An Objective Assessment of Outcomes of Endoscopic Sagittal Craniosynostosis Release

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WHAT WE LEARNED

Endoscopic treatment with helmet-guided remodeling successfully created normal head shapes in 73% of patients with sagittal craniosynostosis

INTRODUCTION & BACKGROUND

One in 2,200 newborns are diagnosed with craniosynostosis. Most cases involve the sagittal suture. Surgical treatment of craniosynostosis has traditionally been considered an art, with its outcomes heavily relying on the expertise and subjective decisions of the surgical team. During the past decade, endoscopic strip craniectomy with post-operative helmet guided remodeling has become a popular less invasive treatment method. Since machine learning now enables an objective evaluation of head shape, we sought to determine if this treatment for sagittal craniosynostosis produces normal head shapes at the end of treatment.

STUDY QUESTION

Is there a difference between patient's treated with endoscopic strip craniectomy for sagittal craniosynostosis, and an objective learning algorithm that describes morphometrically normal shaped heads?

AIMS

- To quantify pre-surgical head shape difference in patients with craniosynostosis using computed tomography imaging.
- To quantify post-surgical head shape differences in patients with craniosynostosis using three-dimensional photographic imaging.
- To compare the surgical outcomes of this treatment approach to normal shaped skulls using a machine learning algorithm.

METHODOLOGY

- Submission of IRB for approval.
- Identified patient population treated with endoscopic strip craniectomy with helmet remodeling between 2017 and 2021 from our institutional EPIC database.
- Patients with sagittal craniosynostosis, who had endoscopic strip craniectomy with helmet guided remodeling, and pre and postoperative calvarial CT and 3D imaging were included
- Patients with a previous cranial vault surgery, multiple suture synostosis, syndromic and genetic conditions, medial comorbidities and no calvarial 3D or CT imaging were excluded
- Objective evaluation of head shape using an existing machine learning algorithm based on a normative statistical model (ages 0-10 years) was conducted using retrospective imaging throughout each patient's treatment course.
- Risk Scores were developed from pre-operative, post-operative, and end of treatment head shape metrics.
- Risk Scores describe the likelihood that a head shape is normal vs pathological.

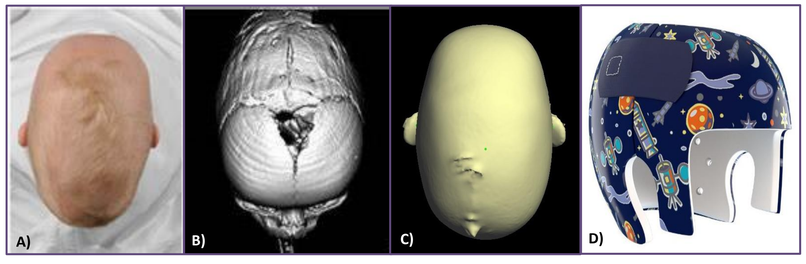
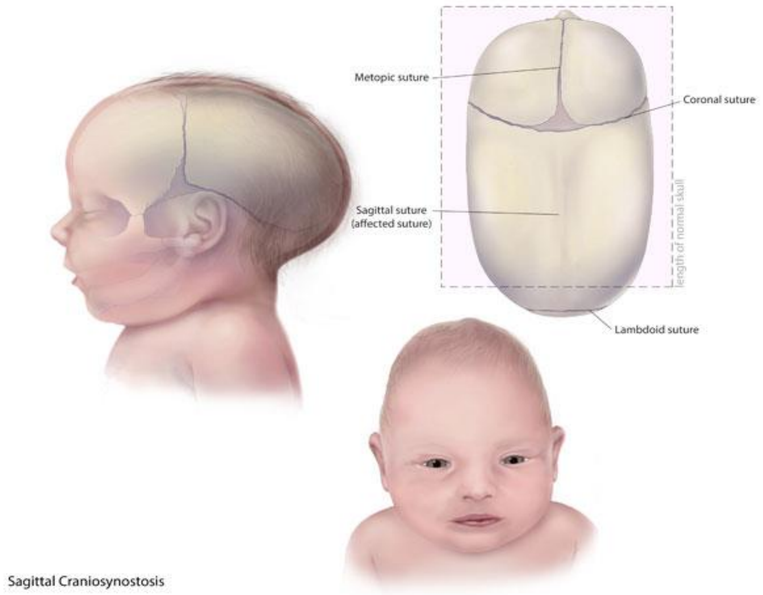


Figure 1: A) Superior view of sagittal craniosynostosis in a patient pre-surgical intervention. **B)** CT image depicting closure of the sagittal suture and patent lambdoid suture. **C)** Superior view of a 3dMD image depicting sagittal craniosynostosis in a patient. **D)** Example of a cranial helmet used for post-operative remodeling of the skull.



RESULTS

- Twenty-six patients were identified and analyzed.
- Our quantitative evaluation method identified 19/26 (73%) with a normal head shape post-operatively at discontinuation of helmet therapy with risk scores ranging from 0.79% to 20%.
- Within the group with normal outcomes, 4/19 (21%), 9/19 (47.5%), 4/19 (21%), and 2/19 (10.5 %) were operated upon at 2-3 (Figure 2), 3-4 (Figure 3), 4-5 (Figure 4), and 5-6 months of age (Figure 5), respectively.

