resulting from:
  - deformational plagiocephaly
  - brachycephaly
  - scaphocephaly
  - post-operative craniosynostosis
It is a Custom Medical Device!
Modeling considerations

- Time of onset
- Degree of severity
- Diagnosis / Etiology
- Developmental level
- Associated conditions (Torticollis)
Contraindications

• Craniosynostosis
  – Can be used post operatively

• Hydrocephalus
  – Can be used post op with special care taken to prevent occlusion of the shunt

• Children younger than 3 months

• Children older than 18 months
Head and skull growth

• As the brain grows the cranial sutures allow for rapid and symmetrical expansion of the skull

• After 2 years the skull’s growth is no longer elastic

• Complete treatment before the sutures close
Cranial Growth Patterns

- 80% of head growth occurs within the first 12 months after birth.
  - 1 – 3 months: 2 cm per month
  - 4 – 6 months: 1 cm per month
  - 6 – 12 months: .5 cm per month

[Image: CDC Growth Charts: United States]

[Graph: BOYS HEAD CIRCUMFERENCE]
http://www.geocities.ws/dol911/growth/growthcharthead.jpg
Cranial Growth Patterns

- Repositioning is most effective in the first three months.
- CROs applied during months 4-6 can capture and direct 3 cm of circumferential growth into the flattened areas.

GIRLS HEAD CIRCUMFERENCE
http://www.geocities.ws/dol911/growth/growthchartghead.jpg
Principles of Cranial Remolding Orthoses

• There is a critical window of opportunity, specifically between 4-6 months of age, when the head is most actively growing

• Provide total contact in the areas where growth is to be inhibited

• Provide space in the areas where expansion is desired

• It is preferred to end treatment by 12 months of age
Principles of Cranial Remolding Orthoses

• Take advantage of the greatest period of cranial growth, between 4 – 6 months of age.

• Control both the direction and shape of brain and cranial growth in a symmetrical and proportional medical device.
Principles of Cranial Remolding Orthoses

• CROs do not “squeeze” the head to change the shape

• CROs contact or “hug” the long or wide dimensions to curb growth and provide a void over the short or narrow dimensions to allow growth into that space

• CROs are passive; the growth of the brain and skull are active
CROs are for **Moderate to Severe** Asymmetry and/or Disproportion

![Normal, Plagiocephaly, Brachycephaly, Dolichocephaly or Scaphocephaly](https://media.licdn.com/mpr/mpr/AAEAAQAAAAAAJoAAAAJGVkZDhmNTE1LWVmN2UtNDRhYy1iY2RhLTESMzAyNmE2NzYxOQ.png)
How to quantify mild, moderate and severe deformational plagiocephaly?

Normal

Mild?

Moderate?

Severe?
Argenta Classifications

DEFORMATIONAL PLAGIOCEPHALY

TYPE 1.
Posterior flattening
Normal

TYPE 2.
Ear shift
Mild

TYPE 3.
Forehead deformity
Moderate

TYPE 4.
Cheek, face & jaw deformity
Severe

TYPE 5.
Vertical and/or temporal deformity
Severe

DEFORMATIONAL BRACHYCEPHALY

TYPE 1. (or 6A)
Central posterior flattening
Mild

TYPE 2. (or 6B)
Widening of the posterior skull
Moderate

TYPE 3. (or 6C)
Temporal and/or vertical deformity
Severe

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Key Anatomical Landmarks

**Eurion (EU)**
- Widest points on either side of the cranium

**Frontozygomaticus (FZ)**
- Outer edge of the eyebrow

**Excanthion (EX)**
- Outer edge of the eyelids

**Glabella (GL)**
- Midpoint of the brow

**Subnasion (SN)**
- Midpoint below the nose

**Tragion (T)**
- Anterior to the ear

**Occipital protuberance or opisthocranion (OP)**
- Back of the head
Clinical Tools

- Wooden ML gauge
- Digital ML gauge
- Flexible tape measure

Circumference

Viscerocranium – facial

Neurocranium – skull width / length
Key Anthropometric Measurements

**Circumference**
- Taken at eyebrow level
- Head in neutral position
- Tape is parallel to floor

[Image of baby with tape measure on head]

