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Use of a Hand Held Laser Scanner to Monitor Efficacy of Craniofacial Treatment Modalities

Wake Forest University Baptist MEDICAL CENTER

OBJECTIVES

1) To validate the efficacy of soft shell helmet therapy for infants with positional plagiocephaly.
2) To develop an imaging modality that provides an objective method to assess the efficacy of craniofacial therapy.

INTRODUCTION

Deformational plagiocephaly is characterized by occipitoparietal flattening of the infant's cranium secondary to prenatal or postnatal external constraint. In the past decade, the incidence of deformational plagiocephaly has risen from 1 in 300 live births to approximately 10% to 15% in otherwise healthy infants.1-3
There are problematic sequelae associated with untreated positional plagiocephaly. These include not only cosmetic issues such as mandibular malalignment and scoliosis of the face,4 but also developmental delay manifested in the form of language disorders, learning disability, attention deficits, and a delay in early gross motor milestones.5,6
As the cranial asymmetry will not resolve naturally,7 therapeutic options for positional plagiocephaly include active counterpositioning, external orthotic or helmet therapy, and surgery. Though surgery is rarely necessary, there is considerable debate regarding the most efficacious mode of therapy for this condition.
Additionally, there exists a need for an effective analytical tool to assess the progress achieved with various craniofacial treatment modalities.8-11 Methods such as direct observation and measurements using calipers introduce subjectivity and accuracy concerns, while sophisticated imaging studies such as CT produce objective values but are expensive, involve exposure to ionizing radiation, and may require sedation of the infant.

METHODS

This study will involve a total of 200 infants who present to the North Carolina Center for Craniofacial Deformities at Wake Forest University Baptist Medical Center with a diagnosis of positional plagiocephaly. Three-dimensional laser scanning was preformed for each child at their initial visit and at each of the follow-up appointments occurring at intervals of 6-8 weeks. The patients will be followed until the cranial asymmetry reaches satisfactory resolution, and will then be released to the care of their pediatricians.
The images obtained by the operation of the hand-held laser scanner (FastSCAN Cobra; Polhemus Inc, Colchester VT) were refined in the accompanying computer software program.

The three-dimensional images were then reformatted into a standard orientation using scan comparison utility software (Delta; Farfield Technology, Christchurch, New Zealand). The software facilitates a visual comparison, which is enhanced by color field mapping of the cranial surface. Intracranial measurements and quadrant volumetric calculations were performed to quantitatively assess therapeutic efficacy.

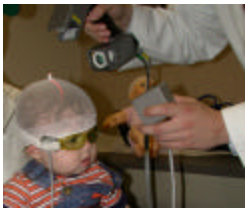

Fig. 2. Hand held laser scanning procedure

Fig. 1. Soft shell helmet therapy

Fig. 3. FastSCAN Cobra

Delta Scan Comparison Utility Software: Current Applications

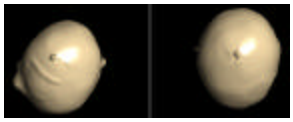

Fig. 4. Scan comparison: Pre-treatment vs. Post-treatment

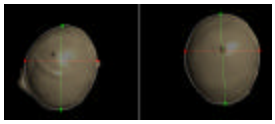

Fig 5. Point to point intracranial measurements

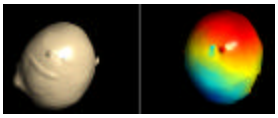

Fig. 6. Color map display of volume displacement

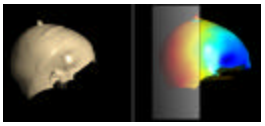

Fig. 7. Volume calculation: lateral view

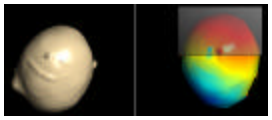

Fig. 8. Volume calculation: superior view

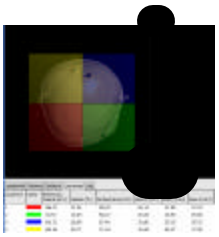

Fig. 9. Quadrant volume calculations: Pre-treatment

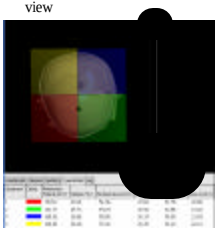

Fig. 10. Quadrant volume calculations: Following 4 months helmet therapy

RESULTS

Since May 2004, 186 children have been enrolled in the study. The mean age of the infants at presentation was 6.2 months, with an age range of 1.5 months to 11.0 months. Of the 186 infants, 138 (74.2%) were male and 48 (25.8%) were female. This is in accordance with the predilection for positional plagiocephaly in males reported in other studies.5,14,16-18 Occipital flattening occurred on the right side in 89 (48.8%), on the left side in 67 (36.0%), and bilaterally in 28 (15.2%) of the patients. The higher incidence of right occipital flattening is also consistent with that reported in the literature.2,5,9,12-18

Efficacy of helmet therapy was evaluated through visual comparison of the three dimensional images using the scan comparison utility software, as well as objective data measurements. Based on visual comparison alone, a marked decrease in cranial asymmetry was seen in the infants following only 6-8 weeks of therapy. Preliminary intracranial measurements and quadrant volumetric calculations also indicate substantial resolution of cranial asymmetry.

CONCLUSIONS

Soft shell helmet therapy used by WFUBMC is an effective therapeutic modality for the treatment of positional plagiocephaly.

The efficacy of soft shell helmet therapy is validated by the objective quantification methods utilized in this and previous studies.12 Soft shell helmet therapy achieves a decrease in cranial asymmetry comparable to that of other therapeutic modalities, while avoiding the expensive and labor intensive aspects of other methods reported in the literature.

Three dimensional imaging utilizing a hand held laser scanner is an effective imaging modality for the assessment of craniofacial treatment modalities.

3D imaging eliminates the subjectivity associated with most techniques used to assess the efficacy of craniofacial therapy. Additionally, it provides an imaging modality that does not involve exposure to ionizing radiation, nor does it incur the high cost of CT. The benefits of 3D imaging are numerous, as it can be utilized immediately in the clinic for visual comparison of pre- and post-treatment images of the infant's head, and can provide quantitative data via volumetric calculations.

Further development of the imaging software will allow for the implementation of more sophisticated and rapid volumetric analyses.

The scan comparison utility software will continue to be developed through close collaboration between the software developers and WFUBMC so as to generate a program that enables the user to perform specific and repeatable measurements that can be analyzed to assess the efficacy of various craniofacial treatment modalities.

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