OMICS Group Conferences
Accelerating Scientific Discovery
2nd International Conference and Exhibition on
Occupational Health & Safety
May 21-22, 2013 DoubleTree by Hilton Beijing, China

Comparative experiment on nanoparticle-induced toxicity in human vascular endothelial cells

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Objective: To compare the toxic effects of three different particles on vascular endothelial cells, and to investigate the influence of the particle composition and sizes on the cardiovascular toxic effects.

Methods: Nano-SiO2 particles, nano-TiO2 particles and standard quartz particles were selected as the test substances, and The nano-TO2 particles and standard quartz particles were used as composition controls and size controls, respectively. The human umbilical vein endothelial cells were exposed to different doses (5.0, 10.0, 20.0, 40.0 μg/ml) of three particles as well as particle-free DMEM medium (0 μg/ml dust) for 24h. Then, the culture supernatants were collected, and the activities of lactic dehydrogenase (LDH) and total superoxide dismutase (SOD) as well as the releases of NO, tumor necrosis factor-α (TNF-α), and interleukin-6 (IL-6) were measured.

Results: Comparing with those of 0 μg/ml dose group, the LDH activities of all nano-SiO2 groups, 10.0, 20.0, and 40.0 μg/ml nano-TiO2 groups and 10.0, 20.0, and 40.0 μg/ml standard quartz groups were significantly increased ($P<0.01$); the SOD activities of 5.0,10.0, and 20.0 μg/ml nano-SiO2 groups, 40.0 μg/ml nano-TiO2 group, and 20.0 and 40.0 μg/ml standard quartz groups were significantly increased ($P<0.05$), but that of the 40.0 μg/ml nano-SiO2 group was significantly decreased ($P<0.01$); the TNF-α releases of 10.0, 20.0, and 40.0 μg/ml nano-SiO2 groups, all nano-TiO2 groups, and 40.0 μg/ml standard quartz group were significantly increased ($P<0.01$); the IL-6 releases of 10.0, 20.0, and 40 μg/ml nano-SiO2 groups, 20.0 and 40.0 μg/ml nano-TiO2 groups, and 40.0 μg/ml standard quartz group were significantly increased ($P<0.01$). When the dust dose were 5.0, 10.0, 20.0, and 40.0 μg/ml, the LDH activities of nano-SiO2 groups were significantly higher than those of standard quartz group ($P<0.05$); when the dust doses were 10.0, 20.0, and 40.0 μg/ml, the LDH activities of nano-TiO2 groups were significantly lower than those of standard quartz groups ($P<0.05$). When the dust dose were 5.0, 10.0, 20.0, and 40 μg/ml, the SOD activities of nano-SiO2 groups were significantly higher than those of standard quartz groups ($P<0.01$); When the dust dose was 20 μg/ml, the SOD activity of nano-TiO2 group was significantly higher than that of standard quartz groups ($P<0.01$); When the dust dose were 5.0, 10.0, 20.0, and 40.0 μg/ml, the TNF-α releases of nano-SiO2 groups were higher than those of standard quartz group($P<0.01$); when the dust doses were 5.0 and 10.0 μg/ml, the TNF-α releases of nano-TiO2 groups were significantly higher than those of standard quartz group ($P<0.01$). When the dust doses were 5.0, 10.0, 20.0, and 40 μg/ml, the IL-6 releases of nano-SiO2 groups were significantly higher than those of standard quartz ($P<0.05$); when the dust doses were 20.0 and 40.0 μg/ml, he IL-6 releases of nano-TiO2 groups were significantly higher than those of standard quartz group ($P<0.05$).

Conclusion: All the three particles were able to exert certain toxic influences on vascular endothelial cells. Nano-SiO2 particles have the most toxic effects, and nano-TiO2 particles and standard quartz particles have shown uncertain effects. The toxicity of particles is linked to their components and size.

Key words: Nanoparticles; Vascular endothelial cells; Superoxide dismutase; Lactate dehydrogenase

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