CRANIAL CIRCUMFERENCE
Key Anthropometric Measurements

Cranial width
- eurion to eurion
- eu-eu

Cranial length
- glabella to opisthocranion
- gl-op

CRANIAL PROPORTION
https://www.researchgate.net
Key Anthropometric Measurements

Cephalic Index (CI) or Cephalic Ratio

- \( \frac{\text{Cranial width}}{\text{cranial length}} \times 100 \)
- "Normal" skull CI is about 80%

CRANIAL PROPORTION
https://www.researchgate.net
Key Anthropometric Measurements

Cranial Vault Asymmetry (CVA)
- Also referred to as oblique diagonal difference and transcranial diagonal difference (TDD)
- Right anterior to left posterior
- Left anterior to right posterior
- Discrete difference between the two linear distances

CVA = Diagonal A – Diagonal B
Cranial Vault Asymmetry Index (CVAI)

- Relative difference that accounts for changes in circumference; should get smaller with treatment and improving symmetry.

\[
\frac{\text{Diagonal A} - \text{Diagonal B}}{\text{Diagonal A or B}} \times 100
\]

(diagonal A is the longer value)
Key Anthropometric Measurements

Cranial Base Asymmetry

- From tragion to subnasion
- Difference between right and left sides
- Relates to ear asymmetry
Key Anthropometric Measurements

**Orbitotragial Depth Asymmetry**
- From tragion to excanthion
- Difference between right and left sides
- Relates to eye asymmetry
Measurement tracking

Cranial Anthropometric Measurement

<table>
<thead>
<tr>
<th>Name of Patient:</th>
<th>A Child</th>
</tr>
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<tbody>
<tr>
<td>Date of Birth:</td>
<td>7/15/2016</td>
</tr>
<tr>
<td>Prescribing Physician:</td>
<td>Dr. Evans / Dr. Arsenault</td>
</tr>
<tr>
<td>Diagnosis:</td>
<td>Plagiocephaly</td>
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</table>

<table>
<thead>
<tr>
<th>Date of Visit</th>
<th>Age</th>
<th>New Orthosis</th>
<th>Circ. (A)</th>
<th>Width EU/EU (1)</th>
<th>Length A/P (2)</th>
<th>Cephalic Index (M/L x 100 divided by A/P)</th>
<th>Right Anterior to Left Posterior</th>
<th>Left Anterior to Right Posterior</th>
<th>Cranial Vault Asymmetry (Difference FZ to EU R/L)</th>
<th>Cranial Vault Asymmetry (Ratio of FZ to EU as %)</th>
<th>Cranial Base</th>
<th>Orbital Depth</th>
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<tbody>
<tr>
<td>1/20/2017</td>
<td>6</td>
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<td>436.0</td>
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<td>84.36%</td>
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<td>147.0</td>
<td>4.0</td>
<td>2.72%</td>
<td>0.0</td>
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</tbody>
</table>
Integrated Cranial Care Program

NORMOCEPHALY
Normal head shape

Clinical measurements:
TDD < 3mm or CVAI < 3.5

Clinical findings:
All quadrants within normal limits

Treatment recommendations:
Repositioning as needed, consideration of plagiocephaly risk factors, no orthotic treatment required
# Integrated Cranial Care Program

## MILD DEFORMATIONAL PLAGIOCEPHALY

<table>
<thead>
<tr>
<th>Clinical measurements:</th>
<th>TDD 3 – 8mm or CVAI 6.25 – 8.75</th>
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</thead>
<tbody>
<tr>
<td>Clinical findings:</td>
<td>One to two posterior quadrant involvement, minimal ear shift</td>
</tr>
<tr>
<td>Treatment recommendations:</td>
<td>Repositioning with monthly reassessments &lt; 6 months of age, consideration and documentation of plagiocephaly risk factors</td>
</tr>
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</table>
Integrated Cranial Care Program

<table>
<thead>
<tr>
<th>MODERATE DEFORMATIONAL PLAGIOCEPHALY</th>
<th>Clinical measurements:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TDD 8 – 12mm or CVAI 8.75 – 11.0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two to three quadrant involvement, ipsilateral ear shift, forehead involvement</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment recommendations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repositioning with monthly reassessments and consideration of plagiocephaly risk factors &lt; 4 months of age; CRO considered at 4 months of age with completion of orthotic treatment program by 12 months of age</td>
</tr>
</tbody>
</table>
### Integrated Cranial Care Program

#### Severe Deformational Plagiocephaly

**Clinical measurements:**
- TDD > 12mm
- or CVAI 11.0

**Clinical findings:**
- Four quadrant involvement
- Ipsilateral ear shift
- Ipsilateral forehead bossing
- Contralateral forehead flattening
- Contralateral occipital bossing

**Treatment recommendations:**
- Repositioning with monthly reassessments < 4 months of age
- CRO recommended at 4 months of age
- Completion of orthotic treatment program by 12 months of age
Plagiocephaly

Before

After

Brachycephaly

Time in band 4 months

Before

After
Patient Outcomes
Patient Outcomes
Patient Outcomes
Nobody’s Perfect

• Asymmetry per se, is not abnormal.

