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The effect of taurine administration on vitamin C levels of several tissues in mice*

Short Communication

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Summary. Taurine (2-aminoethane sulphonic acid), a sulphur-containing beta amino acid, is the most prevalent free intracellular amino acid in many human and animal tissues. Vitamin C metabolism is also fluenced by sulphur-containing amino acids. The aim of this study is to investigate the effect of taurine administration on the vitamin C levels of plasma and several tissues (brain, liver, kidneys) in mice with incisional skin wounds. Animals were divided into two as control and taurine groups. Taurine was freshly dissolved in sterile saline and administered daily (60 µl, ip) for five days in the taurine group. At the end of the fifth day, the animals were killed by decapitation. The brain, liver and kidneys were immediately removed. Vitamin C levels were measured in plasma and several tissues. The administration of taurine had no effect on the plasma vitamin C levels ($P > 0.05$) but significantly increased in liver and kidneys ($P < 0.001$). In conclusion, taurine may affect the vitamin C metabolism in tissues by different mechanisms.

Keywords: Taurine – Vitamin C – Mice

Introduction

Taurine (2-aminoethane sulphonic acid), is a naturally occuring β-amino acid derived from methionine and cysteine metabolism and differing from other amino acids by replacement of the COOH group with a SO_3H group. Because mammalian ability to synthesize taurine is limited, dietary intake plays an important role in maintaining body taurine pools (Stapleton et al., 1998). Taurine affects various biological and physiological functions including cell membrane stabilization (Pasantes-Morales, 1985), antioxidation (Nakamura et al., 1993; Dinçer et al., 1996), detoxification (Dinçer et al., 2002), osmoregulation (Huxtable, 1992), neuromodulation (Kuriyama, 1980), brain and retinal development (Sturman, 1986). Vitamin C (L-Ascorbic acid), is water-soluble. Humans, nonhuman primates and guinea pigs have lost the ability to synthesize vitamin C because they carry a nonfunctional gene for the enzyme, L-gulono-γ-lactone oxidase, which is required for the last step of vitamin C biosynthesis. In addition, even in animals that can synthesize vitamin C, this occurs only in the liver (mammals) or kidneys (reptiles) (Kaplan et al., 1992, Rice, 2000). It is the one vitamin that can affect glucoregulation and accelerate wound healing, protect fatty tissues from oxidation damage, play an integral role in collagen synthesis (Zhang et al., 1999). Vitamin C and taurine exhibit a protective effect against free radical-induced oxidative damage. Having all this in mind, experiments were undertaken to investigate the connection between taurine treatment and vitamin C levels in the plasma, brain, liver, and kidneys of murine with incisional skin wounds. Our results show that in liver and kidneys of mouse, vitamin C level can be enhanced in both taurine treatment and incisional skin wounds.

Material and methods

This study was performed on 13 Swiss Albino mice of both sexes, weighing 32.2 ± 1.0 g. They received water and food ad libitum before the operations. The animals were anesthetized with ether and their backs were shaved

* The protocol was received and approved by the Animal Care Committee and Surgical Research Center of Gazi University Medical School.

Table 1. Vitamin C levels of the plasma, brain, liver, and kidneys

		Vitamin C Levels			
Groups	n	Plasma (mg/dl)	Brain (mg/g tissue)	Liver (mg/g tissue)	Kidneys (mg/g tissue)
′C	7	0.16 ± 0.03	15.96 ± 2.54	3.51 ± 0.49	0.54 ± 0.16
″T	6	0.16 ± 0.04	17.19 ± 1.21	$8.79 \pm 1.59^*$	$8.03 \pm 2.63^*$

′ Control group: Sterile isotonic saline (C, 60 microliter ip, n:7) was applied to seven mice over the postoperative period. ″ Experimental group: Taurine (50 mM) was freshly dissolved in sterile isotonic saline prior to injection (T, 60 microliter ip, n:6). * It is significantly different from the control group ($P < 0.001$)

and cleased with tincture of iodine. Two standard wounds were incised on both sides at the spine. The wounds were sutured by 3 silk stitches (Foschi et al., 1988). After surgery, each animal was placed in an individual cage. The mice were divided into two groups. Experimental protocols:

I. Control group: Sterile isotonic saline (C, 60 µl ip, n:7) was applied to seven mice over the postoperative period.
II. Experimental group: Taurine (50 mM) was freshly dissolved in sterile isotonic saline prior to injection (T, 60 µl ip, n:6).

All treatments, starting on day zero and continuing to day five, were applied twice a day for four days. On day five, animals were killed by ether anaesthesia.

Vitamin C levels of blood: Blood vitamin C levels were determined for each animal. It was estimated by the method of Roe (1967).