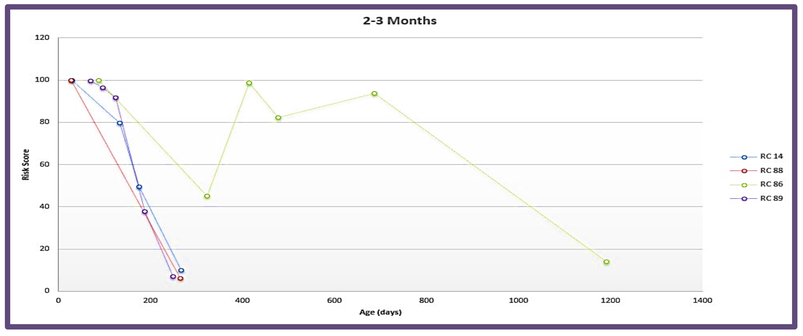


Figure 2: Graph of risk score vs. patient age for patients aged 2-3 months, n=4

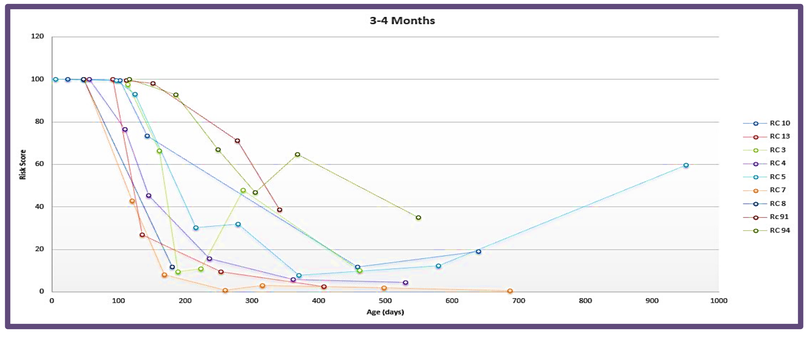


Figure 3: Graph of risk score vs. patient age for patients aged 3-4 months, n=9

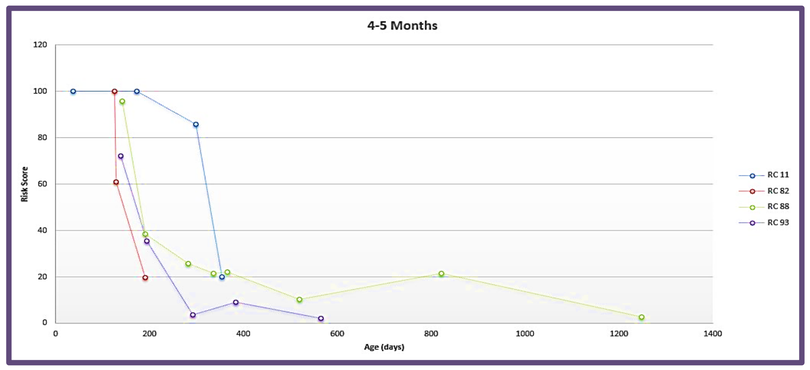


Figure 4: Graph of risk score vs. patient age for patients aged 4-5 months, n=4

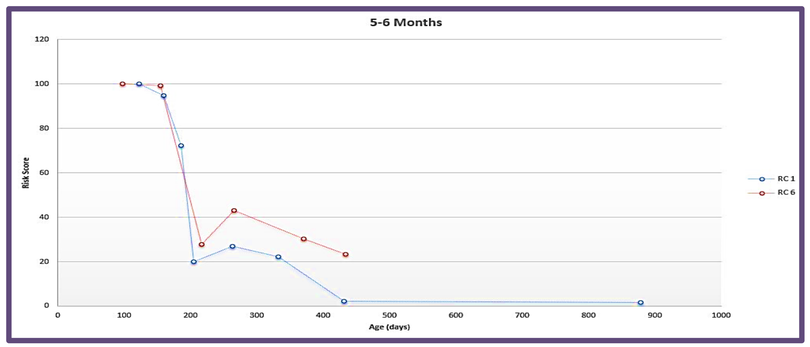


Figure 5: Graph of risk score vs. patient age for patients aged 5-6 months, n=2

CONCLUSIONS & IMPLICATIONS

- In this cohort, objective evaluation of surgical outcomes shows that minimally invasive endoscopic treatment followed by helmet-guided remodeling successfully creates normal head shapes in 73% of patients with sagittal craniosynostosis.
- Machine learning enables discriminating, objective analysis of craniosynostosis patients and will have a significant impact on future patients and operating craniofacial surgeons.

LIMITATIONS

- Our study is a single-institution retrospective study and our ability to produce scientifically significant results may be under-powered.
- Limited database of patients with sagittal craniosynostosis that were treated with endoscopic strip craniectomy with post-operative helmet guided remodeling

FUTURE DIRECTIONS

- A parallel study comparing the outcomes of this endoscopic surgery and helmeting treatment plan, with the long-standing open surgical procedure for this patient population.
- Analysis of patients diagnosed with metopic, lambdoid, and unicoronal synostosis at who have undergone a single suture strip craniectomy or biparietal morcellation.

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