• The magnitude of the asymmetry determines whether the head shape is abnormal.
# Wearing Instructions (23 Hrs)

<table>
<thead>
<tr>
<th>Day</th>
<th>ON Time</th>
<th>OFF Time</th>
<th>Naps</th>
<th>Nighttime</th>
<th>Skin Check</th>
<th>Reapply Orthosis</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1 hour</td>
<td>1 hour</td>
<td>No</td>
<td>No</td>
<td>Each time removed.</td>
<td>At least 3 times.</td>
</tr>
<tr>
<td>2</td>
<td>2 hours</td>
<td>1 hour</td>
<td>No</td>
<td>No</td>
<td>Each time removed.</td>
<td>At least 3 times.</td>
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<tr>
<td>3</td>
<td>4 hours</td>
<td>1 hour</td>
<td>Yes</td>
<td>No</td>
<td>Each time removed.</td>
<td>At least 2 times.</td>
</tr>
<tr>
<td>4</td>
<td>6 hours</td>
<td>1 hour</td>
<td>Yes</td>
<td>No</td>
<td>Each time removed.</td>
<td>At least 2 times.</td>
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<tr>
<td>5</td>
<td>6—8 hours</td>
<td>1 hour</td>
<td>Yes</td>
<td>No</td>
<td>Each time removed.</td>
<td>At least 2 times.</td>
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<tr>
<td>6</td>
<td>8 hours</td>
<td>1 hour</td>
<td>Yes</td>
<td>Yes</td>
<td>Each time removed.</td>
<td>8 hours day / 8 hours night</td>
</tr>
<tr>
<td>7</td>
<td>23 hours</td>
<td>1 hour</td>
<td>Yes</td>
<td>Yes</td>
<td>Each time removed.</td>
<td>Success!</td>
</tr>
</tbody>
</table>
Hygiene

• Kiddos will sweat (profusely) for the first 1-2 weeks of CRO wear. The body typically acclimates to the temperature change leading to less sweating over time.
• The orthosis should be cleaned daily with baby soap and water, or a 50/50 rubbing alcohol/water mix
• Rinse well and allow to air dry
• No bleach or other harsh chemical cleansers
Patient Follow Up

• CROs must be fit in 5-10 days of the scan
• The patient will be seen
  – Evaluation and scanning Appointment
  – Delivery appointment 1 week
  – 1 week post delivery follow up
  – 2 weeks follow up
  – Every 2 – 3 weeks until discharge
  – As problems arise
Torticollis Orthotics
Kentucky Collar Cervical Orthosis

Treats conditions such as torticollis

- Sizes 3X Small through adult XL
- High-temperature plastic customized to each patient
- Applies flexible low-load passive stretch (LLPS)
- Optional forehead strap

KENTUCKY COLLAR
TOT Collar

- Child and adult sizes
- Conservative treatment of infants with congenital muscular torticollis
- Provides negative stimulus with lateral posts
- Requires direct supervision and remove for sleeping!
Clinical Recommendations

• Clinical recommendations are based upon many variables:
  
  – Age of the infant
  – Duration and effectiveness of repositioning efforts
  – Severity of deformity
    • Determined by measurements, scan, summary report and visual examination
  – Goals of the parents
Questions?
Comments?
Discussion!
CMT Clinical Practice Guideline
Action Statements for the 2013 Congenital Muscular Torticollis Clinical Practice Guideline

• Education, Identification and Referral

• Physical Therapy Examination & Evaluation

• Physical Therapy Intervention

• Physical Therapy Discontinuation, Reassessment and Discharge
Education, Identification and Referral Action Statements

