The influence of scopolamine and extreme temperatures on the lipid level in some mouse organs

Jolanta Klusek [1], Grażyna Świderska-Kołacz [1], Artur Jóźwik [2] & Adam Kołątaj [2]

[1] Department of Genetics, Institute of Biology, Świętokrzyska 15, 25-406 Kielce, Poland
[2] Institute of Animal Genetics and Breeding, Polish Academy of Sciences, Jastrzębiec, 05-552 Wólka Kosowska, Poland

Correspondence to: Dr. Jolanta Klusek
Institute of Biology, Swietokrzyska Academy,
Swietokrzyska 15, 25-406 Kielce, POLAND
EMAIL: j.klusek@pu.kielce.pl

Submitted: November 23, 2005 *Accepted: December 12, 2005*

Key words: **mice; temperature; scopolamine; triacyloglyceride; cholesterol**

Neuroendocrinol Lett 2006; **27**(3):369–372 **PMID:** 16816830 NEL270306A16 ©Neuroendocrinology Letters **www.nel.edu**

Abstract

OBJECTIVES: The effect of scopolamine administration at dose 0,5 g/kg b.w. and high (+40 °C) and low (+4 °C) temperature on the level of triacyloglycerides, total lipids and cholesterol in the mouse liver, kidney and muscle of males and females.
METHODS: The homogenates of the liver, kidney and muscle were taken for examination. The concentrations of triacyloglycerides, total lipids and cholesterol was estimated according to the Bio-La-Tests (Poland).
RESULTS: The concentration of triacyloglycerides and total lipids in the liver, kidney and muscle increased of males and females after scopolamine injections and after exposure to high and low temperatures.
CONCLUSION: Scopolamine may effect an increase in the rate of the lipid metabolism.

Introduction

Scopolamine is the parasympatytolitic alkaloid analysed in human and animal physiology [1–4, 9–10, 12]. The basic factor necessary for the organism in any environment is its ability to utilize the metabolic energy at an anadequate level. It is known that lipids play an important role in regulation of energetic processes.

In connection with these data we examined the changes of the lipid concentration in liver, kidney and muscle of mice exposed to the effect of 4 °C and 40 °C environmental temperatures and scopolamine injections.

The simultaneous treatment of mice with scopolamine and high or low temperature as stress factors may cause the specific adaptation reactions in these animals.

Material and Methods

The study employed randomly chosen Swiss mice, 40 males and 40 females, 8 weeks old, and 22.5±2.1 g of body weight, from the Institute of Animal Genetics and Breeding, Polish Academy of Sciences in Jastrzębiec (Poland). The mice were maintained in standard cages in a ventilated room under a natural photoperiod at 21 °C. They were fed a standard Murigran diet (16% protein) produced by Animal Food Co., in Lomna near Warsaw (Poland) and had constant access to water. The animals were divided into four groups (n=10 each): a control group injected with 250 μl of 0.9% NaCl solution and three experimental groups. The first group received 0.5 mg/kg b.w. scopolamine; the second group received scopolamine and was exposed for three days to a temperature of +4 °C; the third group

ORIGINAL ARTICLE

received scopolamine and was exposed to a temperature of +40 °C for 3 days. All injections were administrated during three days to the right femoral muscle, between 8.00 a.m. and 9.00 a.m.

Four hours after the last injection the animals were killed by decapitation. The liver, kidney and left femoral muscle were immediately prepared. The liver was perfused with physiological solution cooled to 4 °C to remove blood. Tissues were homogenized with a homogenizer with a Potter teflon piston in 0.1 M phosphate buffer (pH 7.4) containing EDTA. Ready-made Bio-La-Tests (Poland) were used to determine concentrations of triacyloglycerides, total lipids and cholesterol in supernatants of the liver, kidney and muscle obtained by centrifuging homogenates in a Janetzki K-24 centrifuge at 12 000 rpm. The concentrations of the estimated lipids have been given as μmol/g of fresh tissue. The results were analysed statistically with the analysis of variance.

This experiment was performed under a permit from the Animal Research Ethical Commission of the Institute of Genetics and Animal Breeding.

Results and Discussion

Table 1 shows that scopolamine caused an increase in the triacyloglyceride level in the liver (up to 133,6%), kidney (up to 126%) and muscle (up to 126,4%) of females only in comparison with control values.

The administration of the scopolamine in connection with low (+4 °C) and high (+40 °C) temperature of an environment significantly increased the concentration of triacyloglycerides in livers of males only (to 124,4% and 126,8% see Table).

Scopolamine influenced (Table 2) total lipid concentration in the liver of males (up to 125,6%) and females (126,3%) as well as in the kidney of females (124,6%). Scopolamine injection at a low temperature (+4 °C) increased these values only in the liver and muscle of females to 129,9% and 129,2% in comparison with control values. On the other hand scopolamine and high temperature (+40 °C) increased the concentration of the total lipids in the liver (up to 138,4%), kidney (126,5%) and muscle (126,9%) of males only.