Vitamin C levels of tissues: Their brains were rapidly removed from the skulls. The chests and abdomens were opened. The liver, and kidneys were excised. Vitamin C levels of the tissues were assayed by a modification of the method of Roe and Kuether (Berger et al., 1989).

Statistical analysis

All values were expressed as mean ± SE. The findings were statistically analyzed using the Factorial Anova Versus the Single Control group by SPSS 8.0 programmes. P value of <0.05 was considered as significant.

Results

Vitamin C levels of blood, brain, liver, and kidneys are shown in Table 1. The taurine treatment did not bring about a significant difference in the vitamin C level of the plasma (C-T: $P > 0.05$). The brain vitamin C level in the application of taurine was insignificantly higher compared to the control group (C-T: $P > 0.05$).

However, it was observed that taurine application was effective in the increase in the vitamin C levels of liver and kidneys (C-T: $P < 0.001$).

Discussion

Vitamin C and taurine have common characteristics such as antioxidation, blood glucose regulation (Kulalowski and Maturo, 1984; Kaplan, 1995; Rice, 2000). In the present study, the effects of taurine treatment on incisional skin wound situation on vitamin C levels of blood and several tissues were determined by spectrophotometric procedure. Vitamin C is produced in many plants, microorganisms, and animals such as rats, mice (Braun et al., 1994; Rice, 2000). The more vitamin C is demanded the more it is synthesized. Free radicals are produced in the body as by products of normal metabolism. Free radicals are normally neutralized by efficient systems in the body that include antioxidant enzymes and nutrient-derived antioxidant small molecules (Sardesai, 1995). The nutrient-derived antioxidant small molecules are not only vitamin C but also taurine (Sardesai, 1995; Stapleton et al., 1998). Assesments of lipid peroxidation have included the analysis of lipid peroxides and breakdown products of lipids. Among these products malondialdehyde (MDA) is often used as a reliable marker of lipid peroxidation (Zhang et al., 2002). In some conditions with stress such as incisional skin wounds production, oxidative stress causes the level of antioxidants to fall below normal (Sardesai, 1995). Dinçer et al. (1996) showed that MDA level of incisional skin wound tissue was decreased in the taurine treatment group. Tensile strength elevation shows that collagen production increases in wound healing. The tensile strength of incisional skin wounds with taurine treatment increased compared to the control group. They suggested that taurine treatment enhanced proliferation of the epidermis and accelerated the healing of incisional skin wounds in mice. Stapleton et al. (1998) reported that taurine has been proposed to act as both a direct and indirect antioxidant. Squiera et al. (1997) showed that taurine acts as an antioxidant by preventing or delaying oxidations. Kılıc et al. (1999) investigated that in model *in vitro* diabetic cataract in isolated rat lenses, the protective effect of taurine was determined. In taurine-treated lenses lactate dehydrogenase leakage was significantly

decreased, and their clarity was maintained. There are some studies on the regulating role of taurine on collagenogenesis and on the prevention of abnormal collagen production such as fibrosis (Gordon et al., 1986; Wang et al., 1989). Previously it has been shown that vitamin C is essential for collagen synthesis (Appling et al., 1989; Sauberlich, 1994). Zhang et al. (1999) reported that vitamin C can accelerate wound healing, protect fatty tissues from oxidation damage, and play an integral role in collagen synthesis. We found that liver vitamin C level in the taurine treatment group was higher than those of the control group. This result indicates that vitamin C synthesize of liver was increased by taurine treatment. In stress situation, such as incisional skin wounds, epinephrine, norepinephrine levels of blood increase (Moffett et al., 1993). Vitamin C has numerous biologic functions. Diliberto et al. (1987) have presented evidence that dopamine-beta-hydroxylase, which catalyzes the final step in the biosynthesis of norepineprine, uses vitamin C as the electron donor in reducing molecular oxygen to hydroxyl oxygen. It has also been reported that vitamin C serves on a cofactor for the dopamine β-hydroxylase which participate in the biosynthesis of norepinephrine (Sauberlich, 1994). In our study, we showed that vitamin C level of kidneys increased by taurine treatment. Thus, the increase of vitamin C in kidneys may have been due to its employment in the norepinephrine synthesize. In addition to its functions as an antioxidant in the central nervous system, vitamin C has been shown to be a neuromodulator of both dopamine- and glutamate-mediated neurotransmission (Grünewald, 1993; Rebec and Pierce, 1994). Predominant localization of vitamin C in neurons is consistent with such neuromodulatory functions (Rice, 2000). In our study, in insignificant increase of vitamin C in the brain has been observed in the taurine treatment of mice with incisional skin wounds. In conclusion, vitamin C levels of liver and kidneys increases in incisional skin wounds and taurine treatment. Therefore, it can be assumed that vitamin C synthesize may have been increased in the skin wounds with taurine treatment, because of a greater need of vitamin C.

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