Study of Mesenchymal Stem Cell Function on Zinc Oxide Nanoparticles

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Statement of Purpose:

Nanostructures of Zinc Oxide (ZnO) have wide range of potential applications in nanoelectronics, optoelectronics, sensors, field emission, light-emitting diodes, photocatalysis, nanogenerators, and nanopiezotronics. In addition to conventional electronics applications, nanoscale ZnO can be potentially used in different ways to treat the various human diseases using the techniques in nanobiotechnology. ZnO nanoparticles with the size in the range of 20-50 nm can be mimic the extracellular matrix (ECM) closely because the protein molecules in the ECM are in the same size range. Therefore, ZnO nanoparticles can be considered as a biomimetic material. In order to apply ZnO nanoparticles for treatment of human diseases the nanoparticles should not be toxic with the living cells. The objective of this study is to investigate the mesenchymal stem cell (MSC) function on ZnO nanoparticles.

Materials and Methods

The nanocrystalline ZnO particles were prepared by hydrolysis of zinc nitrate in a homogeneous medium as previously described [1]. The morphology of ZnO nanoparticles was analyzed using a scanning electron microscopy (SEM). The C57/BL-6 strain, 6 weeks old, male mice were purchased from the Charles Rivers Laboratory, Wilmington, MA. Mice were housed in the animal care facilities of UT. Mice were euthanized by CO_2 inhalation performed according to the American Veterinary Medical Association (AVMA) panel on euthanasia and the UT guidelines. The MSCs were isolated from bone marrow stroma in the mouse femurs and expanded using our published procedures [2]. MSCs were seeded on 96 well plates containing sterilized ZnO nanoparticles at a density of 30,000 cells per well and kept in the incubator. Cell viability assay was performed using a LIVE/DEAD cell assay (Molecular probes) after washing unattached cells with phosphate buffered saline (PBS) at day 2 (n=3). The fluorescence images of cells were taken using a Leica fluorescence microscope with 100X magnification.

Results

We examined the nature of ZnO nanoparticles by SEM (Figure1). The average size of these nanoparticles was is around 30 nm. In order to obtain the initial cell viability on ZnO nanoparticles, LIVE/DEAD cell assay was performed. After treating with LIVE/DEAD cell assay, live cells stained with green color and dead cells stained with red color. No red cell was observed in the ZnO nanoparticles sample confirming that the cells were viable with the ZnO nanoparticles (Figure 2).

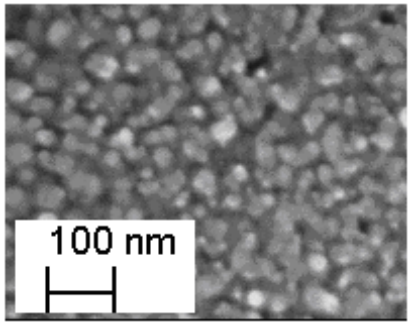

Figure 1: SEM image of ZnO nanoparticles.

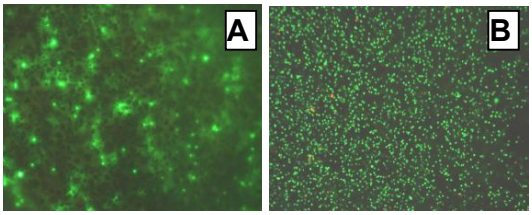

Figure 2: LIVE/DEAD cell viability assay for MSCs cultured in osteogenic medium at day 2 in ZnO nanoparticles (A) and control (without ZnO nanoparticles) (B). Magnification 100x.

Conclusions: In this study, ZnO nanoparticles have shown the mesenchymal stem cell viability when treated with LIVE/DEAD cell assay at day 2. Therefore, it is important to investigate other functions of mesenchymal stem cell seeded ZnO nanoparticles which can be potentially applied to treat the human diseases.

References:

1. Xu H, Wang H, Zhang Y, He W, Zhu M, Wang B, Yan H. Ceramics International, 30(1), 93-97, 2004.
2. Jayasuriya AC, Bhat A. J Tissue Eng Regen. Med 4(5):340-8, 2010.

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