



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 ¹(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

- **Effective treatment** for improving head shape

(di Ribaupierre 2007, Graham 2005, Lee 2006, Littlefield 2000, Losee 2007, Loveday 2001, Plank 2006, Pollack 1997)

- **Standard of care** in the United States





Study Aim

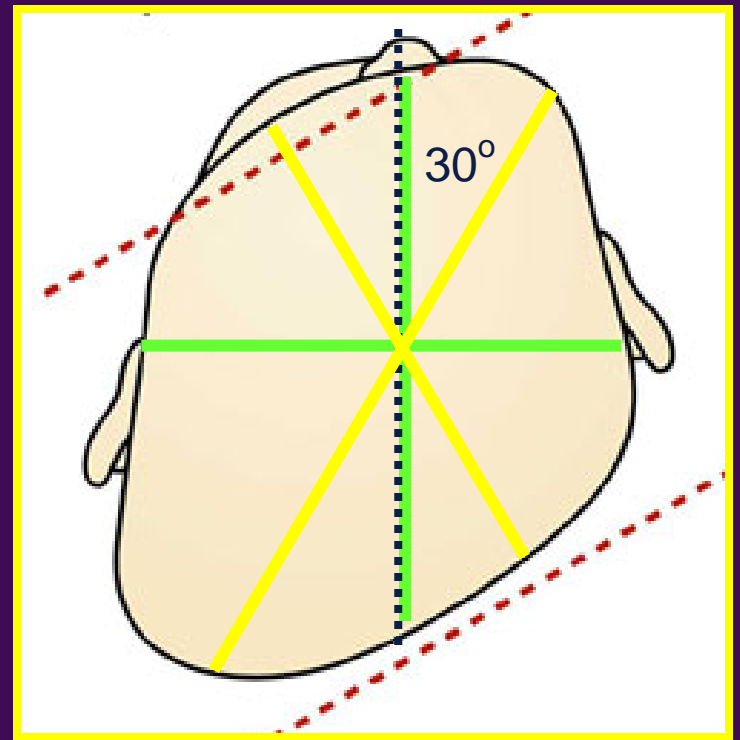
- To determine the **natural progression** of non-synostotic plagiocephaly of children between the ages of 18 and 48 months.
- Hypothesis:
Children with deformational plagiocephaly **will not experience a natural improvement** in head shape.
- To determine the **parent satisfaction** with the child's current head shape.



Measurements

$$\text{Cephalic Ratio} = \frac{\text{Length}}{\text{Width}}$$

$$\text{Cranial Vault Asymmetry Index} = \frac{|\text{Diag A} - \text{Diag B}|}{\text{Larger (A or B)}}$$





Severity Scale

Severity Level	Description	CVAI	Suggested Treatment
1	<ul style="list-style-type: none">• All asymmetry within normal limits	< 3.5	None
2	<ul style="list-style-type: none">• Asymmetry in 1 posterior quadrant	3.5 – 6.25	Repositioning
3	<ul style="list-style-type: none">• Asymmetry in 2 quadrants• Minimal ear shift, anterior involvement	6.25 – 8.75	Repositioning or Orthosis
4	<ul style="list-style-type: none">• Asymmetry in 3 quadrants• Moderate ear shift• Anterior involvement, orbital asymmetry	8.75 – 11.0	Orthosis
5	<ul style="list-style-type: none">• Asymmetry in 4 quadrants• Severe ear shift• Anterior involvement, orbital and cheek asymmetry	> 11.0	Orthosis



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

CHILDRENS 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 _____



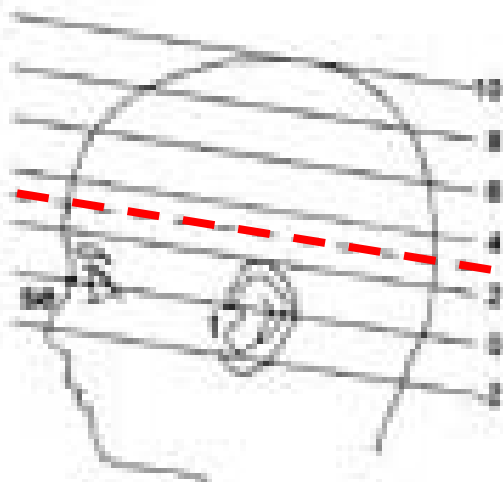
Methods – Visual Observation





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

Fax: -

Age: 7.5 months corrected age

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

Date: 7/3/02

File 2:

