Effect of ascorbate on serum lipids and urate metabolism during exhaustive training

Hidekatsu YANAI* and Mie MORIMOTO†
*Department of Internal Medicine, Sapporo Self-Defense Hospital, Sapporo 062-8610, Japan, and †College of Medical Technology, Hokkaido University, Sapporo 060-8648, Japan

ABSTRACT

Physical activity is associated with beneficial changes in serum lipids, but exhaustive exercise has been suggested to increase oxidative stress. To test the effect of ascorbate (vitamin C) on serum lipids and the metabolism of urate, which is the most important intrinsic antioxidant, during exhaustive exercise, we performed a randomized, blinded, placebo-controlled study on eight male well-trained athletes. Subjects were randomly allocated to either a group given 1000 mg of ascorbate daily (n = 4) or a placebo group (n = 4). Fasting serum lipids and urate concentrations were measured before and after 3 weeks of training. Although serum low-density lipoprotein (LDL)-cholesterol levels decreased and high-density lipoprotein (HDL)-cholesterol levels increased significantly in the ascorbate group after the 3 weeks of training, serum LDL-cholesterol levels increased and HDL-cholesterol levels decreased significantly in the placebo group. Furthermore, serum urate levels were elevated significantly in the placebo group; however, these levels did not change in the ascorbate group. When compared with the placebo group, significantly higher serum HDL-cholesterol and lower serum LDL-cholesterol and urate levels were observed in the ascorbate group after training. In conclusion, our results suggested that ascorbate may contribute to the desirable changes in serum lipids during exhaustive training and suggest the significant association between ascorbate and urate under intense training.

Physical activity is associated with beneficial changes in serum lipids, but exhaustive exercise has been suggested to increase oxidative stress [1,2]. Efficient systems of intracellular and extracellular antioxidant protection, such as urate, exist to suppress free radicals in human body [3]. Ascorbate is also an effective antioxidant in biological fluids [4]. To test the effect of ascorbate (vitamin C) on serum lipids and metabolism of urate, which is the most important intrinsic antioxidant [3], during exhaustive exercise, we performed a randomized, blinded, placebo-controlled study on male well-trained athletes.

The subjects (n = 8) who participated in this study were all healthy non-smoking male well-trained athletes. The participants all underwent the same intensity of exercise, which consisted of a 20 ± 3 km run and isometric training for 2 h every day for 3 weeks. The daily diet provided 2345 ± 50 kcal (where 1 cal ≈ 4.184 J) and consisted of approx. 12–15 % protein, 55–65 % carbohydrate and 25–30 % fat over the study period. Subjects were randomly allocated to either a group given 1000 mg of ascorbate daily (n = 4) or a placebo group (n = 4). There were no significant differences in age (means ± S.D.; 21.0 ± 2.0 compared with 19.8 ± 0.9) and body mass index (means ± S.D.; 21.0 ± 0.9 compared with 20.8 ± 1.1) between ascorbate and placebo groups respectively.

The study was approved by the Ethics Committee in the Medical Office, Higashi-Chitose General Service Unit, Japan Ground Self-Defense Force, and was carried out in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Key words: antioxidant, ascorbate (vitamin C), exhaustive training, serum lipid, urate.

Abbreviations: HDL, high-density lipoprotein; HDL-C, HDL-cholesterol; LDL, low-density lipoprotein; LDL-C, LDL-cholesterol.

Correspondence: Mrs Mie Morimoto (e-mail mie@cme.hokudai.ac.jp).
Correspondence

**Changes in serum LDL-C, HDL-C and triacylglycerol levels in the ascorbate and placebo groups before and after exhaustive exercise**

Serum lipid levels before (open bars) and after (closed bars) exhaustive training. *P < 0.05 and **P < 0.01 (using Student’s t test) compared with levels before training. #P < 0.05 (Mann–Whitney U test) compared with the placebo group.

Figure 1

Triglyceride, triglycerol.

Serum LDL-C levels decreased and HDL-C levels increased significantly in the ascorbate group after 3 weeks of training, but serum triacylglycerol levels did not change significantly (Figure 1). In the placebo group, serum LDL-C levels increased and HDL-C levels decreased significantly after training; however, no significant difference in serum triacylglycerol levels before and after training was observed (Figure 1). Serum urate levels were elevated significantly after training in the placebo group (means ± S.D.; 266.2 ± 49.4 µmol/l before training compared with 365.8 ± 27.7 µmol/l after training; P < 0.05); however, the levels did not change significantly in the ascorbate group (355.4 ± 39.6 µmol/l before training compared with 304.9 ± 30.9 µmol/l after training). We also observed significantly higher serum HDL-C levels and lower serum LDL-C and urate levels in the ascorbate group when compared with the placebo group after training.

Physical activity has been suggested to increase the production of oxygen free radicals, which may consume antioxidants and oxidize LDL [1]. HDL is the principal vehicle for lipid hydroperoxides and has a beneficial function in the hepatic clearance of circulating oxidized lipids [5]. These indicate that an imbalance between free radical production and antioxidants lead to oxidation of LDL and subsequent alterations in HDL metabolism. Ascorbate is a strong determinant of plasma antioxidant capacity and serum lipid resistance to oxidation [6], which can explain the desirable change in serum lipids, resulting in increased HDL-C and decreased LDL-C levels in the ascorbate group. Our present results could also be explained by the effect of ascorbate on insulin sensitivity and subsequent influence on skeletal muscle lipoprotein lipase activity.

Urate is also an important low-molecular-mass antioxidant in plasma and protects serum lipids from oxidation [3]. Elevated plasma urate levels are commonly observed in physically active people [2]. Ascorbate and urate are the strongest determinants of plasma antioxidative capacity and compensate or interact each other [6], which could be a possible explanation for increased serum urate levels in the placebo group and decreased (although not statistically significant) levels in the ascorbate group. These plasma urate changes may also be due to the effect of exercise and ascorbate on renal excretion of urate.

In conclusion, our present results suggest that ascorbate may contribute to the desirable changes in serum lipids during exhaustive training and indicate a significant association between ascorbate and urate under intense physical training. However, we have to mention that more definitive and extensive studies are necessary for the application of our present findings in a practical context for athletes.

**REFERENCES**