**AS 1:** IDENTIFY NEWBORNS AT RISK OF CMT

**AS 2:** REFER INFANTS WITH ASYMMETRIES/CMT TO PHYSICIAN AND PT

**AS 3:** DOCUMENT INFANT HISTORY
Education, Identification and Referral Action Statements

**AS4**: SCREEN INFANTS FOR NON-MUSCULAR CAUSES OF ASYMMETRY AND CONDITIONS ASSOCIATED WITH CMT

**AS 5**: REFER INFANTS FROM PT TO PHYSICIAN IF INDICATED BY SCREEN

**AS 6**: REQUEST IMAGES AND REPORTS
THERAPEUTIC MANAGEMENT OF CMT: EXAMINATION
Examination and Evaluation

Action Statement 7
Examine Body Structures

- Posture and tolerance of positioning in *supine*, *prone*, *sitting* and *standing*
- Bilateral *PROM cervical rotation and lateral flexion*
- Bilateral *AROM cervical rotation and lateral flexion*
- *PROM/AROM B upper/lower extremities*
- *Skin*: integrity, symmetry of folds, presence and location of SCM mass, and size, shape and elasticity of SCM
- *Head/skull shape and craniofacial asymmetries*
- *Signs of pain* or discomfort at rest or with handling
Torticollis Toolkit
AS 7: Examine Body Structures

Infant posture and tolerance to positioning in supine, prone, sitting and standing with or without support as appropriate for age.
AS 7: Examine Body Structures
Supine

• Take photo of infant in preferred resting position. Print.

• Draw straight line through acromion processes, and a second through the corners of both eyes. Measure angle of head tilt.

• Gives you baseline resting position and objective data for measuring progress going forward.
AS 7: Examine Body Structures
Sitting
AS 7: Examine Body Structures

Measure and document B PROM cervical rotation and lateral flexion – CMT severity determined by difference between two sides cervical rotation

Normal Cervical rotation: 110°
Normal Lateral flexion: 70°
AS 7: Examine Body Structures

Measure and document:
B AROM cervical rotation and lateral flexion

Active cervical rotation ROM:
< 3 months of age or inadequate head control in supported sitting – test in supine using visual stim or observation of voluntary movement

≥3 months of age and with adequate head control, measure seated on PT lap on rotating stool.

Active cervical lateral flexion ROM:
For infants ≥ 2 months of age, Muscle Function Scale
6 point scale; CMT infants with 2-3 point difference between sides.
AS 7: Examine Body Structures

Measure AROM and PROM of spine and B upper/lower extremities

- Shoulder girdle – BPI, clavicular fx
- Hips – developmental dysplasia of hip
- Tone – hyper/hypomobility suggesting CNS lesion
AS 7: Examine Body Structures
Skin Integrity

- Presence and location of SCM muscle mass and shape and elasticity of SCM and accessory muscles

- Skin folds - neck and hip/LEs
AS 7: Examine Body Structures

Assess signs of pain:

• Not typically associated with CMT

• May be associated with stretching

• Pain vs distress at separation from familiar caregiver during PT handling
AS 8: Classify level of Severity
AS 9: Examine Activity and Developmental Status

• Examine types of and tolerance to position changes

• Examine motor development for movement symmetry and milestones
  • Test of Infant Motor Performance (≤ 4 moa)
  • AIMS (4-18 months)
AS 10: Examine Participation Status

• Feeding positions
• Sleep positions
• Infant time in prone
• Infant time in equipment and positioning devices including car seats, strollers, bouncers, swings, etc
AS 11: Determine Prognosis

• Expected outcome in objective, measurable terms
• Time frame for intervention to achieve desired outcomes
• Description of potential courses of condition with vs without treatment
• Communication with parents/caregivers!
Lab

Examine Body Structures

• Preferred resting position
• PROM cervical rotation and lateral flexion
• AROM cervical rotation and lateral flexion
THERAPEUTIC MANAGEMENT: INTERVENTIONS
Comprehensive and Targeted Intervention

Going beyond static stretching...sharing the artful movement of this young girl

https://www.youtube.com/watch?v=sqSslKxJ4LE
AS 12: Provide the 5 Components of First-Choice Interventions

1. Neck PROM
2. Neck and Trunk AROM
3. Development of Symmetrical Movement
4. Environmental Adaptations
5. Parent Education

• What is the right timing and mix for your patient?
Clinical Decision Making for CMT

• Three elements of Evidence Based Practice (EBP)
• “Art” within the science
• Terminology-subtle differences from CPG
  – STAGE: pertains to tissue recovery and development
  – SEVERITY: Sub-type of CMT
Therapeutic Management: Intervention

- EBP guidelines exist for DOSE
  - But NOT according to classification of severity
- Clinical expertise and parent values guide application of interventions
Clinical Decision Making for First Choice Intervention Methods

- **Stage**: Early “acute” to Late “chronic” (CPG = Classification Severity)
- **Severity**: CMT (CPG= Sub-Type)
- **Nature**: ICF model—identify all contributors to the cause of the child’s functional limitation(s)—big picture
- **“Irritability”**: Patient (and caregiver) tolerance for tx/resistance OR to describe degree of response to change
- **Stability**: Measured responsiveness to change. Treatment outcome.

