

CLINICAL SCIENCES

Intravenous Ascorbic Acid: Protocol for its Application and Use

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High dose intravenous (IV) ascorbic acid (AA) has been used as therapy for infectious disease from bacterial and viral origin and adjuvant therapy for cancer. In this publication we describe a clinical protocol that has been developed over the past twenty years utilizing high dose

IVAA as therapy for cancer. This includes principles of treatment, rationale, baseline workup, infusion protocol, precautions and side effects.

Key words: Intravenous ascorbic acid, Intravenous vitamin C, Cancer

High dose intravenous ascorbic acid (IAA) has been used as a therapy for bacterial infection, viral infection, and as adjuvant therapy for Cancer (1-7). The treatment rationale for the use of IAA in treatment of cancer has been described in detail elsewhere (7-9). In general cancer patients have depressed circulatory, cellular and tissue ascorbate levels and reserves. Ascorbate administered in pharmacological doses enhances various parameters associated with better prognosis (7,8). There is also evidence that physiologically attainable concentrations by intravenous administration are selectively toxic to cancer cells (3-7,10); contrary to the limited levels of ascorbate that can be reached by oral intakes. Moreover, there is evidence of synergism between the conventional methods for cancer treatment (surgery, radiation and chemotherapy) when utilized with ascorbate (11-13).

Principle of Treatment

Over 21 years of clinical experience using intravenous ascorbate in cancer patients indicate that the best responses are obtained when maintaining a continuous high plasma ascorbate level (3-7,10,14). Initially, doses of 15g per infusion were used, once or twice per week. These doses improved patient's sense of well being, reduced

pain and in many cases improved survival times beyond predictions of experienced oncologists. Later using 30 grams of IAA, twice per week, it was found that metastatic lesions in lung and liver of a man with primary renal cell carcinoma disappeared in a matter of weeks (3). At the time it was believed that IAA was helpful to cancer patients solely through two mechanisms; by increasing production and strengthening extra cellular collagen (in this manner preventing metastasis and further tumor growth) and by improving immune function (immune cell's activity and interferon). Subsequently, resolution of bone metastases in a patient with primary breast cancer was reported using infusions of 100 grams once or twice per week (4). Now it is known that other mechanism(s) exists by which ascorbic acid (AA) and its salts are capable of cytotoxic activity against malignant tissue. AA is preferentially toxic to tumor cells (5), this preferential toxicity has been detected in multiple tumor cell types *in vitro* (14).

Also, plasma concentrations of AA required for killing tumor cells have been achieved in humans (5,10). Others have described *in vivo* toxicity of AA in multiple tumor types and in animal models, even in animals bearing human tumors (15-20).

Treatment Rationale

From previous studies (4,10,14), we concluded that:

- tumor cells are more susceptible to high dose ascorbate induced peroxidation products (mainly H₂O₂) due to their relative deficiencies in antioxidant enzymes, mainly catalase and superoxidase dismutase.
- concentrations of ascorbate high enough to kill tumor cells can be achieved in humans by IAA administration.

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