

REVIEW ARTICLE

Orthomolecular Oncology: a Mechanistic View of Intravenous Ascorbate's Chemotherapeutic Activity.

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The effect of vitamin C in cancer has been a subject of great controversy; mainly because of the inconsistent results obtained by oral intakes of ascorbate when used as an anticancer agent. We believe the intravenous application of ascorbate will provide more consistent results in cancer patients since Vitamin C blood levels

attained are substantially higher in a range proven cytotoxic to malignant cells. In this article we will present and discuss our proposed mechanism on the chemotherapeutic activity exhibited by ascorbate.

Key words: Vitamin C, Cancer, Oncology

The effect of ascorbic acid on cancer has been reevaluated in view of new evidence of its anticancer activity when provided by intravenous administration (1-3). In this paper we are proposing the main mechanism by which intravenous ascorbic acid (IAA) is capable of eliciting a chemotherapeutic effect. Ascorbic acid (AA) and its salts are preferentially toxic to tumor cells in vitro and in vivo. AA has the potential to selectively kill tumor cells in a manner similar to other cytotoxic chemotherapeutic agents but without the accompanying adverse effects.

Discussion

An increased glucose consumption rate has been observed in malignant cells (1-3). Glucose molecular structure is similar to that of ascorbate. Warburg postulated that the respiratory process of malignant cells was impaired and the transformation of normal cells to

malignant was mainly due to defects in aerobic respiratory pathways (4). Szent-Gyorgyi also viewed cancer as originating from insufficient availability of oxygen (4). Oxygen by itself has an inhibitory action on malignant cell proliferation (5) by directly interfering with anaerobic respiration (fermentation, lactic acid production). In addition certain oxidation intermediates have demonstrated antineoplastic activity (6). In order to be able to divide and proliferate the cell needs to reduce its cohesiveness and dismount part of its structure. This unstable state of cellular organization facilitates free radical damage by oxidative species in the malignant cell and at the same time predisposes normal cells to the malignant state. Interestingly, during differentiation there is an increased cellular production of oxidants that appear to provide one type of physiological stimulation for changes in gene expression that lead to a terminal differentiated state (7). Ascorbic acid not only has antioxidant properties but also pro-oxidant activity capable of selective cytotoxic effects on malignant cells at high concentrations (8).

It has been suggested that ascorbate promotes oxidative metabolism by inhibiting utilization of pyruvate for aerobic metabolism (9). Also an inhibitory effect on growth of several types of tumor cells has been produced by ascorbate and/or its derivatives. This inhibitory action was not observed in normal fibroblasts (10). This cytotoxic activity produced by ascorbate in an array of malignant cell lines has been associated to its pro-oxidant activity (11-16). Ascorbate can generate hydrogen peroxide (a reactive species) upon oxidation with oxygen in biological

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