*Adapted from Maitland approach to manual therapy*
Severity Classification System (SCS) 
7 tiers; mild to most severe

Early Identification Birth-3 mo
1. Grade 1: Early Mild
2. Grade 2: Early Moderate
3. Grade 3: Early Severe

Late Identification ->3 months
4. Late Mild
5. Late Moderate
6. Late Severe
7. Late Extreme

Question: How does STAGE of condition influence the clinician’s prioritization of impairments for each targeted intervention? Decisions about dose?
How does type of CMT inform Intervention?

1. Postural: head/neck positional preference without PROM restrictions
2. Muscular: head/neck positional preference and PROM restrictions
3. SCM Mass: head/neck positional preference and PROM restrictions and fibrotic thickening (often palpable lesion) of the SCM
Clinical Reasoning/Case 2 Preview: Sub Type 3 Head/neck preference w/ PROM limitation/SCM mass

• Which interventions should we use? What information do you need for this case?
• What other impairments and limitations for this patient?
• CPG stresses importance of treating beyond the body-structure level for best outcomes
**NATURE** (illustrated with ICF model)

**Body Structure/Function Problems:**
- Cervical PROM restriction
- Impaired neck ROM
- Weak neck flexors and extensors

**Activities Limitations or Ability:**
- Head Lag (transfers, bathtime)
- Asymmetrical head position supine

**Participation Behaviors:**
- Won’t nurse on left side

**Personal Factors**
- Multiple caregivers
- Parental Feelings of Guilt

**Environmental Factors**
- Limited floor space in home

**Health Condition**
- CMT-TYPE 2
“IRRITABILITY” Informs Intervention

Health Condition
CMT-TYPE 2

Body Structure/Function Problems:
- Cervical PROM restriction
- Impaired neck ROM
- Weak neck flexors and extensors

Activities Limitations or Ability:
- Head Lag (transfers, bathtime)
- Asymmetrical head position supine

Participation Behaviors
- Won’t nurse on left side

Personal Factors
- Multiple caregivers
- Parental Feelings of Guilt

Environmental Factors
- Limited floor space in home
STABILITY

• CPG informs the prognosis for degree of change and also informs PT’s actions for referral
• How does STABILITY (responsiveness) influence choice of interventions?
• How does STABILITY influence your choice of measurement tools used to measure progress toward goals?
• How does child’s maturation/development influence your determination of the STABILITY of the case?
INTERVENTIONS: How to Choose?

Organized by Developmental Age?
Organized by ICF model?
Prioritized by STABILITY?
Prioritized by available tools and expertise?
Prioritized by measurement tool(s)?
AS 12: First Choice Interventions
Reality of PROM vs AROM

• Before vs After Visual Righting
• Before vs After Head Control-Supine, Prone, Seated
• Before vs After patient establishes pattern of resistance to passive movement
AS 12: Passive Neck ROM

Targeted Motions
Lateral Flexion
Ipsilateral Rotation

Initial Objective: Tx without promoting a pattern of resistance from the child~
Or
Diminish pattern if it already exists

Methods
Dose/Duration (CPG)
Direct/Indirect

Principles
• Gentle
• Employ soft tissue creep
• One plane at a time if beyond midline
• Give rest breaks
AS 12: PROM

Dose/Duration

“Intense”

• Every day, throughout the day

• More the better…. 100x a day better than 50x a day..

