The effect of fluorescent nanodiamond particle size on cellular function

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Introduction

Fluorescent nanodiamonds made from high-pressure high-temperature diamond can be produced in sizes from 10 nm to several hundred nanometres. Their fluorescence brightness is size-dependent: 100 nm sized particles are many orders of magnitude brighter than 10 nm sized particles [1]. While 100 nm particles can be clearly imaged in cellular systems, for many experiments in biology particles well below 100 nm in size are desirable. It is known from experiments conducted with other nanoparticles that particle size strongly affects how cells respond to and interact with nanoparticles [2]. However, the effect nanodiamond particle size has on cell stress, uptake, and viability is not clearly understood.

Here we have investigated the effect particle size has on the biological interactions of the nanodiamonds and the biological response to the presence of different sized nanodiamond particles. We examine how nanodiamond particles ranging in sizes from 20-140 nm effect, cell viability, cell cycle, reactive oxygen stress (ROS), caspase-3/7 apoptosis and nanoparticle uptake in two different cell lines: U87-MG astrocyte and HaCaT keratinocytes cells.

Results and discussion

We observe a decrease in cell viability in diamond treated cells that is both size and concentration-dependent (Fig 1). The U87MG cell viability shows a decrease even at 5 μg mL-1, while the HaCaTs show no difference in viability at the lower concentration. Both cell lines shows a significant decrease in cell viability at 25 μg mL-1, Further, at 25 μg mL-1, we note a relationship between nanodiamond size and cell viability. The 40-90 nm particles show a more significant decrease than the 20 nm and 140 nm particles. Similarly, cells treated with 25 μg mL-1 of diamond show ROS activity increases as the nominal particle size increase.

Interestingly, when we examined cell death, diamond treated cells showed a significant delay in apoptosis compared to untreated cells. However, this apoptosis delay was only seen in the U87MG cells and not in other cell lines.

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| **Fig 1.** Cell viability of U87-MG (A) and HaCaT (B) cells in the presence of fluorescence nanodiamonds of various sizes. UNT = untreated control, 24 hour incubation, n = 10 and error bars are standard deviation. |

Our study clearly shows that how cells respond to nanodiamonds depends on the particles’ size. This response also critically depends on the type of cell investigated, highlighting the need for a more detailed understanding of the interactions between nanomaterials and cells.

References

[1] Wilson, *et al*. (2019). Nanotechnology **30**, 385704, doi:10.1088/1361/a283d

[2] Chan, *et al.* (2016). Nature Nanotechnology **3**, 145, doi:10.1038/nnano.2008.30