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Beneficial effects of taurine on serum lipids in overweight or obese non-diabetic subjects

M. Zhang[1], **L. F. Bi**[2], **J. H. Fang**[2], **X. L. Su**[2], **G. L. Da**[3], **T. Kuwamori**[4], and **S. Kagamimori**[1]

[1] Department of Welfare Promotion and Epidemiology, Toyama Medical and Pharmaceutical University, Toyama, Japan
[2] Inner Mongolia Medical College, Hohhot, Inner Mongolia, China
[3] Inner Mongolia College, Hohhot, Inner Mongolia, China
[4] Department of Food and Nutrition, Toyama College, Toyama, Japan

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Summary. Taurine has beneficial effects on lipid metabolism in experimental animals fed with high-cholesterol or high fat diets. Whether taurine benefits lipid metabolism in humans has rarely been investigated. The aim of this study was to evaluate the effects of taurine on serum lipids in overweight or obese young adults. Thirty college students (age: 20.3 ± 1.7 years) with a body mass index (BMI) $\geq 25.0\,kg/m^2$, and with no evidence of diabetes mellitus were selected and assigned to either the taurine group (n = 15) or the placebo group (n = 15) by double-blind randomization. Taurine 3 g/day or placebo was taken orally for 7 weeks. Triacylglycerol (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) and plasma glucose were measured before and after supplementation. The atherogenic index (AI) was calculated as (TC − HDL-C)/HDL-C. There were no differences in any baseline parameter between the two groups. Taurine supplementation decreased TG and AI significantly. Body weight also reduced significantly in the taurine group. These results suggest that taurine produces a beneficial effect on lipid metabolism and may have an important role in cardiovascular disease prevention in overweight or obese subjects.

Keywords: Taurine – Obesity – Lipid metabolism – Cardiovascular diseases

Introduction

Obesity is increasingly rapidly throughout the world. Excess weight is known to associate with an increased incidence of cardiovascular disease, dyslipidemia, type 2 diabetes mellitus, hypertension, stroke, osteoarthritis, and some cancers (Burton et al., 1985; Must et al., 1999). Cross-sectional analyses have shown that the prevalence of high serum total cholesterol (TC) and low high-density lipoprotein cholesterol (HDL-C) are raised with increase in BMI, and the cohort study has shown that BMI is one of the independent risk factors for stroke and coronary heart disease in Chinese populations (Zhou et al., 2002).

Taurine, 2-amino ethanesulfonic acid, is a common constituent of the human diet and one of the most abundant free amino acids in mammalian cells (Wright et al., 1986). An early study showed that taurine decreases the body weight in hyperglycemic obese mice (Fujihira et al., 1970). Recent studies have demonstrated that taurine has beneficial effects on serum lipids in rats, mice, rabbits and humans (Mizushima et al., 1996; Murakami et al., 1999; Yokogoshi et al., 1999; Nakaya et al., 2000; Balkan et al., 2002; Matsushima et al., 2003). Taurine suppresses the development of atherosclerotic lesions in mice (Matsushima et al., 2003) and prevents cardiovascular disease in humans (Yamori et al., 2001). Although oral taurine supplementation attenuates the increase in TC, low-density lipoprotein cholesterol (LDL-C) and LDL in healthy men given high fat and cholesterol diet (Mizushima et al., 1996), until now there has been no report on the effect of taurine on lipid metabolism and body weight in obese adults. In this study, therefore, we investigated whether taurine is effective in improving serum lipids and subsequently influencing body weight in overweight or obese non-diabetic young subjects.

Material and methods

Subjects and study design

Volunteers were recruited by advertisement from two colleges in Hohhot city, Inner Mongolia, China. Volunteers underwent a medical history and physical examination to determine their eligibility. Finally, thirty students with body mass index (BMI) $\geq 25.0\,kg/m^2$, which is the WHO criteria for overweight and obesity (BMI of $\geq 25.0\,kg/m^2$ and $< 30\,kg/m^2$ is defined as overweight and of $\geq 30\,kg/m^2$ as obesity) (World Health Organization,

1997), and fasting plasma glucose concentration <7 mmol/L, which is the diagnostic threshold for diabetes mellitus (Alberti and Zimmet, 1998), were recruited into this study (BMI 25.0–33.3 kg/m^2; aged 20.3 ± 1.7 years; 14 men and 16 women). None of the volunteers had a known history of endocrinal disease such as diabetes mellitus and none were taking medication. All subjects gave written informed consent, and the study was approved by the Institutional Review Board of Inner Mongolia Medical College.

Volunteers were randomly assigned to either the taurine supplementation group (n = 15) or the placebo group (n = 15) by a double-blind approach. After baseline measurements, the subjects took 3 g/day of taurine powder in capsules (1 g/time, 3 times/day; purity ≥ 99%; Jianli Pham Co., Beijing, China) or placebo in capsules (potato starch powder) orally for 7 weeks. During the supplementation period, subjects were asked not to change their daily physical activity and dietary habits.

Measurements

Measurements were undertaken before and after the 7 weeks of supplementation. Height and weight were measured without shoes and with light clothing. Body mass index (BMI) was calculated as weight (kg)/height (m)^2.

