Arh. hig. rada toksikol., **30** (1979) suppl. pp. 1271–1280.

OCCUPATIONAL FINGER TREMOR AND ITS DOMINANT FOCUS IN FEMALE CASH REGISTER OPERATORS

G. UMEDA

Research Institute Kitakyusyu Simin Kogai Kenkyusyo, Kitakyushu, Japan

ABSTRACT

Occupational finger tremor was an important physical sign of health hazard in checkers (cash register operators). The study included three hundred and twenty-six female checkers, 44 female students as controls, 43 female bank clerks, and a cohort of female typists. The average rate of tremor prevalence in checkers was 27.0%, and it increased in proportion to the severity of occupational cervicobrachial disorders. The tremor was caused by work loads and a single-handed operation of machine. The reductions of work loads decreased the prevalence to 7.4%, but a high speed operation of machine constituted a cause of tremor, on the contrary. The incidence rate of occupational cervicobrachial disorders in checkers who handled a machine with a single hand was estimated at 9.3% by person-years observation, and it was higher than in typists (5.3%) handling a mechanical typewriter with both hands. The most characteristic feature of tremor was that it was provoked by some indifferent agents such as mental strain, cool ambient air, humidity, etc. The incidence rate of the tremor provoked by these agents was estimated at 54.5% in 22 hospitalized patients. These cases revealed that a latent dominant focus may be formed in the higher parts in the central nervous system. Rolando's EEGs showed an increased excitability reinforced by light flickering, and the skin temperature reaction of blood vessel had an oscillation specific to the disturbances of the hypothalamus. The tremor was extremely resistant to the therapy, and persisted for a long time. The therapy should aim at restoring peripheral blood circulation, depressing muscle pain, and at a rehabilitation activity.

Finger tremor was an extremely important physical sign of occupational cervicobrachial disorders in female cash register operators. The tremor was observed even in the operators who did not complain of any subjective symptoms of the disorders. The tremor began to appear more frequently with the development of a pathological process in the neck-shoulder-arm region. Accordingly, the tremor may be recognized as being an essential parameter of health hazard.

A characteristic feature of the tremor was that it was extremely resistant to the therapy and could be induced by agents indifferent to work loads. Particularly the provocation of tremor by indifferent agents such as a change in temperature, excessively cool room temperature, irritation, rage, etc. suggested to the author the presence of a dominant focus in the central nervous system.

However, it was extremely difficult to investigate the dominant focus except by adopting a neurosurgical approach. Therefore, an epidemiological approach was used and clinical investigations were made in cash register operators, bank clerks, students as controls, and a cohort of typists. The results obtained have provided a basis for a follow-up study and for a solution of occupational health problems in this country.

SUBJECTS AND METHODS

Three hundred and twenty-six female cash register operators (hereinafter referred to as checkers) with a mean age 22 years (range 19–27) were divided into 3 groups after a routine medical examination for occupational cervicobrachial disorders. Group A, comprised 188 checkers, without complaints, of whom 35 had tremor. Group B, included 85 checkers, who needed health consultations and considerable reductions of work loads, 27 of them with tremor. In Group C, which comprised 53 patients with classical disorders, 26 demonstrated a typical tremor.

Forty-four female students with a mean age 19 years (range 18–20 years) served as controls. Forty-three female bank clerks with a mean age 20 years (range 18–22 years) whose working conditions were different from those of the checkers were also investigated, none of them having any tremor. A cohort of 40 female typists (18 to 36 years of age) was selected for a comparative study on the prevalence of tremor.

Observations of finger tremor were made in the subjects at rest with eyes closed and in a sitting position with the upper extremities extended upward and forward. Macroscopically recognized pathological tremor was marked with a positive sign, and in some cases the tremor was recorded by a microvibration pick-up equipped with an electrocardiograph in order to analyse the tremor under the same conditions as above.

Subjective symptoms were studied by the use of the questionnaire proposed by the Committee of Cervicobrachial Disorders of the Japanese Association of Industrial Health and Cornell Medical Index by Brodman.

Peripheral circulatory reaction to extreme cold was investigated by the method of Yoshimura[9]. The right middle finger tip was dipped into ice water (0 °C) for 30 minutes, and the skin temperature of the back of the finger tip was recorded every minute after immersion.