A relation was not observed between cholesterol level and applied stress factors (Table 3). A small increase in cholesterol level can be a preparatory factor for increased glycocortycoid biosynthesis.

Many data show that scopolamine regulates many of an organism's metabolic pathways. It exerts a depressing influence on the central nervous system and strongly slows down the cortex cerebri reactions. It decreases the tonus of the smooth muscles and affects the glands' secretion [5–6, 8, 11, 13–14]. We suppose that it has not such great influence on triacyloglyceride concentra-tion because we observed its increase in females only. These results may suggest that the injection of scopolamine activates in females the tissue lipolise.

It is possible that scopolamine can lead directly to estrification of free lipid acids from triacyloglycerides. The exposure to cold and heat in connection with scopolamine injection showed its influence in the male liver only.

It is interesting that total lipid concentration increased in males and females. Probably it was connected with the stimulation of the liver lipogenesis. The simultaneous scopolamine injection and exposure to heat may cause generally an increase in the lipogenesis rate. The increase in the lipid concentration observed in the males and females was similar (125.6% and 126.3%).

Table 1. Changes of triacyloglyceride concentration ($\overline{X}$ ±SD), and percent (versus control as 100%) in examined mice (μmol/g tissue) after scopolamine administration and high and low temperature, (n=10);

Factor	Liver	Kidney	Muscle
MALES			
Control	12.3 ± 2.8[1,2]	8.3 ± 2.6	6.1 ± 1.5
	100.0	100.0	100.0
Scopolamine	13.3 ± 3.3	9.4 ± 2.8	6.5 ± 0.8
	108.1	113.2	106.5
Scopolamine +4°C	15.3 ± 3.7[1]	8.2 ± 1.3	7.2 ±2.3
	124.4	98.8	118.0
Scopolamine +40°C	15.6 ± 4.2[2]	9.6 ± 2.7	6.7 ± 2.7
	126.8	115.7	109.8
FEMALES			
Control	11.9 ± 2.4[3]	7.3 ± 2.3[4]	5.3 ± 2.4[5]
	100.0	100.0	100.0
Scopolamine	15.9 ± 2.7[3]	9.2 ± 2.5[4]	6.7 ± 1.4[5]
	133.6	126.0	126.4
Scopolamine +4°C	13.4 ± 3.1	8.7 ± 2.7	6.1 ± 2.3
	112.6	119.2	115.1
Scopolamine +40°C	12.7 ± 2.6	7.2 ± 3.1	5.7 ± 0.8
	106.7	98.6	107.5

1-1; 2-2; 3-3; 4-4; 5-5 – statistically significant difference at P<0.01

Table 2. Changes of total lipids concentration ($\overline{X}$ ±SD), and percent (versus control as 100%) in examined mice (μmol/g tissue) after scopolamine administration and high and low temperature, (n=10);

Factor	Liver	Kidney	Muscle
MALES			
Control	8.6 ± 1.5[1,2]	6.8 ± 0.9[3]	6.7 ± 1.3[4]
	100.0	100.0	100.0
Scopolamine	10.8 ± 5.9[1]	7.7 ± 3.2	6.9 ± 2.1
	125.6	113.2	103.0
Scopolamine +4°C	10.0 ± 3.3	6.5 ± 2.9	7.0 ± 2.2
	116,3	95.6	104.5
Scopolamine +40°C	11.9 ± 3.6[2]	8.6 ± 2.1[3]	8.5 ± 3.0[4]
	138.4	126.5	126.9
FEMALES			
Control	9.5 ± 3.9[5,6]	6.1 ± 3.4[7]	4.8 ± 1.4[8]
	100.0	100.0	100.0
Scopolamine	12.0 ± 4.1[5]	7.6 ± 2.1[7]	5.0 ± 1.4
	126.3	124.6	104.2
Scopolamine +4°C	12.3 ± 2.1[6]	6.4 ± 2.2	6.2 ± 1.4[8]
	129.9	104.9	129.2
Scopolamine +40°C	9.4 ± 4.6	7.3 ± 2.7	5.4 ± 2.7
	98.9	119.7	112.5

1-1; 2-2; 3-3 ……..8-8 - statistically significant difference at P<0.01

Table 3. Changes of cholesterol concentration ($\overline{X}$ ±SD), and percent (versus control as 100%) in examined mice (μmol/g tissue) after scopolamine administration and high and low temperature, (n=10);

