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Silica coated magnetic nanoparticles alter the formation of lamellar bodies in pulmonary type II cells *in vitro*

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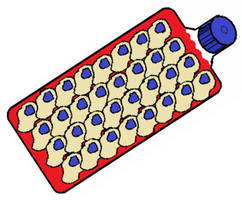
INTRODUCTION

Lung surfactants, i.e. the substances that reduce surface tension of alveoli, are essential for unimpeded breathing. Surfactants are composed mainly of phospholipids that are embedded inside the concentric membranes of lamellar bodies (LBs), secretory organelles that are formed inside type II pulmonary cells. Nanoparticles (NPs) can disturb lipid metabolism (1). When NPs are inhaled, they can reach the alveoli and potentially disturb the function of pulmonary cells (2).

EXPERIMENTAL APPROACH

Cell culture



Pulmonary type II cells (A549)

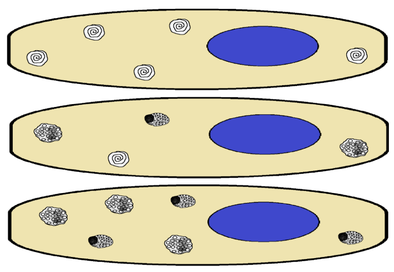
Treatments

Control (cell culture medium only)

20 µg/mL silica coated γ-Fe_2O_3 NPs

50 µg/mL silica coated γ-Fe_2O_3 NPs

Exposure for 48 h



Experimental methods

Fluorescent microscopy
(staining of phospholipids)
&
Colorimetric phosphatidylcholine measurement
(major component of lung surfactant)
&
Transmission electron microscopy
(TEM)

RESULTS

Fluorescent microscopy (staining of phospholipids)

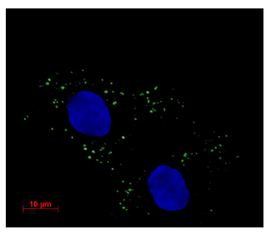


FIG. 1: Control cells.

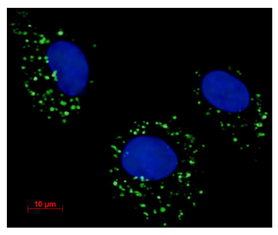


FIG. 2: Cells exposed to 20 µg/mL silica coated γ-Fe_2O_3 NPs.

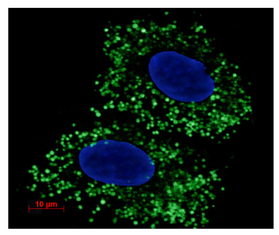
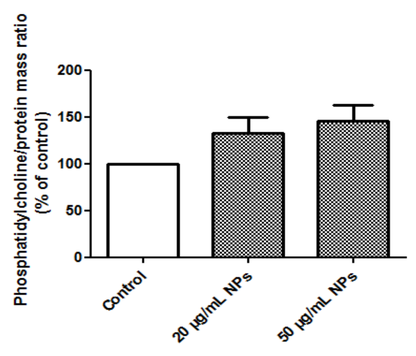


FIG. 3: Cells exposed to 50 µg/mL silica coated γ-Fe_2O_3 NPs.

The optical section images of A549 cells exposed to silica coated γ-Fe_2O_3 NPs showed increased number of intracellular vesicles filled with phospholipids that are stained with green fluorescent dye. Nuclei are stained with blue Hoechst dye.

Colorimetric phosphatidylcholine measurement



Cells exposed to silica coated γ-Fe_2O_3 NPs have significantly increased phosphatidylcholine content.

Transmission electron microscopy (TEM)

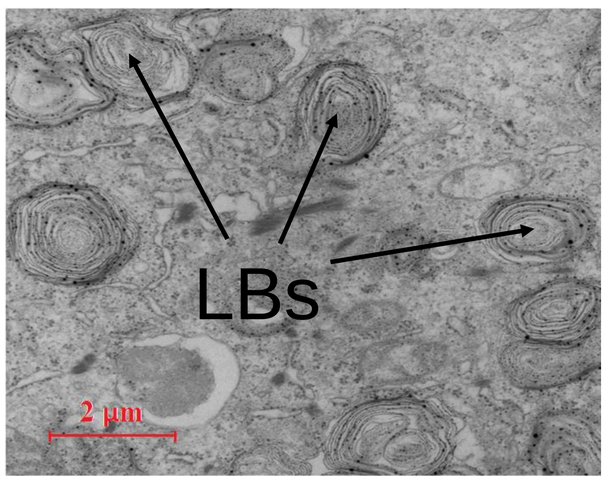


FIG. 1: Control cell filled with lamellar bodies (LBs).

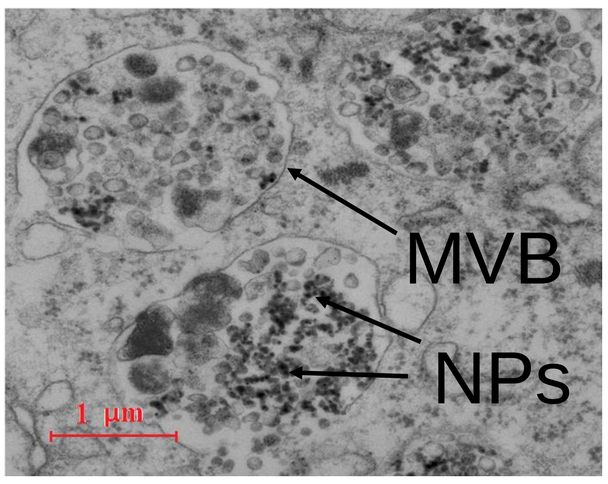


FIG. 2: Cell exposed to 20 µg/mL silica coated γ-Fe_2O_3 NPs. Internalised NPs were stored mainly in multivesicular bodies (MVB). Number of LBs was reduced.

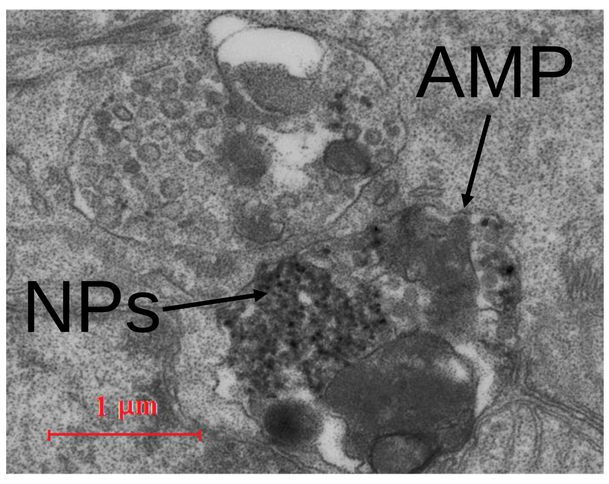


FIG. 3: Cell exposed to 50 µg/mL silica coated γ-Fe_2O_3 NPs. Internalised NPs were stored predominantly in amphisomes (AMP). Number of LBs was strongly reduced.

CONCLUSIONS

Despite the significant increase in the intracellular vesicles filled with phospholipids and intracellular phosphatidylcholine content in the NP-exposed cells, the TEM showed markedly reduced levels of LBs. The TEM micrographs revealed that the NP-exposed cells were fulfilled with increased number of multivesicular bodies and autophagic vacuoles, which are involved in the biogenesis of LBs (3). These results suggest that the selected NPs affect the LB biogenesis. Our findings are of particular importance since disturbed formation of the surfactant film in the alveoli can lead to life-threatening conditions (4).

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