Breast Cancer Specific Photosensitive Polymer Compound, a Comparison

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Breast cancer is a widespread concern with a variety of forms, requiring research into many solutions as it can express different characteristics. In the case of triple negative breast cancer (TNBC), it is the most resilient compared to other forms of breast cancer. TNBC lacks the receptors ER, PR, and HER2 which are indicative of other breast cancer types. The absence of these receptors makes TNBC resistant to most cancer treatments that target the individual receptors. Instead, treatments such as chemotherapy, radiation, and excision if possible are the best measures against TNBC but can be more taxing on the patient.[1] For this reason, estrogen receptor positive (ER+) breast cancer was used in this study to allow a comparison between the most resistant breast cancer, TNBC, to one that is less so, ER+ breast cancer.

Photodynamic therapy (PDT) is a high-energy light procedure that involves a localized effect on a cancer tumor. The high-energy light activates photosensitizers (PS) which generate reactive oxygen species so that the cells of the tumor will undergo necrosis/apoptosis.[2] Chlorin is a preferred PS given its high singlet oxygen yield and reactivity only under wavelengths of light of 660-670 nm.[3] A drawback to the use of chlorin in the body is that it is hydrophobic and has poor tumor targeting capabilities.[4] Therefore, the use of a thermosensitive polymer, poly(N-isopropylacrylamide) (PNIPAM), is crucial to allowing transport of the PS through the body while tumor targeting with the PDT light making PNIPAM release the chlorin to work only in the area of a tumor.[5] The same concept goes for gold nanoparticles (AuNPs) as they are also active in damaging tumor cells when in the area of the light, but instead act as photothermal sensitizers being activated through the thermal changes that occur in the tissue as a result of PDT. These require polymers or other carriers such as PNIPAM for significant specificity in order to carry out their effects of photolysis/necrosis.[6]

The aim of this study is to determine ideal concentrations of PNIPAM, AuNPs, and chlorin against TNBC and ER+ breast cancer cells with minimum death of normal breast cells with a standard PDT protocol. The next step is to run statistical analyses to define which concentration is most effective at riding of breast cancer cells when exposed to high-energy light with minimal effects on normal breast cells.

References

1. Denkert, C., Liedtke, C., Tutt, A., & von Minchwitz, G. (2017). Molecular alterations in triple-negative breast cancer-the road to new treatment strategies. *The Lancet*, *389*(10087), 2430-2442. https://doi.org/10.1016/S0140-6736(16)32454-0.
2. Rapozzi, V. & Jori, G. (2015). Basic and clinical aspects of photodynamic therapy. In V. Rapozzi & G. Jori (Eds.), *Resistance to photodynamic therapy in cancer*, (5, pp. 3-26). 10.1007/978-3-319-12730-9.
3. Beack, S., Kong, W.H., Jung, H.S., Do, I.H., Han, S., Kim, H., Kim, K.S., Yun, S.H., & Hahn, S.K. (2015, October 15). Photodynamic therapy of melanoma skin cancer using carbon dot – chlorin e6 – hyaluronate conjugate. *Acta Biomaterialia*. *26*, 295-305. https://doi.org/10.1016/j.actbio.2015.08.027.
4. Wu, J., Feng, S., Liu, W., Gao, F., & Chen, Y. (2017). Targeting integrin-rich tumors with temoporfin-loaded vitamin-E-succinate-grafted chitosan oligosaccharide/D-α-tocopheryl polyethylene glycol 1000 succinate nanoparticles to enhance photodynamic therapy efficiency. *International Journal of Pharmaceutics*, *528*(1-2), 287-298. https://doi.org/10.1016/j.ijpharm.2017.06.021.
5. Nigro, V., Angelini, R., Bertoldo, M., Buratti, E., Franco, S., & Ruzicka, B. (2021). Chemical-physical behaviour of microgels made of interpenetrating polymer networks of PNIPAM and poly(acrylic acid). *Polymers*, *13*(9), 1353. 10.3390/polym13091353.
6. Pustovalov, V.K., Smetannikov, A.S., & Zharov, V.P. (2008). Phothermal and accompanied phenomena of selective nanophotothermolysis with gold nanoparticles and laser pulses. *Laser Physics Letters*, *5*, 775. iopscience.iop.org/lpl.