Electroencephalographic study was performed by the method of Gastaut[2], and Rolando's EEGs were recorded. Responses to the light flickering of 3, 6, 9, 12 and 15 Hz were analysed by the frequency analyser and by the function of D (f).

RESULTS

Tremor prevalence and its characteristics

The intensity of tremor was graded as follows: no tremor (−), slight tremor (±), moderate tremor (+), and intense tremor (++). Slight tremor was excluded from the present study, because it was not always considered as pathological. Both moderate and intense tremor were considered as pathological in nature. The rate of tremor prevalence in all 326 checkers was 27.0%, and that in Groups A, B and C was calculated as 18.6%, 31.8%, and 49.1%, respectively. However, there were no cases of tremor either among controls or bank clerks; a case of tremor was demonstrated in the cohort of typists.

The picture of tremor recorded by a microvibration pick-up is shown in Figure 1. The tremor frequency was about 10 – 12 Hz, and it was accompanied by fluctuations. Macroscopic observations did not detect a difference in tremor between the fingers of the right and left hand, but there was an obvious difference between the right finger tremor and the left one.

FIG. 1 – Moderate tremor recorded by MV pick-up equipped with electrocardiograph. The picture demonstrates moderate tremor with rhythmical waxing and waning fluctuations. The patient, a 24--year-old female, suffered from tremor for over one year.

A characteristic feature of the tremor in checkers was its provocation by some trigger agents which were originally indifferent to work loads, for example, keeping on writing letters, holding a glass in hand, combing hair, etc. Mental strain, emotional stress such as irritation, rage, fall in temperature, cool ambient air, etc were also apt to provoke or aggravate tremor.

The tremor provoked by such indifferent agents was frequently observed in 12 out of 22 hospitalized patients from Group C. It was impossible to make a continuous investigation in all checkers over a long period of time, but it may be presumed on the basis of the above mentioned incidence that the actual prevalence rate of tremor in checkers might exceed the tremor rates in particular groups.

There was a significant correlation between the prevalence rate of tremor and the incidences of subjective symptoms, and the prevalence rate increased in proportion to the severity of disorders. The correlation coefficient was 0.96 and it was statistically significant ($p < 0.01$).

Incidences of subjective symptoms

Subjective symptoms were studied by the use of a questionnaire consisting of 30 questions. As shown in Table 1, questions Nos 1 – 11 related to the complaints of the upper extremities, questions Nos 12 – 14 to those of the lower extremities, questions Nos 15 – 20 to those of the autonomic nervous activity, and finally questions Nos 21 – 30 to those of the central nervous activity.

The incidences of complaints in subjects sampled at random from each group are shown in Table 1. Increase in the incidence rate of subjective symptoms of the upper extremities reflected cumulative neuromuscular fatigue which was an essential cause of health hazards. Clinical pictures of occupational cervicobrachial disorders reflected a decrease in grasping power, pinch power, and back strength, and pains in the neck-shoulder-arm regions, stiff shoulder, numbness of the arms and hands.

TABLE 1

Comparison of incidences (n and %) of subjective symptoms in female checkers with those in female students as controls and female bank clerks.

