

Plasma and urinary catecholamine concentrations in patients with vibration syndrome before and after hospital treatment

by Kazuo Saito, MD, PhD, Sachiko Inuzuka, PhD, Koichi Azuma, MD¹

SAITO K, INUZUKA S, AZUMA K. Plasma and urinary catecholamine concentrations in patients with vibration syndrome before and after hospital treatment. *Scand J Work Environ Health* 12 (1986) 262–264. For 23 male and 12 female patients with vibration syndrome the plasma and urinary catecholamine concentrations, the skin temperature, the effects of the nail compression test at room temperature, and the recovery rates of the skin temperature and nail compression test after cold provocation were investigated before and after hospital treatment. The aim was to evaluate the effect of five weeks' hospital treatment on the autonomic nervous balance of patients with vibration syndrome. The plasma norepinephrine concentration tended to decrease in the female patients after the treatment. A decrease in the plasma epinephrine concentration and in the variation between the plasma epinephrine levels during the day were found after the treatment. The total urinary dopamine concentration decreased significantly in the patients after the treatment. The recovery rates of the skin temperature after the cold provocation showed a tendency to increase after the treatment. These results suggest an improvement in the blood circulation of the subjects' hands. The decreases in catecholamine concentration and the variation in the epinephrine levels may have played a role in the improvement of the blood circulation of the patients after the treatment.

Key terms: dopamine, epinephrine, norepinephrine, skin temperature.

Disorders of the sympathoadrenal system, as measured by the concentration of plasma and urinary catecholamines, have been reported in workers who use vibrating tools and in patients with vibration syndrome (4, 5, 7). Local vibration stimuli may cause a decrease in skin temperature (3) and reduced circulation volume of the blood supplied to the fingers (6). Dose-response relationships have been reported between in vitro and in vivo vibratory stimulations and norepinephrine in the excised femoral arteries of dogs and rats (2). Only limited information is available, however, on the effectiveness of hospital treatment on sympathetic nervous system activity when catecholamines are measured. The present study examines changes in catecholamine concentrations in plasma and urine. Skin temperature and nail compression tests at room temperature, and recovery rates for the same tests after cold provocation at 5°C were used as estimations of autonomic nervous system activity and blood circulation in patients before and after five weeks of hospital treatment. With these methods the effectiveness of the hospital treatment of patients with vibration syndrome was evaluated.

Material and methods

Twenty-three male and 12 female patients with vibration syndrome were the subjects of this study. The

average age of the patients was 54 years. Their mean latency interval of vibration tool operation time before the development of vibration disease was 12 years. According to the Japanese Labour Ministry classification system the stages of their disease were CII and CIII. The five-week hospital treatment consisted of exercise and physiotherapy, including hot bath treatments and an intravenous drip injection of 200 mg of adenosine 5'-triphosphate (ATP) in a 5 % glucose solution of 500 ml every day. A urine sample was collected once a day, and blood samples were collected four times a day at 0700, 1330, 1600, and 2100 for two consecutive days each week, including two weeks before and after the treatment. The plasma and urine samples were prepared according to Anton's method (1). Catecholamines were measured by high-performance liquid chromatography using the trihydroxyindole method (Shimazu, type LC-1 and 3, RF-500, Japan).

The recovery rates of alumina extraction were between 57 and 66 %. The limit of sensitivity for the assay was 10 pg/ml for norepinephrine and epinephrine and 500 pg/ml for dopamine. The intra- and interassay coefficients of variation were 6.1 % and 7.5 % (maximum), respectively. For the statistical evaluation of the data, the paired t-test and linear regression analysis were used.

Results

After five weeks of hospital treatment the following results were seen. There was a tendency for the plasma norepinephrine to decrease in the female patients but not in the male patients (table 1). The plasma

¹ Department of Hygiene and Preventive Medicine, Hokkaido University School of Medicine, Sapporo, Japan.

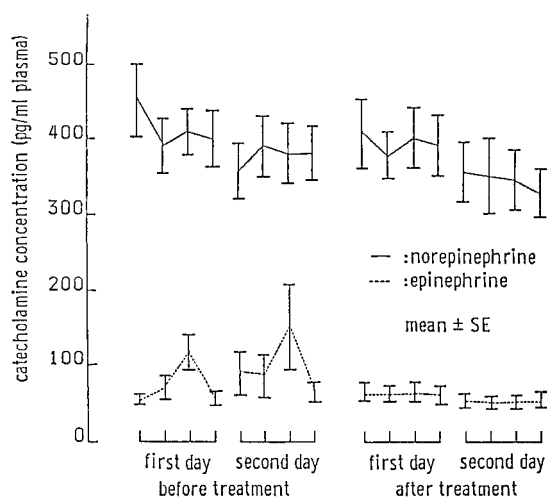
Reprint requests to: Dr K Saito, Department of Hygiene and Preventive Medicine, Hokkaido University School of Medicine, Sapporo 060, Japan.

Table 1. Comparison of the examination results before and after the hospital treatment of patients with vibration syndrome.

