Vitamin C injections slow tumor growth in mice

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High-dose injections of vitamin C, also known as ascorbate or ascorbic acid, reduced tumor weight and growth rate by about 50 percent in mouse models of brain, ovarian, and pancreatic cancers, researchers from the National Institutes of Health (NIH) report in the August 5, 2008, issue of the *Proceedings of the National Academy of Sciences*. The researchers traced ascorbate's anti-cancer effect to the formation of hydrogen peroxide in the extracellular fluid surrounding the tumors. Normal cells were unaffected.

Natural physiologic controls precisely regulate the amount of ascorbate absorbed by the body when it is taken orally. "When you eat foods containing more than 200 milligrams of vitamin C a day--for example, 2 oranges and a serving of broccoli--your body prevents blood levels of ascorbate from exceeding a narrow range," says Mark Levine, M.D., the study's lead author and chief of the Molecular and Clinical Nutrition Section of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), part of the NIH.

To bypass these normal controls, NIH scientists injected ascorbate into the veins or abdominal cavities of rodents with aggressive brain, ovarian, and pancreatic tumors. By doing so, they were able to deliver high doses of ascorbate, up to 4 grams per kilogram of body weight daily. "At these high injected doses, we hoped to see drug-like activity that might be useful in cancer treatment," said Levine.

Vitamin C plays a critical role in health, and a prolonged deficiency

leads to scurvy and eventually to death. Some proteins known as enzymes, which have vital biochemical functions, require the vitamin to work properly. Vitamin C may also act as an antioxidant, protecting cells from the damaging effects of free radicals. The NIH researchers, however, tested the idea that ascorbate, when injected at high doses, may have prooxidant instead of antioxidant activity. Prooxidants would generate free radicals and the formation of hydrogen peroxide, which, the scientists hypothesized, might kill tumor cells. In their laboratory experiments on 43 cancer and 5 normal cell lines, the researchers discovered that high concentrations of ascorbate had anticancer effects in 75 percent of cancer cell lines tested, while sparing normal cells. In their paper, the researchers also showed that these high ascorbate concentrations could be achieved in people.

The team then tested ascorbate injections in immune-deficient mice with rapidly spreading ovarian, pancreatic, and glioblastoma (brain) tumors. The ascorbate injections reduced tumor growth and weight by 41 to 53 percent. In 30 percent of glioblastoma controls, the cancer had spread to other organs, but the ascorbate-treated animals had no signs of disseminated cancer. "These pre-clinical data provide the first firm basis for advancing pharmacologic ascorbate in cancer treatment in humans," the researchers conclude.

Interest in vitamin C as a potential cancer therapy peaked about 30 years ago when case series data showed a possible benefit. In 1979 and 1985, however, other researchers reported no benefit for cancer patients taking high oral doses of vitamin C in two double-blind, placebo-controlled clinical trials.

Several observations led the NIH researchers to revisit ascorbate as a cancer therapy. "Clinical and pharmacokinetic studies conducted in the past 12 years showed that oral ascorbate levels in plasma and tissue are tightly controlled. In the case series, ascorbate was given orally and

intravenously, but in the trials ascorbate was just given orally. It was not realized at the time that only injected ascorbate might deliver the concentrations needed to see an anti-tumor effect," said Levine, who noted that new clinical trials of ascorbate as a cancer treatment are in the planning stages.

Data from Levine's earlier studies of the regulation and absorption of dietary vitamin C were used in the revision of the Institute of Medicine's Recommended Dietary Allowance for the vitamin in 2000. In the current study, Levine led a team of scientists from the NIDDK and the National Cancer Institute (NCI), both components of the NIH, as well as the University of Kansas. "NIH's unique translational environment, where researchers can pursue intellectual high-risk, out-of-the-box thinking with high potential payoff, enabled us to pursue this work," he said.

Source: National Institute of Diabetes and Digestive and Kidney Diseases