Abstract Submitted
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A Computational Analysis of Bone Formation in the Cranial Vault CHANYOUNG LEE, Department of Mechanical and Nuclear Engineering, The Pennsylvania State University, JOAN T. RICHTSMEIER, Department of Anthropology, The Pennsylvania State University, REUBEN H. KRAFT, Department of Mechanical and Nuclear Engineering, The Pennsylvania State University — Bones of the cranial vault are formed by the differentiation of mesenchymal cells in osteoblast cells on a surface that surrounds the brain, eventually forming mineralized bone. Signaling pathways causative for the cell differentiation start from some actions of extracellular proteins driven by information from genes. We assume that the interaction of cells and extracellular molecules which are associated with cell differentiation can be modeled using Turing's reaction-diffusion model, which is a mathematical model for pattern formation controlled by two interacting molecules (activator and inhibitor). In this study we hypothesize that regions of high concentration of an activator develop into primary centers of ossification, the earliest bone. In addition to the Turing model, we use another diffusion model dealing with a morphogen associated with bone growth. These mathematical models were solved using the finite element method. The computational domain and model parameters are determined using a large collection of experimental animal models. The results show that the five ossification centers that form in our model occur at the same position as those identified in experimental data. As bones grow from these ossification centers, sutures form between the bones.

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