FP19

Hybrid model for craniosynostosis

Jing Jin, R. Eagleson, Sandrine de Ribaupierre
Western University, London, ON, Canada

Introduction: Craniosynostosis cases in which skull growth is restricted perpendicular to the fused suture have been observed since an initial description reported by Virchow in 1851. Since then, multiple explanations and models to explain the skull shape have been developed. The restriction in growth perpendicular to the prematurely fused suture has been modeled, but it is unclear whether the asymmetrical bone deposition seen in animal models apply to humans (Delashaw 1991).

Methods: We have developed a hybrid model (standard finite element method with volume-preserving structural modeling) composed of the nine segmented skull plates as rigid surfaces, deformable sutures, and a volumetrically-controllable deformable brain. To represent scaphocephaly and metopic suture synostosis, we fused respectively the parietal bones or the frontal bones, and used our model to simulate brain/skull growth. Stress and strain forces were analysed at multiple nodes along the sutures during the growth, and we were able to model a number of growth patterns along the suture edges, in conjunction with the resulting overall skull shape.

Results: The skull measurements obtained from the models were then compared to CT-scan of patients with craniosynostosis. We obtained similar cranial indexes and skull shapes in our computed models as found in patients.

Conclusion: Our model can produce intuitive 3D graphical representations of the brain/skull growth to help understand abnormal skull growth in craniosynostosis, and can be used as a planning tool to predict the qualitative outcome resulting from a planned surgical correction.