AB019. Gold-nanoparticle-assisted cell perforation by means of an optofluidic probe (needle-like) coupled to nanosecond laser

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Background: Cell transfection has the potential to transform gene therapy, potentially enabling the treatment of genetic diseases. We are developing a cell transfection approach that uses laser pulses and gold nanoparticles to induce transient holes in the cell membrane, thus allowing external material to pass into the cell before the membrane is healed. Our previous research has demonstrated the feasibility of perforating the cell membrane *in vitro* by irradiating (λ =532 nm, τ =6 ns) cancer cells previously incubated with gold-nanoparticles (100 nm). Our ultimate goal is to develop an optofluidic probe (needle-like) capable of performing simultaneous and precise delivery of a perforation mixture (nanoparticles and perforation indication dye) and laser pulses *in vivo*. We will present the initial validation of the technology with *in vitro* perforation of cancer cells.
Methods: MDA-MB-231 cells were cultured in DMEM + GlutaMax (9% FBS, 1% P/S). The medium was changed to Leibovitz's L-15 for experimentation. 100 nm gold nanoparticles and a perforation indicator dye (calcein, green dye) were placed on cells by pumping them through the optofluidic tip. The optofluidic tip was coupled to a nanosecond laser (λ=532 nm, τ=6 ns). Cells were irradiated with 5 laser pulses (Energy: 15–38 µJ) through the optrode tip at a distance of 50 µm. Successful cell uptake was indicated by calcein uptake. Cells were incubated in 0.5% CO_2 for one hour following irradiation. Then, propidium iodide (PI, red dye) was added to investigate cell death. The quantification of the perforation efficiency and viability was performed with fluorescence microscopy.
Results: We have been able to successfully inject cells by pumping the perforation mixture through an optofluidic tip. The early quantitative results indicate that injection efficiencies are near 35% at the optimal fluence with cell viability near 90%. These efficiencies are similar to our previous results involving pre-incubation of cells with the perforation mixture.
Conclusions: Our results show the feasibility of cell transfection using a particularly designed optofluidic probe (needle-like) for light and liquid delivery. The method does not involve pre-incubation of cells with the preformation mixture and thus brings the technology closer to *in vivo* applications.
Keywords: Nanoparticles; cells; perforation; irradiation; transfection

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