The Effect of Different Diode Laser Powers in Photodynamic Therapy

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Abstract: This preliminary photodynamic therapy study investigated the effect of different diode laser powers (mW) for the activation of two photosensitizers (AlTSPc, aluminum tetrasulfonatedphthalocyanine and ZnTSPc, zinc tetrasulfonatedphthalocyanine) in healthy normal fibroblast cells.

1. Introduction

Photodynamic therapy (PDT) is a treatment for cancer which requires an interaction between a photosensitizer (PS; drug or dye) and light (laser) of an appropriate wavelength in the presence of tissue molecular oxygen, to produce reactive oxygen species for the destruction of cancer cells [1]. For PDT to be considered as an effective cancer treatment it should be able to cause the destruction of cancer cells with minimum damage to healthy normal cells. The efficacy of PDT using AlTSPc and ZnTSPc activated with a diode laser at a wavelength of 672 nm on melanoma cancer cells as well as healthy normal fibroblast and keratinocyte cells has been tested previously [2]. The use of continuous wave (CW) lasers (e.g. diode lasers) in PDT is well documented [1], however the available literature on the laser power required and fluence rate effects in PDT is contradictory [3].

2. Methodology

The effect of CW diode laser power of 3.82 mW and 31.8 mW on photosensitized fibroblast cells were investigated. Healthy normal skin fibroblast cells were cultured in 24-well tissue culture plates at a cell density of 20 000 cells/ml and were exposed to either AlTSPc (40 µg/ml) or ZnTSPc (50 µg/ml) for 2 hours. Thereafter, cells were irradiated with a diode laser emitting a wavelength of 672 nm. The output power (31.8 mW or 3.82 mW) of a beam (1 cm in diameter) was measured and the irradiation time was calculated to deliver a light dose of 4.5 J/cm^2. After laser exposure the plates were incubated in a 5% CO_2 incubator for 24 hours before cell viability was measured using the CellTiter Blue® Viability Assay. The untreated cells with 0 µg/ml of the PS were not irradiated and used as a control. Cells treated with the laser but without PS were used as another control.

3. Results and Discussion

Figure 1 and Figure 2 shows the PDT effects on fibroblast cells photosensitized with either AlTSPc or ZnTSPc activated with a diode laser (λ = 672 nm) emitting an output power of 3.82 mW and 31.8 mW respectively.

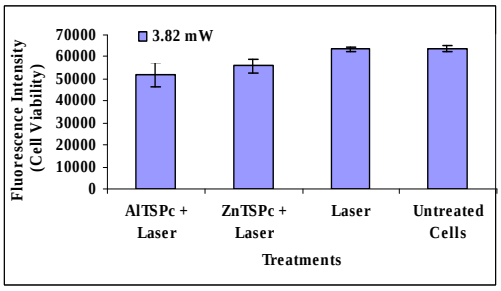

Fig. 1: The cell viability of fibroblast cells after photosensitization with 40 µg/ml of AlTSPc and photoactivation using a light dose of 4.5 J/cm^2 with an emitting output power of 3.82 mW from a CW laser source.

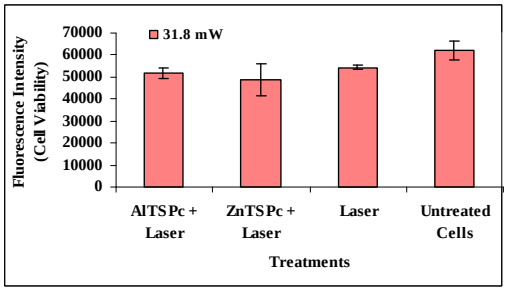

Fig. 2: The cell viability of fibroblast cells after photosensitization with 50 µg/ml of ZnTSPc and photoactivation using a light dose of 4.5 J/cm^2 an emitting output power of 31.8 mW from a CW laser source.

These results indicate that irradiation with a diode laser using the same light dose but varying the output power to 3.82 mw and 31.8 mW had similar PDT effects in decreasing the cell viability of healthy normal fibroblast cells for both the photosensitizers. Further experimental work is needed to investigate the minimal output power which is less destructive to healthy normal cells and that can be used to kill 50% of cancer cells e.g. melanoma cancer cells.

4. References

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