

PHARMACOLOGY

A Pilot Clinical Study of Continuous Intravenous Ascorbate in Terminal Cancer Patients

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Case studies suggest that vitamin C, given intravenously at doses of 10-100 grams/day can improve patient well being and in some cases, reduce tumor size. While ascorbate is generally considered safe, clinical data on high intravenous doses is limited. Twenty-four late stage terminal cancer patients were given continuous infusions of 150 to 710 mg/kg/day for up to eight weeks. Blood chemistry and blood count profiles were obtained at roughly one-week intervals while patient health, adverse events and tumor progression were monitored. The majority of patients were vitamin C deficient prior to treatment. Intravenous infusions increased plasma ascorbate concentrations to a mean of 1.1 mM. The most common adverse events reported were nausea, edema, and dry mouth or skin; and these were generally minor. Two Grade 3 adverse events 'possibly related' to the agent were reported:

one patient with a history of renal calculi developed a kidney stone after thirteen days of treatment and another patient experienced hypokalemia after six weeks of treatment. White blood cell counts were stable while hemoglobin and hematocrit levels dropped slightly during treatment, consistent with trends observed prior to therapy. Blood creatinine, BUN, glucose, and uric acid concentrations decreased or remained stable during therapy, suggesting that ascorbate infusions did not adversely affect renal function. One patient had stable disease and continued the treatment for forty-eight weeks. These data suggest that intravenous vitamin C therapy for cancer is relatively safe, provided the patient does not have a history of kidney stone formation.

Key words: Ascorbic acid, Cancer, Clinical trial, Pharmacokinetics

Vitamin C (ascorbic acid, ascorbate) is a water-soluble redox agent that plays roles in collagen and carnitine synthesis and may be important in maintaining proper immune cell function (1). Pre-clinical data suggests that, at sufficient concentrations, ascorbate is toxic to tumor cells (2-4), enhances the efficacy of chemotherapy and radiation (5), and protects normal tissues from oxidative damage associated with these modalities (6). In two clinical studies conducted by Pauling and Cameron in the mid 1970's, advanced cancer patients given intravenous infusions of 10 g/day ascorbate for ten

days, followed by longer term oral uptake at the same dose, showed increased survival when compared to 'historical' controls. Japanese case studies using similar doses of ascorbate found that supplementation increased survival times in a similar fashion (7). Two controlled double-blind studies at the Mayo Clinic, however, showed no benefit of orally administered (10 g/day) vitamin C in patients with advanced colon or rectal cancer (8,9).

Since plasma ascorbate concentrations were not measured in these clinical studies, we do not know if the protocols achieved ascorbate concentrations necessary to produce the effects observed in pre-clinical studies. For example, ascorbate is preferentially toxic to tumor cells at millimolar concentrations (2,4,10-12). Since ascorbate is not well absorbed at high doses when administered orally (13), the Mayo Clinic regimen was unlikely to produce plasma concentrations sufficient to reach a cytotoxic effect. With intravenous administration, however, plasma ascorbate concentrations sufficient to kill tumor cells can be attained (14). Moreover, several clinical case studies detail benefits ranging from improved quality of life to complete remission in cancer patients

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