• 10-15 second hold per rep average

Direct/Indirect

Direct stretching

• 2 person technique
• 1 person technique

Indirect

• Carrying
• Positioning for sleep
AS 12: PROM  Supine Suggestions

Warm-Up
- Objectives: head in midline, gravity minimized, establish visual “rapport”
- Shoulder depression B. Monitor and time with breath for stretch
- Patty cake, hands to mouth, hands to feet ipsilateral and contralateral
- Pull to Sit: from wedge>>flat surface; from shoulders>>from hands
- Knees to chest B. Maintain head/upper torso in midline, alternate knees side to side

Roll to sidelying to both affected and non affected side
• May need to start with support under ear of and gradually remove
Roll to affected side, maintain head in position and roll body back supine—may need to support ½ way
AS 12: PROM>>AAROM>AROM

Prone Suggestions

Roll sidelying to prone
• Start over shoulder of non-affected side
• For affected side, perform slowly and with head/neck support as now head is lifted from support surface

Prone
• In tucked position, visual stimulus as incentive to maintain rotation
• On forearms and/or knees, support level shoulders and head in midline, eyes on visual cue
• Visual stimulus to facilitate ipsilateral neck rotation
AS 12: AROM and Natural Righting Reactions for Tilt Correction

Visual righting

Head righting

• Lap sitting
• Physioball
• Vertical and horizontal suspension
AS 12: AROM and Equilibrium Reactions to Promote Neck Rotation Symmetry

Objective: require axial rotation and promote protective extension with arms

Side-sit
Side sit to prone
Seated clock-reach-start with lateral reach ipsilateral and progress to across midline
• Forward and lateral reach: 9-3 o’clock
• Posterior reach 4-8 o’clock positions
AS 12: First Choice Interventions
Movement Symmetry

- Which movements?
- What other than direction of movement is meant by “symmetry?”
- How do we quantify what we observe?
AS 12: 12 Month Old
AS 12: AROM
AS 12: First Choice Interventions for Movement Symmetry Developmental Exercise

Resources:
Standardized measurements
• Example today: Alberta Infant Motor Scale
Open resource caregiver education
• Pathways.org (milestones)
Interventions and HEP:
• Consistent with Impairments & Activities
• Consistent with Goals
AS 12: First Choice Interventions
Environmental Adapations

Purpose: Create an environment that encourages infant to expand into their area of restriction.

Key Factors:
– Amount of time
– Preferred positioning of caregiver
– Naturally occurring items/equipment
AS 12: First Choice Interventions
Caregiver Education

Purpose: Empower caregiver/family to incorporate home exercise program into daily life.

Key Factors:
- Caregiver/family factors
- Naturally occurring items/equipment
- Make it fun and part of bonding experience
- Toy placement to encourage infant to expand into their area of restriction
AS 12: First Choice Interventions
Environment Adaptations-Baby Room
AS 12: First Choice Interventions
Caregiver Education

Increase caregiver awareness of simple solutions for daytime and nighttime

Pathways.org
AS 12: First Choice Interventions
Environmental Adaptations
Midline Sitting
AS 12: First Choice Interventions
Caregiver Education
Positioning

• Birth to 3 months
  – Carseats, swings, baby carriers, etc
  – Sidelying for play
  – Introduce tummy time

• 3-6 months
  – 1+ hr of tummy time
  – Supported sitting

• 6 to 12 months
  – Continue to encourage tummy time
  – Sitting
AS 12: Caregiver Education
Positioning equipment

• Considerations:
  – COST
  – Ease of use

• Recommendations:
  – Limit “baby containment devices”
  – Various positions and surfaces
  – Reinforce midline orientation
  – Encourage tummy time
AS 12: Caregiver Education
Tummy Time

• Back to Sleep Initiative
• Introduce Tummy Time as early as possible
  – Diaper changes
  – Work up to 1 hour per day by 3 months
• Prone options
  – Chest to Chest
  – Lap Soothe
  – Superman Carry

www.pathways.org
### AS 12: Caregiver Education

#### Feeding Positions

**Breastfeeding a Child with Torticollis**

<table>
<thead>
<tr>
<th>For the child whose head turns to their RIGHT</th>
<th>Easier positions</th>
<th>Harder Positions</th>
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<tbody>
<tr>
<td><strong>Left Breast</strong></td>
<td>Cradle or Cross Cradle Hold Sidelying</td>
<td>Football Hold Straddle</td>
</tr>
<tr>
<td><strong>Right Breast</strong></td>
<td>Football Hold Straddle</td>
<td>Cradle or Cross Cradle Hold Sidelying</td>
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</table>

<table>
<thead>
<tr>
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<th>Easier positions</th>
<th>Harder Positions</th>
</tr>
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<tbody>
<tr>
<td><strong>Left Breast</strong></td>
<td>Football Hold Straddle</td>
<td>Cradle or Cross Cradle Hold Sidelying</td>
</tr>
<tr>
<td><strong>Right Breast</strong></td>
<td>Cradle or Cross Cradle Hold Sidelying</td>
<td>Football Hold Straddle</td>
</tr>
</tbody>
</table>

*http://otnotes.blogspot.com*
AS 12: First Choice Interventions
Caregiver Education

Play!!!