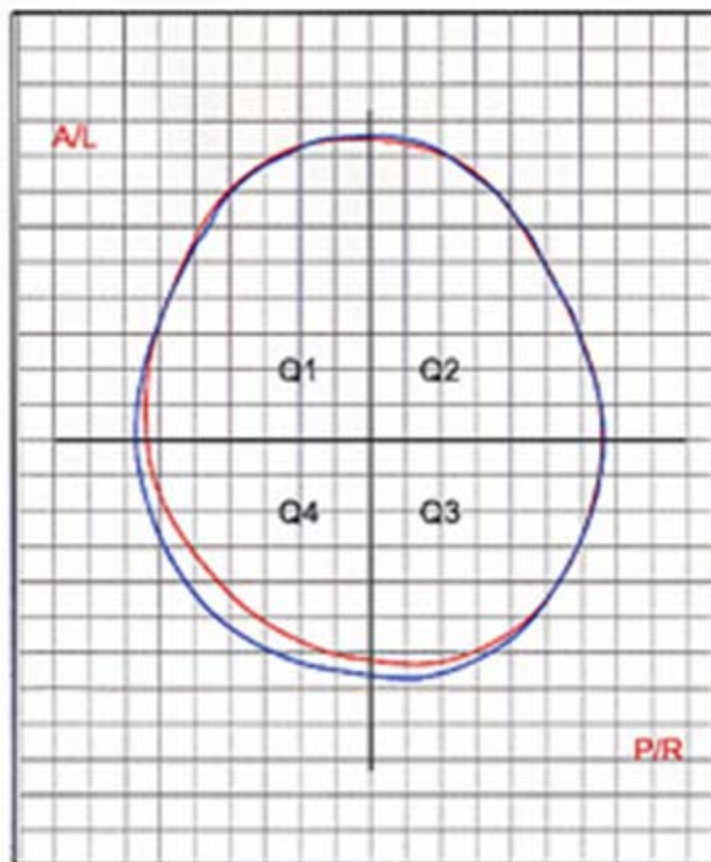
Date: 12/16/02

To: 5

Section: 3



Measurement		Shape 1	Shape 2
	(mm)	402.3	439.8
Cranial Breadth (M-L)	(mm)	114.5	130.1
Cranial Length (A-P)	(mm)	141.5	149.3
Cephalic Ratio (M-L / A-P)		0.809	0.871
Radial Symmetry Index (RSI)	(mm)	58.1	32.8
Oblique Cranial Maximum,	at 15.4 deg (mm)	143.8	151.8
Oblique Cranial Minimum,	at -69.7 deg (mm)	110.6	126.9
Oblique - User Specified 1,	at -30.0 deg (mm)	125.9	141.2
Oblique - User Specified 2,	at 30.0 deg (mm)	139.8	149.1
Cursor Specified - D1	(mm)	10.5	10.5
Cursor Specified - D2	(mm)		
Q1 Volume (A/L)	(cc)	83.5	112.4
Q2 Volume (A/R)	(cc)	98.1	124.4
Q3 Volume (P/R)	(cc)	82.5	128.8
Q4 Volume (P/L)	(cc)	96.1	135.8
Anterior Symmetry Ratio		0.850	0.903
Posterior Symmetry Ratio		0.858	0.948
Overall Symmetry Ratio		0.854	0.926
Upper Facial Left (TrL-Se)	(mm)	91.2	96.0
Upper Facial Right (TrR-Se)	(mm)	86.1	87.6
Upper Facial Symmetry Ratio		0.943	0.913
Cranial Base Width (TrL-TrR)	(mm)	114.8	124.9
Vertex Height (Lev0-Lev10)	(mm)	97.0	111.1





