THE HARTWELL FOUNDATION

2008 Individual Biomedical Research Award

Review of Proposed Research

Investigator: J. Kent Leach, Ph.D.
Assistant Professor
Department of Biomedical Engineering

Institution: University of California, Davis

Proposal: Engineered Composite Materials for Treating Premature Suture Fusion in Infants

Dr. Leach proposes an innovative approach to correcting craniosynostosis, a defect occurring in one out of every 2,000 live births caused by premature hardening of the skull. The causes are ambiguous and may be genetic, the result of abnormal fetal growth, or possibly fetal position during pregnancy. Like pieces of a jigsaw puzzle, six separate bones of the neonate skull normally cover the brain and meet together along jagged lines called cranial sutures. During early development, the fibrous joints separating the tiny plates normally remain soft and flexible to allow for expansion of the brain, only later hardening or fusing together to completely encase and protect the brain. However, if there is premature closure of one or more sutures before the growth of the brain is complete, surgical intervention during the first 6 months of life is essential in order to relieve the resultant elevated intracranial pressure. Without complex surgical reconstruction of the skull to assure the brain can grow to a normal size, the child will endure facial asymmetry, vision impairment, deafness, and abnormal brain function. Surgery involves the removal of defective fused bone, breaking and reshaping it into smaller fragments and reimplanting pieces. Careful follow-up is necessary to ensure that fusion of the implanted pieces does not rapidly reoccur, as further surgical intervention carries substantial risk of infection, blood loss, air embolism and seizures. Dr. Leach believes there is an alternative to re-implanting defective bone. Using unique biomaterials designed to direct both the rate and magnitude of bone formation, he will take advantage of the tailorability and reproducibility of synthetic biomaterials used currently as replacement bone grafts. He will enhance the biomaterials with the diverse collection of molecules normally present within the biological network that surrounds cells in native bone, called the extracellular matrix, or ECM. If successful, the implantation of such nonimmunogenic graft materials will regulate bone formation by controlling the behavior of bone-forming cells within the developing suture, while simultaneously providing the protective hardness of bone tissue within the skull. Important to growing pediatric patients, these materials will resorb harmlessly into surrounding tissues, thus eliminating the need for any subsequent surgery to remove them as the skull continues normal growth and development.