Item	Number	Before treatment		After treatment	
		Mean	Standard error of the mean	Mean	Standard error of the mean
Plasma norepinephrine (pg/ml)					
Men	21	404.4	37.5	421.3	39.2
Women	12	344.2	39.8	266.1	128.4*
All subjects	33	383.6	28.8	368.0	31.1
Plasma epinephrine (pg/ml)					
Men	22	92.4	21.2	66.5	7.9
Women	12	96.1	36.3	46.1	5.6*
All subjects	34	93.7	18.6	59.3	5.7**
Free urinary dopamine (μ g/d)					
Men	22	240	25	200	26
Women	12	203	50	173	27
All subjects	34	226	23	191	19
Total urinary dopamine (μ g/d)					
Men	22	914	138	468	36**
Women	12	755	198	705	175
All subjects	34	858	108	552	67**
Free urinary norepinephrine (μ g/d)					
Men	21	39.5	4.9	42.1	3.8
Women	12	46.7	15.6	38.7	7.4
All subjects	33	41.8	6.4	40.8	3.6
Total urinary norepinephrine (μ g/d)					
Men	21	133.0	15.9	117.2	12.5
Women	12	115.1	25.6	112.9	26.9
All subjects	33	126.5	13.8	115.7	12.4
Free urinary epinephrine (μ g/d)					
Men	23	8.3	0.9	6.4	0.9
Women	12	6.5	0.3	4.0	0.9
All subjects	35	6.8	0.7	5.6	0.6
Total urinary epinephrine (μ g/d)					
Men	23	15.2	2.0	11.6	1.8
Women	12	7.7	1.8	11.7	2.4
All subjects	35	12.6	1.5	11.2	1.4
Skin temperature recovery ^a (%)					
Men	21	60.9	3.2	65.4	3.5
Women	11	68.3	4.6	77.5	5.5**
All subjects	33	63.5	2.7	69.5	3.0*
Nail compression test recovery ^a (%)					
Men	21	116.4	6.3	112.6	4.9
Women	11	122.1	9.8	101.9	3.3*
All subjects	33	118.3	5.2	109.0	3.4

^a Recovery had occurred 5 min after the cold provocation test.* $p < 0.10$, ** $p < 0.05$.

epinephrine concentration of all the patients showed a significant decrease (table 1). The standard deviation of the plasma epinephrine concentration was lower (figure 1). The total dopamine excretion showed a significant decrease (table 1). Significant correlation coefficients (r) ($p < 0.05$) of the free urinary catecholamines were observed ($N = 31$, norepinephrine versus epinephrine $r = 0.4588$, norepinephrine versus dopamine $r = 0.4498$, epinephrine versus dopamine $r = 0.4607$). The recovery rates of the skin temperature after cold provocation showed a tendency to increase (table 1).

**Figure 1.** Comparison of the plasma catecholamine concentration before and after the hospital treatment of patients with vibration syndrome.

Discussion

An improvement in skin temperature produced by hospital treatment has been reported in the literature (8). Our results showed the same improvement of skin temperature recovery rates in the fingers after cold provocation. The relationships between various kinds of physical or mental stress and activity of the sympathoadrenal system, as measured by urinary excretion (9) and plasma concentrations (10) of norepinephrine, epinephrine, and dopamine have been reported. An unstable state of the plasma epinephrine concentration was observed before the treatment in this experiment. This phenomenon may simply reflect the stress of hospitalization. Two consecutive days were used for taking samples in each period to avoid this effect, but the samples taken on these two days were similar (figure 1). The stable state of the plasma epinephrine may relate to the pathogenesis of vibration disease per se.

A high concentration of plasma norepinephrine and urinary dopamine was observed in the patients before the hospital treatment. After treatment these indices were lower. These data confirm the results of Lutai's report on urine samples (5). Circulating dopamine participates in the general sympathetic response only when the adrenal component is maximally activated (10). The decrease in the dopamine level after treatment may well indicate the return of the system to a stable state.

Norepinephrine responds mainly to physical activity and cold stressors (9). Since the physical activity and room temperature of the subjects were similar, the decrease in epinephrine of the female patients may show a smooth circulation of blood flow. These results and observations of urinary-balanced catecholamine

excretion indicate that a stable state of the sympathoadrenal system appeared in the patients with vibration syndrome after five weeks of hospital treatment.

References

1. Anton NA, Sayre DF. A study of the factors affecting the aluminum oxide-thrihydroxylindole procedure for the analysis of catecholamines. *J Pharmacol Exp Ther* 138 (1962) 360—375.
2. Azuma T, Ohhashi T, Sakaguchi M. Vibration-induced hyperresponsiveness of arterial smooth muscle to noradrenaline with special reference to Raynaud's phenomenon in vibration disease. *Cardiovasc Res* 12 (1978) 758—764.
3. Iwata H, ed. Body reaction by vibration. In: *Vibration syndrome*. Kindaishuppan Ltd, Tokyo 1974, pp 21—35.
4. Krasavina TS, Volkova TN, Gornik VM. Functional condition of the sympatho-adrenal system in patients with late stages of vibration disease. *Klin Med (Moscow)* 55 (1977) 77—80.
5. Lutai AB. Condition of catecholamine metabolism in patients with vibration disease. *Gig Tr Prof Zabol* 15 (1971) 45—48.
6. Makarenko NA. Vegetative nervous system in patients with vibration disease. *Gig Tr Prof Zabol* 13 (1969) 51—52.
7. Miyashita K, Shiomi S, Itoh N, Kasamatsu K, Iwata H. Epidemiological study of vibration syndrome in response to total hand-tool-operating time. *Br J Ind Med* 40 (1983) 92—98.
8. Saito K. Experimental studies on balneotherapy of local vibration hazards as an occupational disease. *Onsenkagaku* 23 (1972) 107—108.
9. von Euler US. Quantification of stress by catecholamine analysis. *Clin Pharmacol Ther* 4 (1964) 398—404.
10. Woolf PD, Akowuah ES, Lee L, Kelly M, Feible J. Evaluation of the dopamine response to stress in man. *J Clin Endocrinol Metab* 256 (1983) 246—250.