Abstract

Transplantation of pancreatic islets (PIs) represents an alternative treatment for type 1 diabetes mellitus. Post-transplant monitoring of islets by a reliable imaging method may contribute to the improvement of the transplantation outcome. In this thesis, novel visualization approaches for PIs were tested using magnetic resonance (MR) and optical imaging on phantoms and experimental animals, including Chemical Exchange Saturation Transfer (CEST) MR, fluorine (^{19}F) MR, bioluminescence and fluorescence imaging.

MR imaging based on frequency-selective method CEST was performed on islets labeled with Eu-/Yb-based chelates. Labeled islets possessed low MR signal in phantoms, what would have been unsatisfactory for *in vivo* applications. Moreover, viability and function of labeled islets was impaired reflecting limited applicability of these agents for islet labeling and visualization.

Genetically modified bioluminescent islets showed suitable properties for longitudinal tracking of their post-transplant fate at an artificial transplant site - subcutaneously implanted polymeric scaffolds. Using multimodal imaging (MR and bioluminescence), the optimal timing for transplantation of islets into the scaffolds was assessed in diabetic rats. Islets transplanted into scaffolds using the optimized timing scheme were sufficiently vascularized and functional.

Finally, we developed a trimodal imaging platform for islets transplanted in scaffolds in rats. Bioluminescent islets labeled with multimodal nanoparticles were specifically visualized by ^{19}F MR and sensitively by fluorescence imaging. A correlation between the bioluminescence and the ^{19}F MR signals was found indicating the fast clearance of nanoparticles from the transplantation site after cell death. This finding addresses one of the major issues with intracellular imaging labels and proved that the proposed imaging model is reliable for reflecting the status of transplanted PIs *in vivo*.