No.	Subjective symptoms	Controls (N = 18)		Bank clerks (N = 13)		Checkers					
						Group A (N = 19)		Group B (N = 18)		Group C (N = 15)	
		n	%	n	%	n	%	n	%	n	%
1.	difficulty in making a bed	0	0	0	0	0	0	1	5.7	9	60.0**
2.	difficulty in combing hair	0	0	0	0	0	0	3	16.7**	6	40.0**
3.	difficulty in holding a telephone receiver	0	0	0	0	2	10.5	2	11.1	5	33.3**
4.	difficulty in carrying a handbag	0	0	0	0	0	0	3	16.7**	6	40.0**
5.	difficulty in wringing a wet towel	0	0	0	0	0	0	3	16.7**	2	13.3
6.	difficulty in writing letters	1	5.6	2	15.4	3	15.8	10	55.6**	13	86.7**
7.	difficulty in eating fish with chopsticks	0	0	0	0	0	0	3	16.7**	1	6.7
8.	difficulty in paring a fruit	0	0	0	0	0	0	0	0	1	6.7
9.	often dropping things	0	0	0	0	1	5.3	3	16.7**	5	33.3**
10.	waking up at night due to a dull pain	0	0	0	0	2	10.5	3	16.7**	3	20.0*
11.	difficulty in buttoning up	0	0	0	0	0	0	0	0	0	0
12.	difficulty in descending the stairs	0	0	1	7.7	0	0	2	11.1	6	40.0**
13.	often stumbling	1	5.6	1	7.7	1	5.3	2	11.1	3	20.0
14.	feeling tired after a little walk	0	0	1	7.7	0	0	5	27.8**	8	53.3**
15.	cannot bear keeping hand in cold water	0	0	1	7.7	0	0	1	5.7	3	20.0*
16.	feeling unwell in bad weather	0	0	2	15.4	4	21.1*	5	27.8**	4	26.7*
17.	cannot bear being in an air-cooled room	0	0	1	7.7	1	5.3	3	16.7**	3	20.0*
18.	feeling unwell when exposed to wind	0	0	0	0	0	0	0	0	0	0
19.	not minding too hot a bath	1	5.6	0	0	1	5.3	2	11.1	5	33.3
20.	not feeling hot when everybody feels hot	0	0	0	0	0	0	0	0	2	13.3
21.	difficulty in falling asleep	0	0	0	0	3	15.8	8	44.4**	10	66.7**
22.	having unpleasant dreams	0	0	0	0	1	5.3	0	0	0	0
23.	feeling drowsy	2	11.1	0	0	4	21.1	4	22.2	4	26.7
24.	unable to read for long	0	0	1	7.7	6	31.6	5	27.8**	10	66.7**
25.	often failing to hear other people	0	0	1	7.7	2	10.5	1	5.7	3	20.0*
26.	feeling tired in having a talk	0	0	0	0	0	0	2	11.1	3	20.0*
27.	getting tired watching television	0	0	0	0	0	0	5	27.8**	9	60.0**
28.	feeling painful in the sitting position	1	5.6	4	30.8	3	15.8	10	55.6**	9	60.0**
29.	wanting to lie down at leisure time	2	11.1	4	30.8	9	47.4*	10	55.6**	14	93.3**
30.	feeling gloomy due to a physical pain	0	0	0	0	1	5.3	2	11.1	8	53.3**

Checkers were divided by the routine examination into three groups A, B and C. Group A was normal, Group B needed health consultation and considerable reductions of work loads. Group C had occupational cervicobrachial disorders. N is the number of samples collected at random from each group.n is the number of the answer "YES", % expresses an incidence rate of subjective symptoms.

* and ** show statistically significant differences ($p < 0.05$ and $p < 0.01$, respectively). Questions No. 1 to No. 11 relate to complaints of the upper extremities, No. 12 to No. 14 to those of the lower extremities, No. 15 to No. 20 to those of the autonomic nervous activity, and finally No. 21 to No. 30 to those of the central nervous activity.

Subjective symptoms, particularly those of the upper extremities and the central nervous activity tend to increase in proportion to the severity of the disorders.

Incidences of subjective symptoms of the autonomic and central nervous activity also considerably increased, and were accompanied with such clinical findings as abnormal palmar perspiration, changes in skin temperature, painful menstruation, difficulty in falling asleep, easy irritability, sleep disturbances, etc.

General and systematic subjective symptoms were investigated by the use of Brodman's Cornell Medical Index. Twenty samples from each of the 4 groups, including controls, Groups A, B and C of the checkers, were collected on a random basis. Incidences of complaints were compared, and significant differences between controls and checkers ($p < 0.05$ or $p < 0.01$ by χ^2 test) were obtained in answers to 26 of the 200 questions.

Table 2 shows that many kinds of subjective symptoms other than those of neuromuscular fatigue reflected complex pathology of occupational cervicobra-

TABLE 2

Comparison of incidence of systematic subjective symptoms in checkers with those in female students as controls by the use of Cornell Medical Index by Brodman.