Factor	Liver	Kidney	Muscle
MALES			
Control	5.2 ± 0.6	5.8 ± 1.4	4.7 ± 1.2
	100.0	100.0	100.0
Scopolamine	6.3 ± 1.7	5.9 ± 2.1	4.8 ± 0.9
	121,1	101.7	102.1
Scopolamine +4°C	5.4 ± 0.9	6.0 ± 0.9	5.2 0.7
	103.8	103.4	110.6
Scopolamine +40°C	5.9 ± 1.8	6.2 ± 2.2	5.3 ± 0.6
	113.5	106.9	112.8
FEMALES			
Control	6.5 ± 3.7	4.1 ± 2.4	4.8 ± 1.4
	100.0	100.0	100.0
Scopolamine	7.4 ± 2.3	4.2 ± 0.5	4.8 ± 0.6
	113.8	101.7	98.5
Scopolamine +4°C	7.0 ± 1.5	4.5 ± 1.4	5.8 ± 2.5
	116.7	109.2	120.5
Scopolamine +40°C	6.3 ± 2.1	3.9 ± 0.7	4.5 ± 1.1
	97.5	95.1	93.7

An earlier study by Klusek [7] showed that the temperature of the environment influenced the level of studied lipids in the examined mice. The rise in temperature to 40 °C increased the triacyloglyceride level in the liver, the kidney and skeletal muscle in mice and decreased in these organs the total lipid concentration. However a low temperature of the environment +4 °C caused a decrease in triacyloglyceride level and total lipids in liver and skeletal muscle in these examined mice.

On the basis of the obtained results we suggest that scopolamine may indicate a small increase in the rate of lipid metabolism.

REFERENCES

1 Anagnostaras SG, Maren S, Sage JR, Goodrich S, Fanselow MS. Scopolamine and Pavlovian fear conditioning in rats: does-effect analysis. Neuropsychopharmacology 1999; **21**:731–744.
2 Bejar C, Wang RH, Weinstock M. Effect of rivastigmine on scopolamine-induced memory impairment in rats. Eur J Pharmacol 1999; **383**:231–240.
3 Davidson MC, Marrocco RT. Local infusion of scopolamine into intraparietal cortex slows covert orienting in rhesus monkeys. J Neurophysiol 2000; **83**:1536–1549.
4 Higgs S, Deacon RM, Rawlins JN. Effects of scopolamine on a novel choice reaction time task. Eur J Neurosci 2000; **12**:1781–1788.
5 Ikemoto S, Goeders NE. Intra-medial prefrontal cortex injections of scopolamine increase instrumantal responses for cocaine: an intravenous self-administration study in rats. Brain Res Bull 2000; **51**:151–158.

6 Ison JR, Bowen GP. Scopolamine reduces sensitivity to auditory gaps in the rat, suggesting a cholinergic contribution to temporal acuity. Hear Res 2000; **145**:169–176.
7 Jones CK, Shannon HE. Effects of scopolamine in comparison with apomorphine and phencyclidine on prepulse inhibition in rats. Eur J Pharmacol 2000; **391**:105–112.
8 Kikuchi M, Wada Y, Koshino Y, Nanbu Y, Hashimoto T. Effects of scopolamine on interhemispheric EEG coherence in healthy subjects: analysis during rest and photic stimulation. Clin Electroencephalogr 2000; **31**:109–115.
9 Koller G, Satzger W, Adam M, Wagner M, Kathman N, Soyka M, Engel R. Effects of scopolamine on matching to sample paradigm and related tests in human subjects. Neuropsychobiology 2003; **48**:87–94.
10 Lynch CS, Ruppel TE, Domingue RN, Ponthier GL. Scopolamine inhibition of female sexual behavior in rhesus monkeys (Macaca mulatta). Pharmacol Biochem Behav 1999; **63**:655–661.
11 Nakai M, Maeda M. Scopolamine-sensitive and resistant components of cerebral cortical blood flow elicited by periaqueductal gray matter of rats. Neurosci Lett 1999; **270**:173–176.
12 Osipova D, Ahveninen J, Kaakkola S, Jaaskelainen IP, Huttunen J, Pekkonen E. Effects of scopolamine on MEG spectral power and coherence in elderly subjects. Clin Neurophysiol 2003; **114**:1902–1907.
13 Philippens I.H, Melchers B.P, Olivier B, Bruijnzeel PL. Scopolamine augments the efficacy of physostigmine against soman poisoning in guinea pigs. Pharmacol Biochem Behav 2000; **65**:175–182.
14 Rao U, Lutchmansingh P, Poland R.E. Age-related effectsof scopolamine on REM sleep regulation in normal control relationship to sleep abnormalities in depression. Neuropsychopharmacology: 1999; **21**:723–730.
15 Taffe MA, Weed M.R, Gold LH. Scopolamine alters rhesus monkey performance on a novel neuropsycholo-gical test battery. Brain Res Cong Brain Res 1999; **8**:203–212.