• Cervical rotation
  – Birth to 3 months
  – 3-6 months
  – 6-12 months

• Cervical lateral flexion
  – Birth to 3 months
  – 3-6 months
  – 6-12 months
AS 13: Provide Supplemental Interventions

• Purpose: Increase awareness of adjunct treatment options to support primary interventions.

• Options:
  – Myokinetic Stretching technique
  – Microcurrent Therapy
  – Kinesiology taping
  – Soft Tissue Massage
Case Studies

• Participants please divide into groups
  – Seeking a blend of “expert” and “novice” and “in between” clinicians, regardless of discipline

• Please do your best to complete tasks in time requested in session and be prepared to discuss and demonstrate!

• Tasks-see handout
Case 1: Maddie is a 7 month old little girl who presents to your clinic with R torticollis; referring pediatrician has noted that she has full cervical PROM B, but tends to posture with her head in approximately 25 degrees of R lateral flexion in multiple positions. Birth history is unremarkable; pt is third child to her mother who reports that both of her older children, aged four and six years, are typically developing. Maddie rolls sup>prone, pivots on her tummy, and is not yet sitting independently.
Case 2
James is a two month old baby boy who presents to your clinic with L torticollis with SCM mass. He was born at 41 weeks gestation weighing 9 pounds, 4 ounces and his delivery was forceps assisted. He is the first born child to his parents, who are married professionals; both will return to work full time when he is four months of age and he will be cared for at home by his grandmother.
Case 3: Andrew is a 7 month old boy who presents to your clinic with L torticollis without SCM mass, diagnosed at four months of age by his pediatrician, who instructed her parents in a home stretching program, which they report having done “off and on”. They report that it is getting more difficult to do the stretches, as Andrew struggles and cries, and that while his head/neck mobility seems mildly improved, there is still asymmetry present. At his six month appointment, the pediatrician agreed with parents that Andrew would benefit from more intensive intervention, and referred his for physical therapy. You note right away that Andrew has apparent plagiocephaly, with flattening of the left posterior aspect of his head and approximately 20 degree tilt. His mother expresses guilt about “letting this happen.”
Case 4

Hunter is an 13 month old boy from a rural county, who is referred to you by his pediatrician with the diagnosis of R torticollis and positional plagiocephaly. Medical care in his first year has been limited by his family’s lack of transportation and poor follow up with scheduled well baby visits; an early intervention referral has led you to an in-home evaluation where you measure a $> 40^\circ$ difference between L and R neck lateral flexion and rotation, and noticeable facial asymmetry.
AS 14: Refer for Consultation beyond Conservative Intervention if Outcomes are Delayed or Incomplete

- Asymmetries of head, neck, trunk not resolved after 4-6 weeks of initial intense tx OR
- After 6 months of tx with only moderate resolution
- Infants older than 12 mo on initial exam AND either facial asymmetry and/or 10-15 degree difference persists
- Infants older than 7 months with SCM mass
- Side of torticollis changes
AS 15: Document Outcomes and Discharge When Criteria are Met

• Full PROM within 5 degrees of non affected side
• Symmetrical AROM = PROM
• Age appropriate motor development
• No visible head tilt
• Parents/caregivers understand elements to monitor as child grows
AS 16: Provide Follow-Up Screening

• 3-12 months post discharge OR when child initiates walking (whichever comes later)
  – Positional preferences
  – Structural and movement symmetry of neck, face, head, trunk, hips, UEs, LEs, developmental milestones

Re-examination warranted if parent or teacher of elementary school age child presents with late developing or residual asymmetries, developmental delays, or preferential positioning.
Implementation!

• Keep a copy of CPG handy
• Adapt exam forms to include a place to document each of recommended measures
• Seek training on standardized measurement tools and interventions
• Build relationships with referral sources to encourage early referral
• Measure individualized outcomes across ICF domains
• Recognize that implementation takes time and ongoing resources
Thank you for participating!
General Course References


