Natural Progression of Non-Synostotic Plagiocephaly

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MSPO Research Project
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Outline

- Background of Plagiocephaly
- Study Aims
- Methods
- Results
  - Head Shape Severity
  - Parent Satisfaction
- Future Research
What is Plagiocephaly?

- **Flattening** of the head (Littlefield 1998)

- **Types**
  - Synostotic – due to premature closure of the skull sutures
  - **Non-synostotic** – due to external molding forces on the skull
    - Deformational plagiocephaly (DP)
    - Positional plagiocephaly
Incidence and Prevalence

- Prevalence of deformational plagiocephaly (van Vlimmeren 2007)
  - Varies with age
    - Birth – 13%
    - 6 weeks – 16%
    - 4 months – 19.7%

- Incidence has increased in the last 15 years (van Vlimmeren 2007)
Treatment of DP

- Cranial Orthosis
  - **Standard of care** in the United States
Study Aim

- To determine the natural progression of non-synostostic plagiocephaly of children between the ages of 18 and 48 months.

  - Hypothesis:
    Children with deformational plagiocephaly will not experience a natural improvement in head shape.

- To determine the parent satisfaction with the child’s current head shape.
Measurements

**Cephalic Ratio**: \[ \text{Cephalic Ratio} = \frac{\text{Length}}{\text{Width}} \]

**Cranial Vault Asymmetry Index**: \[ \text{Cranial Vault Asymmetry Index} = \frac{|\text{Diag A} - \text{Diag B}|}{\text{Larger (A or B)}} \]
<table>
<thead>
<tr>
<th>Severity Level</th>
<th>Description</th>
<th>CVAI</th>
<th>Suggested Treatment</th>
</tr>
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<tbody>
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<td>Repositioning or Orthosis</td>
</tr>
<tr>
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<td>• Asymmetry in 3 quadrants</td>
<td>8.75 – 11.0</td>
<td>Orthosis</td>
</tr>
<tr>
<td>5</td>
<td>• Asymmetry in 4 quadrants</td>
<td>&gt; 11.0</td>
<td>Orthosis</td>
</tr>
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</table>
Methods – Subjects

- Twenty two subjects

- Inclusion criteria
  - Age between 18 and 48 months
  - Diagnosed with deformational plagiocephaly
    - Includes scan of head shape obtained before age 1 year
  - Declined treatment with cranial remolding orthosis
  - Severity of 3 or higher
Methods – Survey

- Survey
- Interventions
- Parent impression

CHILDREN'S HEALTHCARE OF ATLANTA

Patient Research Survey
Non-Synostotic Progression of Natural Plagiocephaly

Please answer the following questions about your child to the best of your ability.

Child’s Name ____________________________
Date of Birth ________________________, Current Age ____________________

Birth History
☐ Full term
☐ Premature, _____ Weeks
Complications (including time in NICU)

Health History
Has your child had any of the following?
☐ Torticollis.............. ☐ with surgical correction
☐ Physical Therapy....... ☐ for torticollis, _____ weeks
                  ☐ for other ______________________
☐ Occupational Therapy
☐ Speech Therapy
☐ Hearing problems, please explain ____________________________
                  ☐ Frequent ear infections, how often?
                  ☐ Ear tubes
☐ Vision problems, please explain ____________________________
                  ☐ Glasses
☐ Dental problems, please explain ____________________________
☐ Surgeries, please explain _________________________________
Methods – Visual Observation
Methods – Scan

- Re-scan subjects using STARscanner
- Compare variables with scan from time of initial diagnosis
  - Diagonal Difference
  - Cranial Vault Asymmetry Index
  - Cephalic Ratio
  - Severity Level
## STARscanner Summary Report