Results – Head Shape

	Pre	Post	T-test ($p < 0.05$)
Diagonal Difference (mm)	12.9 ± 2.7	12.5 ± 3.4	$p = 0.58$
CVAI	8.4 ± 1.5	7.3 ± 1.8	$p = 0.02$
Cephalic Ratio	0.887 ± 0.05	0.844 ± 0.05	$p < 0.001$



Results – Head Shape

		Post Severity Level			
		2	3	4	5
Pre Severity Level	3	30% n=3	50% n=5	20% n=2	0% n=0
	4	16.7% n=2	66.7% n=8	8.3% n=1	8.3% n=1



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





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Questions



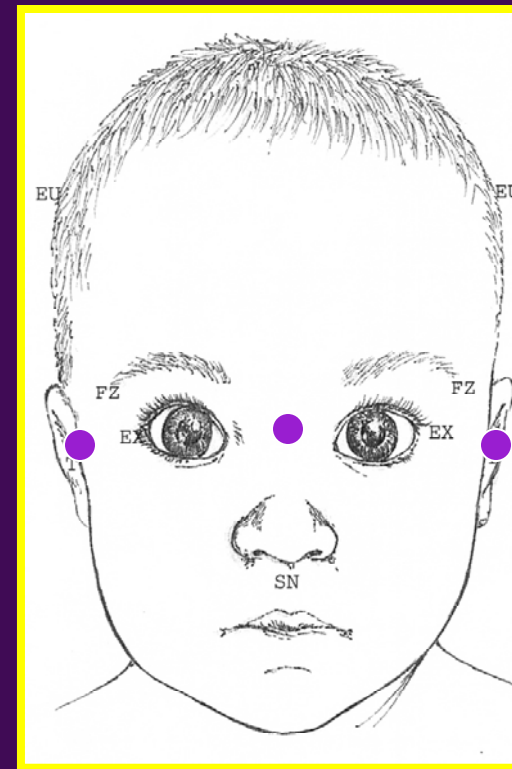
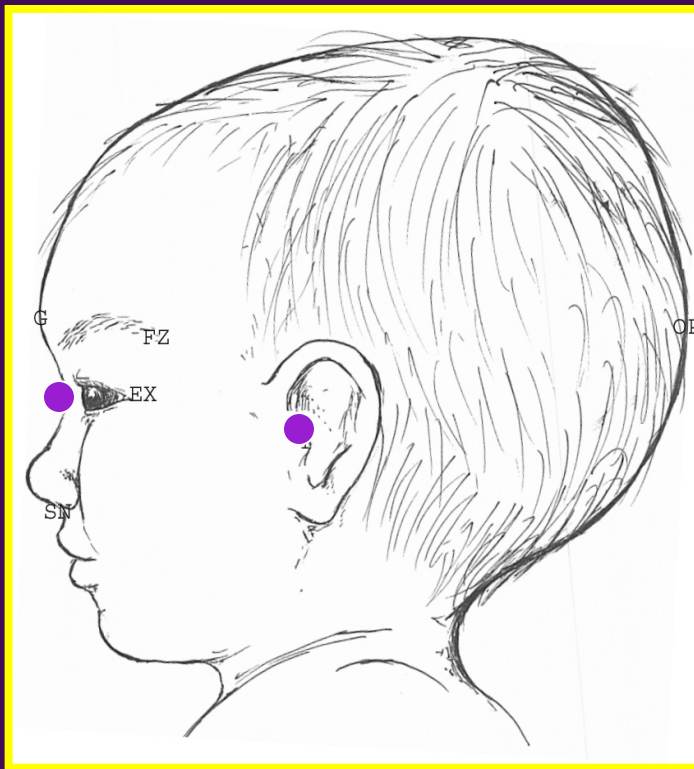


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Markers for measurements





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

	Torticollis	No Torticollis
Improved	10	7
Worsened	1	4