Synthesis and Characterization of 5-ALA Gold Nanoparticles: Photo and Sonosensitizer Agent for Atherosclerosis

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Atherosclerosis is a chronic inflammatory disease and the main cause of human death worldwide. Studies have proposed that macrophages play a significant role in the development, progression, and destabilization of atherosclerotic plaques[1]. Thus, reduction of macrophages from plaque represents a new strategy for the treatment of atherosclerosis. Photodynamic and Sonodynamic therapies (PDT and SDT, respectively) are emerging as new atherosclerosis treatments [1, 2]. The subsequent generation of free radicals by activated photo and sonosensitizers can lead to apoptotic cell death. The use of gold nanoparticles (AuNPs) as the vehicle for a sensitizer delivery improves reactive oxygen species formation [3]. Previous works demonstrated that aminolevulinic acid (5-ALA) mediated PDT could reduce macrophage content and inhibit plaque progression, indicating a promising approach to treat inflamed atherosclerotic plaque[4]. In this study ALA:AuNps functionalized with polyethylene glycol (PEG) were synthesized mixing 5-ALA with tetrachloroauric(III) acid in milliQ water solution followed by photo reduction with 300 Watts Xenon lamp. The synthesized nanoparticles were characterized by UV/Vis optical absorption, and electron microscopy. Singlet oxygen generation efficiency was measured by trapping with 1,3-diphenylisobenzofuran for irradiations with 590 nm LED (~100 mW) and pulse ultrasound irradiation (1 and 3W/cm^2 with 1.0 and 2.0 MHz). The potential use of ALA:AuNps as a sensitizer for photo and sonodynamic therapies were investigated on THP-1 macrophage. Cytotoxicity test were also described. The findings suggested that ALA:AuNps under LED illumination and ultrasound had photo and sonodynamic effect on THP-1 macrophages via generation of intracellular singlet oxygen, indicating that ALA:AuNps could be used as a novel photo and sonosensitizer for atherosclerosis.

Keywords: PDT, SDT, atherosclerosis, 5-ALA, gold nanoparticles.

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References

[1] J.L. Cheng, X. Sun, S.Y. Guo, W. Cao, H.B. Chen, Y.H. Jin, B. Li, Q.N. Li, H. Wang, Z. Wang, Q. Zhou, P. Wang, Z.G. Zhang, W.W. Cao, Y. Tian, International Journal of Nanomedicine 8 (2013) 669-676.

[2] H. Wang, X. Zhu, R.L. Han, X. Wang, L.M. Yang, Y. Wang, Microporous and Mesoporous Materials 239 (2017) 78-85.

[3] M. Benito, V. Martin, M.D. Blanco, J.M. Teijon, C. Gomez, Journal of Pharmaceutical Sciences 102(8) (2013) 2760-2769.

[4] C.H. Peng, Y.S. Li, H.J. Liang, J.L. Cheng, Q.S. Li, X. Sun, Z.T. Li, F.P. Wang, Y.Y. Guo, Z. Tian, L.M. Yang, Y. Tian, Z.G. Zhang, W.W. Cao, Journal of Photochemistry and Photobiology B-Biology 102(1) (2011) 26-31.