



# INTRACRANIAL AND WHOLE BRAIN VOLUMES IN INFANTS WITH SAGITTAL CRANIOSYNOSTOSIS

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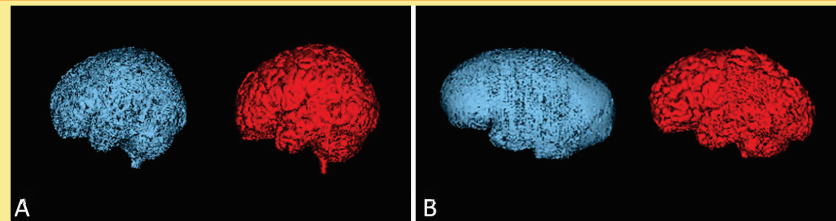
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## INTRODUCTION

### What is craniosynostosis?

Craniosynostosis is defined as the premature fusion of one or more of the cranial sutures<sup>1</sup>. Single-suture craniosynostosis occurs in approximately 1 in 2000 live births and has been associated with brain dysmorphology<sup>2,3,4,5</sup>. Isolated sagittal synostosis, which accounts for 57% of isolated synostosis cases, is the most common form<sup>1</sup>.



**Figure 1.** These 3-D reconstructions of MR images show **A.** the endocranial surface (blue) and brain (red) of an unaffected infant, and **B.** those of a patient with sagittal craniosynostosis.

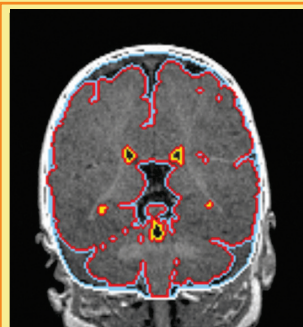
### Why study the brain in craniosynostosis?

It has been suggested that premature fusion of cranial sutures restricts and alters brain growth by limiting the space within the cranial vault, leading to the hypothesis that cognitive deficits result from reduced intracranial volume<sup>6,7,8,9</sup>. The primary goal of scientific exploration of craniosynostosis is to understand its aetiology in order to determine how to better treat and ultimately prevent the condition.

**In this study we test the hypothesis that intracranial volumes and whole brain volumes in infants diagnosed with isolated sagittal synostosis differ from those of unaffected infants.**

## MATERIALS AND METHODS

Our study sample consisted of magnetic resonance images (MRIs) obtained from six infants with isolated sagittal synostosis, aged 11-38 weeks, and three age-matched unaffected infants. Measurements of intracranial volume and whole brain volume from MRIs were obtained using Analyze 10.0® (**Figure 1**), and we statistically compared the measurements of the two groups using Mann-Whitney U tests. Whole brain volume, volume of cerebrospinal fluid, ventricular volume, and intracranial volume were manually segmented for each individual (**Figure 2**). We define whole brain volume as all brain tissue superior to the foramen magnum, including the cerebrum, cerebellum, and brain stem. Cerebrospinal fluid includes the fluid in the subarachnoid space, and ventricles refer to ventricular contents.



**Figure 2.** Representation of cerebrospinal fluid volume in blue, whole brain volume in red, and ventricular volume in yellow.

## RESULTS

Our results show that infants with sagittal craniosynostosis show increased whole brain volumes [10.5% different] and intracranial volume [13.7% different] relative to unaffected infants. However, neither of these differences were statistically significant [**Table 1**]. These findings suggest that the skull does not significantly constrict the brain in infants with sagittal synostosis, and that the mild cognitive deficits observed in these infants do not result from restriction of brain growth by the overlying skeletal system.

**Table 1.** Mean values (in mm<sup>3</sup>) for the volumetric measures of cerebrospinal fluid (CSF), whole brain volume (WBV), Intracranial volume (ICV) is defined as CSF+ ventricles + WBV. Mann-Whitney p-values are also presented, comparing the WBV and ICV between the two cohorts.

	WBV	ICV
<b>Sagittal</b>	773357.2	939967.4
<b>Unaffected</b>	692112.0	811417.7
<b>p-value</b>	0.439	0.3

## DISCUSSION AND CONCLUSIONS

The brain morphology of infants with craniosynostosis has been said to represent the changes in the cranial vault following premature fusion of the cranial sutures<sup>10,11,12</sup>. Mild to moderate risk for neurodevelopmental delays have been shown in children with single-suture craniosynostosis<sup>13,14,15</sup>. Our preliminary results show slightly increased whole brain volumes and slightly increased intracranial volumes when compared to those of unaffected children, despite not being statistically significant. This suggests that constricted cranial volumes are not the primary causative agents of observed cognitive deficits in children with craniosynostosis. Further work is underway to better understand the effects of sagittal craniosynostosis on brain development and its structural morphology.

## ACKNOWLEDGEMENTS AND REFERENCES

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