1550125

Endovascular Non Thermal Irreversible Electroporation Attenuates Post-Angioplasty Luminal Loss and Neointimal Formation in New-Zealand White Rabbits

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Using fundamental principles of electroporation and computer simulations of temperature and electrical fields we developed a novel endovascular ablation approach - non thermal irreversible electroporation (NTIRE), which selectively destroys cellular components of the arterial wall without affecting the extracellular scaffold. METHODS: Computer simulations were used to demonstrate that NTIRE does not induce thermal damage to the arterial wall. Using an endovascular approach, a custom made device was used in-vivo to apply ninety NTIRE pulses to the right iliac arteries of eight New-Zealand white rabbits. Evaluation at 7 and 35 days included H&E, Masson's trichrome, elastic Von Gieson, smooth muscle actin, proliferating cell nuclear antigen, Von Willebrand, and S-100 antigen. In addition, 24 iliac arteries of 12 additional animals were used to evaluate the effect of NTIRE on luminal loss at 35 days in a rabbit model of balloon angioplasty. RESULTS: One week after NTIRE, normal iliac arteries experienced complete transmural and circumferential cellular ablation, minimal damage to extra-cellular components and re-endothelialization. After five weeks there was no evidence of vascular smooth muscle cells (VSMC) regeneration and. In angioplasty-damaged arteries, results at 35 days demonstrated the ability of NTIRE to significantly reduce post-angioplasty luminal loss. Compared with controls, NTIRE-treated arterial segments were wider (0.85±0.18 vs. 0.58±0.22 cm2, $p = 0.001$), experienced less luminal loss (18%±19% vs. 38%±24%, $p<0.001$), demonstrated wider point of maximal stenosis (0.21±0.09 cm vs. 0.11±0.06, $p = 0.004$), and showed less neointimal formation (3.91±1.39 vs. 2.64±2.29 mm2, $p < 0.001$).The results suggest that NTIRE can ablate cells with minimal damage to extra-cellular components, minor inflammatory response and limited VSMC regeneration. NTIRE holds the potential to treat restenosis and cardiac arrythmias.