Oxygen-Delivering Scaffolds Promote Bone Regeneration

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Tissue engineering provides a viable means of regenerating bone tissues following injuries that lead to large volumetric defects. Our lab has developed advanced biomaterial and stem cell-based approaches to promote functional recovery following critical-sized craniofacial bone injuries. I will present the findings from a study focused on designing biomaterials to guide bone regeneration *in situ* using intraoperative protocols for combining autologous stem cells with advanced 3D-printed scaffolds. Additionally, low oxygen (O_2) diffusion into large tissue engineered scaffolds hinders the therapeutic efficacy of transplanted cells. To overcome this, we developed hollow, hyperbarically-loaded microtanks (µtanks) to serve as O_2 reservoirs and adapted these for bone regeneration. Specifically, we fabricated biodegradable µtanks from polyvinyl alcohol and poly(lactic-co-glycolic acid) and embedded them to form 3D-printed, porous poly-ε-caprolactone (PCL)-µtank scaffolds. PCL-µtank scaffolds were loaded with pure, hyperbaric O_2. and we demonstrte that µtank-mediated transient hyperoxia has no toxic impacts on osteogenic stem cells. We assessed bone regeneration *in vivo* by implanting O_2-loaded, stem cell-seeded, PCL-µtank scaffolds subcutaneously, in calvarial defects, and in mid-facial injuries. Finally, understanding the interaction between vascular cells and osteoprogenitors is critical for developing effective treatment methods. I will describe recent studies in which we developed a quantitative imaging platform for characterizing the spatial relationships between cell populations in vivo.