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TITLE

Plasmonic photothermic angioplasty with nanoparticles and stem cells as the new revolution in interventional cardiology

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Some modern angioplasty techniques generally just affect the geometry of the plaque and have some inherent clinical and technical limitations. Our previous bench-to-bedside studies confirmed high efficacy and safety of nanomedicine-based approach for the management of atherosclerosis.

A total of 120 patients 45-65 years old with PCI (percutaneous intervention) and CABG (coronary artery bypass surgery) indications were assigned to the three groups (40 patients into the group with PCI indications without stenting, 40 – cardiac surgery group, and 40 – with PCI indications to sirolimus stenting control). Patients with PCI indications underwent delivery of nanoparticles (NPs) inside of induced pluripotent stem cells (iPS) or CD73+CD105+ mesenchymal stem cells (MSCs) in medium via catheter-based percutaneous intra- and transmural injection into the plaque and artery. CABG patients run the delivery with bioengineered on-artery patch on the basis of bovine scaffold and iPS or MSCs (with NPs) by MICS (mini-invasive) cardiac surgery. We have used a modified method for the preparation of 90-100 nm versatile multifunctional NPs with iron-silica core and gold-polymeric shell as described by Lee (2008) and Deng H (2005). Studied 10 mm pull-back of proximal left anterior descending arteries was observed by 40 MHz near-infrared spectroscopy (NIRS) intravascular ultrasound (IVUS).

A change of the total vessel volume - TVV (mm3) immediately after the laser irradiation/ in 24 weeks in groups were -18.9/ -46.2%, -10.8/ -33.6% and -1.1/ -2.2% ($p<0.01$) respectively, total plaque volume (TPV) was changed from 233 to 229/209, 236 to 230/221, and 238 to 222/219 mm^3 ($p<0.01$), total lumen volume (TLV) – 304 to 305/318, 303 to 305/ 311, 305 to 317/ 315 mm^3 ($p<0.05$) from baseline to immediately/ at week 24 in groups respectively. Restenosis confirmed in 3 (7.5%) patients of stenting group only. An impact over mineral deposits and calcium necrotic core was predominated in PCI group (-33.4% vs -22.1% and +3.7% respectively, $p<0.005$). Anti-inflammative and anti-apoptotic effects, signs of neovascularization and restoration of artery function were predominated in subsets with progenitor cells ($p<0.01$). Coronary flow-mediated vasodilation was observed after hyperemia and injection of nitroglycerine (+10.2 and +16.6%, +8.2 and +9.6%, +8.1 and +9.8% in groups respectively, $p<0.05$). Mean hazard ratio between PCI group and stenting control if compare with CABG and stenting control achieved 1.05 (CI 95%: 0.95-1.16, $p<0.05$) and 1.03 (CI 95%: 0.93-1.09, $p<0.05$) with favor of nanomedicine-related approaches.

Plasmonics is the high-effective and safe alternative to stenting and CABG for angioplasty especially in combination with stem cells promising the rejuvenation of arteries and revolutionizing current strategy in patients with coronary artery disease.

Biography

Dr. Kharlamov received his M.D. cum laude in 2005 from Ural State Medical University (Yekaterinburg, Russia). After finishing his internship in therapeutics and general cardiology in 2008 at the Department of Internal Medicine in Ural Institute of Cardiology, he started as a physician and translational researcher at the Department of Interventional Cardiology, Acute Care Unit, and founded a Department of Science in the Ural Institute of Cardiology working on the field of novel nanobiotechnologies in cardiology. The main research direction of the group now is a RTD of the new multifunctional nanoparticles for plasmonic photothermic angioplasty and imaging of coronary arteries. The Biotechnology Lab of the Institute is also involved in the growing of the bioengineered on-artery patch structures for the management of atherogenesis. Since 2007 he is working as a scientific assistant to C.E.O. Ural Institute of Cardiology and chief-cardiologist of the Ural Federal District (Russia) Prof. Jan Gabinsky