Blood samples were collected after an overnight fast from the cubical vein and separated immediately after collection. The plasma was stored at −80°C before analysis. Plasma triacylglycerol (TG), TC, and HDL-C were measured by an automated enzymatic method (Olympus AU600, Japan). The atherogenic index (AI) was calculated as (TC − HDL-C)/HDL-C. Fasting plasma glucose was determined by the glucose oxidase method.

Statistical analysis

Normally distributed data are expressed as the mean ± SD, while non-normally distributed data are expressed as the geometric mean (SEM). Non-normally distributed data were log transformed for use in statistical tests. Differences were considered statistically significant at $P < 0.05$. Parameters were compared between the taurine and placebo groups at baseline using the unpaired Student t test. Two-way analysis of variance (ANOVA) on repeated measurements were used to detect statistically significant changes due to supplementation (group × time interaction). When the interaction was significant, the paired t test was used to compare within-group parameters. Statistical analyses were performed by SPSS 10.0 J for Windows (Chicago, IL).

Results

The final results were collected from the 30 subjects and all of them reported compliance with the taurine or placebo,

Table 1. Baseline characteristics of the study population

	Taurine group (N = 15)		Placebo group (N = 15)	
Sex (number)	Male (7)	Female (8)	Male (7)	Female (8)
Age (years)	20.9 ± 2.9	19.5 ± 0.5	21.0 ± 1.5	19.9 ± 0.6
Height (cm)	168.9 ± 6.5	156.0 ± 5.5	169.2 ± 4.7	162.8 ± 3.3
Weight (kg)	73.3 ± 6.3	63.6 ± 6.8	78.4 ± 11.5	70.9 ± 7.8
BMI (kg/m^2)	25.7 ± 0.4	26.1 ± 1.2	27.3 ± 2.9	26.8 ± 2.8

Data are expressed as mean ± SD

Table 2. Effect of 7-weeks taurine supplementation on BMI, serum lipids, atherogenic index, and fasting plasma glucose concentrations

		Baseline	After 7-week	ANOVA Interaction (P value)
Weight (kg)	Taurine	68.1 ± 8.0	66.8 ± 7.4**	0.039
	Placebo	74.4 ± 10.1	74.3 ± 9.3	
BMI (kg/m^2)	Taurine	25.9(1.0)	25.4(1.0)	NS
	Placebo	26.9(1.0)	26.7(1.0)	
TG (mmol/L)	Taurine	1.29 ± 0.46	1.08 ± 0.29*	0.043
	Placebo	1.22 ± 0.37	1.30 ± 0.33	
TC (mmol/L)	Taurine	4.51 ± 0.63	4.26 ± 0.51	NS
	Placebo	4.56 ± 0.50	4.56 ± 0.53	
HDL-C (mmol/L)	Taurine	1.22 ± 0.19	1.30 ± 0.13	NS
	Placebo	1.18 ± 0.14	1.17 ± 0.17	
AI	Taurine	2.75 ± 0.71	2.30 ± 0.46**	0.013
	Placebo	2.91 ± 0.57	2.99 ± 0.76	
Fasting plasma glucose (mmol/L)	Taurine	4.80 ± 0.84	4.30 ± 0.64	NS
	Placebo	4.68 ± 0.76	4.40 ± 0.68	

Data are expressed as mean ± SD or geometric mean (SEM)
* $P < 0.05$, ** $P < 0.01$ vs. baseline. *NS*, not significant

to at least 90% of the total amount. No serious side effects and appetite change with taurine supplementation were reported in this study.

The baseline characteristics of the subjects are summarized in Table 1. The effects of 7-weeks taurine supplementation on body weight, BMI, serum lipids, AI, and fasting plasma glucose are shown in Table 2. There were no differences in any baseline parameters between the two groups. After supplementation, a significant interaction was found for body weight. Body weight decreased significantly in the taurine supplementation group ($P<0.01$), whereas it did not change in the placebo group. However, there was no significant interaction with BMI. A significant interaction was also found for serum TG. TG decreased significantly in the taurine supplementation group ($P<0.05$), whereas it did not change in the placebo group. Although there was no significant interaction for either TC or HDL-C, a downward trend in TC and an upward trend in HDL-C were observed after taurine supplementation. A significant interaction was found for AI, an index calculated from TC and HDL-C. AI markedly decreased with taurine supplementation ($P<0.01$), whereas it did not change with placebo. There was no significant interaction for fasting plasma glucose after supplementation.

Discussion

Our study shows that 7-weeks of taurine supplementation lowers TG concentrations and AI in overweight or obese non-diabetic subjects, whereas placebo does not change any index in the same period. Several animal and human studies have demonstrated that taurine supplementation significantly reduces concentrations of serum TC (Yokogoshi et al., 1999; Nakaya et al., 2000), LDL-C (Mizushima et al., 1996; Murakami et al., 1999), TG (Yokogoshi et al., 1999; Nakaya et al., 2000; Balkan et al., 2002), and increases HDL-C (Murakami et al., 1999; Yokogoshi et al., 1999; Matsushima et al., 2003). However, there has been no report on whether taurine is effective in improving serum lipids in obese people, who are at higher risk of dyslipidaemia and cardiovascular disease. Our present study demonstrates that taurine supplementation decreases serum TG concentration in overweight or obese subjects, which is consistent with the results of previous studies (Yokogoshi et al., 1999; Nakaya et al., 2000; Balkan et al., 2002). In addition, although the effect of taurine supplementation on serum TC and HDL-C was not significant, the trends for a decrease in TC and increase in serum HDL-C result in the significant effect of taurine supplementation on improving the AI, which is an index of atherosclerosis (Schonfeld, 1979).