**Facility:** CHOA

**Age:** 7.5 months corrected age

12 wks premature - 5/1/02 corrected birthdate, Exit Scan

### Date: 7/3/02  File 2:  Date: 12/16/02  Section: 3

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Shape 1</th>
<th>Shape 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranial Breadth (M-L)</td>
<td>402.3</td>
<td>439.8</td>
</tr>
<tr>
<td>Cranial Length (A-P)</td>
<td>114.5</td>
<td>130.1</td>
</tr>
<tr>
<td>Cephalic Ratio (M-L / A-P)</td>
<td>141.5</td>
<td>149.3</td>
</tr>
<tr>
<td>Radial Symmetry Index (RSI)</td>
<td>0.809</td>
<td>0.871</td>
</tr>
<tr>
<td>Oblique Cranial Maximum, at 15.4 deg</td>
<td>58.1</td>
<td>32.8</td>
</tr>
<tr>
<td>Oblique Cranial Minimum, at -69.7 deg</td>
<td>143.8</td>
<td>151.8</td>
</tr>
<tr>
<td>Oblique - User Specified 1, at -30.0 deg</td>
<td>110.6</td>
<td>126.9</td>
</tr>
<tr>
<td>Oblique - User Specified 2, at 30.0 deg</td>
<td>125.9</td>
<td>141.2</td>
</tr>
<tr>
<td>Cursor Specified - D1</td>
<td>139.8</td>
<td>149.1</td>
</tr>
<tr>
<td>Cursor Specified - D2</td>
<td>10.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Q1 Volume (A/L)</td>
<td>83.5</td>
<td>112.4</td>
</tr>
<tr>
<td>Q2 Volume (A/R)</td>
<td>96.1</td>
<td>124.4</td>
</tr>
<tr>
<td>Q3 Volume (P/R)</td>
<td>82.5</td>
<td>128.8</td>
</tr>
<tr>
<td>Q4 Volume (P/L)</td>
<td>96.1</td>
<td>135.8</td>
</tr>
<tr>
<td>Anterior Symmetry Ratio</td>
<td>0.850</td>
<td>0.903</td>
</tr>
<tr>
<td>Posterior Symmetry Ratio</td>
<td>0.858</td>
<td>0.948</td>
</tr>
<tr>
<td>Overall Symmetry Ratio</td>
<td>0.854</td>
<td>0.926</td>
</tr>
<tr>
<td>Upper Facial Left (TrL-Se)</td>
<td>91.2</td>
<td>96.0</td>
</tr>
<tr>
<td>Upper Facial Right (TrR-Se)</td>
<td>96.1</td>
<td>87.6</td>
</tr>
<tr>
<td>Upper Facial Symmetry Ratio</td>
<td>0.943</td>
<td>0.913</td>
</tr>
<tr>
<td>Cranial Base Width (TrL-TrR)</td>
<td>114.8</td>
<td>124.9</td>
</tr>
<tr>
<td>Vertex Height (Lev0-Lev10)</td>
<td>97.0</td>
<td>111.1</td>
</tr>
</tbody>
</table>
### Results – Head Shape

<table>
<thead>
<tr>
<th></th>
<th>Pre</th>
<th>Post</th>
<th>T-test (p&lt;0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagonal Difference</td>
<td>12.9 ± 2.7</td>
<td>12.5 ± 3.4</td>
<td>p = 0.58</td>
</tr>
<tr>
<td>(mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CVAI</td>
<td>8.4 ± 1.5</td>
<td>7.3 ± 1.8</td>
<td>p = 0.02</td>
</tr>
<tr>
<td>Cephalic Ratio</td>
<td>0.887 ± 0.05</td>
<td>0.844 ± 0.05</td>
<td>p &lt; 0.001</td>
</tr>
</tbody>
</table>
# Results – Head Shape

<table>
<thead>
<tr>
<th>Pre Severity Level</th>
<th>Post Severity Level</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
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<tbody>
<tr>
<td>3</td>
<td>30% n=3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>16.7% n=2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30% n=5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>66.7% n=8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20% n=2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.3% n=1</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>8.3% n=1</td>
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Results – Parent Survey

- How do you feel your child’s head shape has changed?
  - Improved: 14
  - Stayed the same: 6
  - Worsened: 0
  - Don’t Know: 2

- How satisfied are you with your child’s current head shape?
  - Very: 11
  - Somewhat: 6
  - Neutral: 0
  - Not very: 5
  - Not at all: 0
Discussion – Quantitative

- Head shapes are improving in CVAI
  - 77% (17 of 22) of subjects CVAI improved

- However, not improving enough to move into a non-treatment classification
  - 77% of subjects would still be recommended for treatment

- Improvement in CR may indicate a less aggressive approach to brachycephaly treatment
Discussion – Qualitative

- Parents are satisfied
  - Hair
  - Growth
  - Justify decision

- Previous study (Steinbok 2007)
  - 77% of parents have no concern with the current shape of the child’s head
  - 60% of parents feel the child’s head shape is normal
Future Work

- Expand sample size
  - Increase number of severe subjects

- Increase age range to look at additional time points

- Study other head shapes

- Multi-center study
Thank You!!!

Aaron Smith, CO
References


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Markers for measurements
Effects of Growth on CVAI

Diagonal 1 = 136.5 mm
Diagonal 2 = 149.3 mm
Difference = 12.9 mm

\[
\text{CVAI} = \frac{12.9}{149.3} \times 100 = 8.64
\]

Diagonal 1 = 175.2 mm
Diagonal 2 = 188.1 mm
Difference = 12.9 mm

\[
\text{CVAI} = \frac{12.9}{188.1} \times 100 = 6.85
\]
Brachycephaly
Why the increase in DP?

- Back to Sleep Program (AAP 1992)
- Use of baby swings, bouncy seats, interchangeable car seats and child carriers (Littlefield 2003)
- Decrease in use of soft bedding (Littlefield 2003)
- Decreased time in prone position (Littlefield 2003)
- Increased awareness of DP by parents and caregivers (Rekate 2007)
Who cares?

- Children
- Parents
- Orthotists
- Third party payers
Results – Parent Survey

- **Torticollis**
  - 11 out of 22
  - Physical therapy
    - 11 out of 11

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<tr>
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<th>Torticollis</th>
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