Effect of Red Selenium Nanoparticles on Head and Neck Squamous Cell Carcinoma

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Statement of Purpose: With approximately 540,000 new cases occurring annually worldwide, a mortality rate of fifty percent, head and neck squamous cell carcinoma (HNSCC) continues to be an extremely difficult cancer to treat, let alone cure. Though patients in the United States tend to receive the best forms of treatment available, survival rates remain low at less than five years,[1] with locoregional reoccurrence being quite common.[2] The disease is most commonly found in middle-aged men who have histories of heavy smoking or tobacco usage and excessive alcohol consumption. However, recent studies have shown that it has an unusually high rate of occurrence in young women, many of whom have had no obvious risk factors, though a possible causal link between HNSCC and human papillomavirus (HPV) has been observed. Genetic analysis of the disease has shown the most likely causes to be tumor suppressor gene inactivation and overexpression of several proto-oncogenes, particularly p53,[1] which regulates cell proliferation via induction of apoptosis. Surgical treatments are available, but the fact that HNSCC occurs in the neck limits the depth to which surgeons can cut, with the additional problem that any immunogenic inflammatory response would cause significant airway obstruction.[3]

In recent years, studies have found selenium to be capable of selectively targeting cells expressing mutated p53 or lacking p53, while simultaneously modulating DNA repair in cells with wild type p53 expression. When delivered to the body in supplementary form, this has been shown to allow for higher tolerable doses of chemotherapeutic medications.[4] Additionally, when coupled covalently to polyethylene glycol (PEG), a nanoparticle anti-aggregate, selenium nanoparticles are capable of inducing apoptosis in drug-resistant cancers cells through the destabilization of the mitochondrial membrane potential.[5] Selenium nanoparticles have therefore been deemed a viable candidate for study of their effect on HNSCC.

Methods: Red selenium nanoparticles were made in lab via the mixing of sodium selenite and glutathione in an alkali environment and were characterized to be 100nm in diameter. Viability tests were performed on human dermal fibroblasts (HDF) and head and neck squamous cell carcinoma (SCC-9) cell lines. HDF and SCC-9 were both obtained from ATCC. HDF was cultured in Dulbecco's Modified Eagle Medium (DMEM), supplemented with 10% fetal bovine serum (FBS), and 1% antibiotic-antimycotic (anti-anti), from 7 to 10 cell passage numbers. SCC-9 was cultured in a 1:1 mixture of DMEM and Ham's F-12 Nutrient Mixture (DMEM:F-12) supplemented with 10% FBS, 1% anti-anti, and 50mg/mL hydrocortisone, from 2 to 5 cell passage numbers. Viability assays were performed for 1, 2, and 3 days, with MTS used at the viability indicator.

Results: Results indicated a capacity for red selenium nanoparticles to induces apoptosis in HNSCC cells at minimum concentrations of 5 μg/mL after three days, while minimizing damage o surrounding fibroblasts.

Conclusions: The in vitro treatment of HNSCC with red selenium nanoparticles displayes promising effectiveness, while simultaneously minimizing cytotoxicity of dermal fibroblasts. Further studies will be conducted to fully characterize the nanoparticles, as well as to analyze the in-depth transport of selenium nanoparticles into the cells, as well as the effect of the particles on intracellular superoxide generation and mitochondrial membrane potential destabilization.

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