



US DEPARTMENT OF DEFENSE
BLAST INJURY RESEARCH PROGRAM
COORDINATING OFFICE

Extremity Trauma Rehabilitation and Treatment Utilizing Vascularized Bone to Improve Outcomes of Face Transplantation

Severe craniofacial injuries are difficult reconstructive challenges and pose significant functional limitations such as difficulty with speech, oral competence, and facial expression for injured Service Members. Conventional methods of reconstructive surgery are often not sufficient to restore normal tissue function or aesthetics, and the need for lifelong immunosuppression to prevent rejection can lead to adverse effects. With support from the Clinical and Rehabilitative Medical Research Program (CRM RP) and Reconstructive Transplant Research Programs, researchers from the New York University School of Medicine plan to investigate whether the inclusion of vascularized bone marrow in craniofacial allografts can minimize immunosuppression and improve functional and aesthetic outcomes in individuals who have sustained severe facial wounds. The initial research has focused on a novel paradigm in surgical technology to facilitate precision during two major phases of a vascularized composite allotransplantation (VCA) procedure – recipient preparation and donor procurement.^{1,2,3} A systematic approach was established wherein craniofacial skeletons of donor and recipient cadavers were rendered in a 3-D virtual environment and then used to simulate a surgical plan and design donor- and recipient- specific surgical tools for precisely matching osteotomy paths. The personalized surgical tools were then fabricated by rapid prototyping, used to simulate craniofacial transplantations with the donor and recipient cadavers, and compared to cadaver transplantations performed with conventional surgery techniques. The use of virtual surgical planning and personalized surgical tools was shown to reduce the time required for donor procurement, recipient preparation, transplantation of the donor allograft, and the total operative time to complete the transplant, by 49-60 percent. A measurement tool to determine the accuracy of spatial positioning and bony contact was developed using the same virtual planning technology, and revealed that a personalized surgical approach significantly improved the placement of bony allografts in cadaver simulations. This research is expected to benefit Service Members and others with devastating craniofacial injuries by providing a standardized and custom VCA surgical process which is defined by both the donor and recipient anatomies. This personalized approach will provide an optimal basis for a future clinical trial in which patients will receive a craniofacial transplant containing a significant amount of vascularized bone marrow, which may be a promising approach to reducing lifelong immunosuppression and restoring normal facial function and appearance post-transplant.

- 1 Sosin, M., Ceradini, D. J., Hazen, A., Levine, J. P., Staffenberg, D. A., Saadeh, P. B., ... Rodriguez, E. D. (2016). Total Face, Eyelids, Ears, Scalp, and Skeletal Subunit Transplant Cadaver Simulation: The Culmination of Aesthetic, Craniofacial, and Microsurgery Principles. *Plastic and Reconstructive Surgery*, 137(5), 1569–1581. <https://doi.org/10.1097/PRS.0000000000002122>
- 2 Sosin, M., Ceradini, D. J., Hazen, A., Sweeney, N. G., Brecht, L. E., Levine, J. P., ... Rodriguez, E. D. (2016). Total Face, Eyelids, Ears, Scalp, and Skeletal Subunit Transplant Research Procurement: A Translational Simulation Model. *Plastic and Reconstructive Surgery*, 137(5), 845e–84e. <https://doi.org/10.1097/PRS.0000000000002326>
- 3 Sosin, M., Ceradini, D. J., Levine, J. P., Hazen, A., Staffenberg, D. A., Saadeh, P. B., ... Rodriguez, E. D. (2016). Total Face, Eyelids, Ears, Scalp, and Skeletal Subunit Transplant: A Reconstructive Solution for the Full Face and Total Scalp Burn. *Plastic and Reconstructive Surgery*, 138(1), 205–219. <https://doi.org/10.1097/PRS.0000000000002322>