Recently, evidence has accrued that the enhanced activity and mRNA expression of cholesterol 7α-hydroxylase, a rate-limiting enzyme in bile acid synthesis, may be the primary mechanisms responsible for the hypocholesterolemic action of taurine (Nakamura-Yamanaka et al., 1987; Murakami et al., 1999 and 2002). In addition, both in vitro and in vivo studies suggest that taurine up-regulates LDL receptor activity (Stephan et al., 1987; Murakami et al., 2002), which is involved in LDL clearance by the liver (Spady et al., 1985). Furthermore, the protective effects of taurine as an anti-oxidant are also noted in spontaneously hyperlipidaemic mice (Matsushima et al., 2003) and in rabbit fed on a high-cholesterol diet (Balkan et al., 2002). On the other hand, a possible mechanism by which taurine increases serum HDL-C is through the stimulation of Apo A-1 production, a major component of HDL (Mochizuki et al., 1998).

The reported effects of taurine on body weight and fat accumulation are contradictory. Two studies reported that the effect of taurine on body weight was not observed in mice and in humans given a high-fat or high-cholesterol diet (Mizushima et al., 1996; Murakami et al., 1999). However, an earlier study showed that taurine caused a marked reduction of body weight increase in young mice of a hereditary hyperglycemic obese stain, and decreased the initial body weight in adult mice of the same strain (Fujihira et al., 1970). Nakaya et al (2000) also indicated that taurine attenuated abdominal fat accumulation in spontaneous type 2 diabetic rats. These contradictory results might be due to the differences in taurine dosage and supplementation period. In this study, a significant decrease in body weight was observed after taurine supplementation, which agrees with the findings of the latter two studies. A possible explanation is provided by the lipid-lowing effect of taurine, which has been demonstrated in this and other studies.

One limitation of this study is that the number of subjects studied was relatively small. In addition, although we asked all subjects not to change their dietary habits and physical activity during the supplementation period, the influence of dietary intake on lipid metabolism and weight change might not be completely excluded because identical experimental diets were not provided and food intake was not calculated because of practical difficulties. However, there were no index changes in the placebo group. According to previous reports, taurine decreased body weight and abdominal fat accumulation without changes in food and water intake (Fujihira et al., 1970; Nakaya et al., 2000). Therefore, the effects of taurine supplementation on serum lipids and body weight observed in our study could be reliable.

Taurine has been shown to have hypoglycemic and anti-diabetic actions (Kulakowski and Maturo, 1984). However,

taurine supplementation did not significantly change fasting plasma glucose concentrations in this study. One possible reason is that plasma glucose concentrations in all subjects were within the normal range. Instead of re-establishing homeostasis, taurine is regarded as an enantiostatic agent capable of antagonizing stress-induced changes by producing other changes that are capable of maintaining physicochemical function (Huxtable, 1996). Therefore, the hypoglycemic effect of taurine was not observed in our subjects, who were likely to have a normal glucose metabolism.

Taurine is rich in many kinds of seafood and fresh water fish (Laidlaw et al., 1990). The WHO-CARDIAC study in 24 populations from 16 countries shows a strong inverse association between concentrations of urinary taurine excretion and ischemic heart disease mortality (Yamori et al., 2001). In that study, the highest urinary taurine excretion was found in Japanese people, who have the dietary habit of consuming much seafood. The present study was conducted in a population who had a relatively very low fish intake, and lower serum taurine concentrations than in Japanese according to our previous investigation (Kibayashi et al., 2000). On the other hand, plasma taurine was significantly low in healthy obese subjects compared with age- and sex-matched non-obese controls (Jeevanandam et al., 1991). Therefore, our present results suggest that increasing dietary taurine intake, especially in areas with a low intake of seafood and in overweight or obese subjects, may provide a positive action in improving lipid metabolism and furthermore preventing cardiovascular disease.

In conclusion, 7-weeks supplementation with taurine is beneficial for the serum lipid profile in overweight or obese subjects by decreasing serum TG and AI. Taurine is also effective in reducing body weight, possibly due to its beneficial effects on lipid metabolism. These results suggest that an increasing taurine intake may be helpful for improving lipid metabolism in obese people and, therefore, play a role in cardiovascular disease prevention.

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Authors' address: Miao Zhang, Department of Welfare Promotion and Epidemiology, Faculty of Medicine, Toyama Medical and Pharmaceutical University, Sugitani 2630, Toyama 930-0194, Japan,
Fax: 81-764-34-5022, E-mail: zhang@ms.toyama-mpu.ac.jp