No.		Questions	Controls N = 20		Checkers Group A (N = 20)		Checkers Group B (N = 20)		Checkers Group C (N = 20)	
			n	%	n	%	n	%	n	%
A	3	Do you often have bad pains in your eyes?	1	5	7	35*	9	45**	11	55**
	6	Are your eyes often red or inflamed?	1	5	5	25	8	40**	12	60**
B	17	Do you frequently suffer from heavy chest colds?	4	20	3	15	11	55**	11	55**
	18	When you catch a cold, do you always have to go to bed?	0	0	2	10	7	35**	8	40**
C	36	Are your ankles often badly swollen?	1	5	0	0	8	40**	8	40**
D	48	Do you often suffer from an upset stomach?	4	20	8	40	13	65**	14	70**
D	51	Are you often sick to your stomach?	1	5	3	15	12	60**	13	65**
	53	Do severe pains in the stomach often double you up?	2	10	5	25	9	45**	13	65**
	60	Do you constantly suffer from bad constipation?	4	20	10	50*	9	45*	12	60**
F	72	Is your skin very sensitive or tender?	1	5	9	45**	10	50**	11	55**
	76	Are you often bothered by severe itching?	4	20	4	20	12	60**	10	50*
G	79	Do you suffer badly from frequent severe headaches?	1	5	4	20	6	30*	11	55**
	80	Does pressure or pain in the head often make life miserable?	0	0	3	15	7	35**	10	50**
	83	Do you often have spells of severe dizziness?	3	15	6	30	14	70**	14	70**
H	97	Have your menstrual periods usually been painful?	10	50	15	75*	16	80*	19	95**
	98	Have you often felt weak or sick with your periods?	3	15	10	50**	16	80**	13	65**
	100	Have you usually been tense or jumpy with your periods?	3	15	10	50**	13	65**	18	90**
I	108	Do you often get spells of complete exhaustion or fatigue?	6	30	16	80**	15	75**	16	80**
	109	Does working tire you out completely?	2	10	6	30	12	60**	15	75**
J	121	Do you wear yourself out worrying about your health?	0	0	2	10	6	30**	8	40**
L	139	Do you usually have great difficulty in falling asleep or staying asleep?	4	20	5	25	10	50*	13	65**
M	149	Must you do things very slowly in order to do them without mistakes?	2	10	8	40*	9	45**	10	50**
Q	179	Do you always do things on sudden impulse?	2	10	9	45**	10	50**	7	35*
	182	Do little annoyances get on your nerves and make you angry?	4	20	4	20	10	50*	12	60**
	186	Do you often get into a violent rage?	2	10	1	5	8	40*	8	40*
R	191	Do you become scared at sudden movements or noises at night?	1	5	5	25	12	60**	6	30*

Twenty samples from each of 4 groups were collected at random. N is the number of samples. n is the number of the answer »YES«, and "%" expresses an incidence rate of subjective symptoms. * and ** show statistically significant differences at levels of $p < 0.05$ and $p < 0.01$ by χ^2 test, respectively.

As is evident from Table 2, occupational cervicobrachial disorders are accompanied with disturbances of several important organs except the autonomic and central nervous system, for example, digestive organ, internal secretion, etc.

chial disorders. Disturbances in sensory organs (A 3 and 6), respiratory system (B 17 and 18), blood circulation (C 36), digestive organs (D 48,51,53 and 60), skin (F 72 and 76), nervous system (G 79,80 and 83), particularly internal secretion (H 97,98 and 100), and suffering from fatigability (I 105 and 109) and neuropsychological stress (M 149, Q 179, 182, 186 and R 191) were noticeable in the clinical picture. Moreover, clinical experience revealed that the prevalence of such disturbances was higher in checkers than in young female workers other than checkers, for example, clerks, typists, telex operators, telephone operators, key punchers, etc.

Peripheral circulatory reaction to extreme cold

The temperature reaction of blood vessel to extreme cold was studied by the method of Yoshimura in order to clarify changes in the autonomic nervous activity. Twenty-one subjects were sampled on a random basis from each of the groups of bank clerks and checkers comprising Groups B and C.

Oscillatory changes in the temperature reaction of peripheral blood vessels as shown in Figure 2 were demonstrated in 13 checkers and in 3 bank clerks. The analysis of the oscillatory curves by the mathematical model proposed by Kishikawa and Umeda[3] suggested that the oscillatory changes in the temperature reaction of blood vessels may be induced not only by arteriovenous anastomosis, but also by the vegetative and central nervous system.

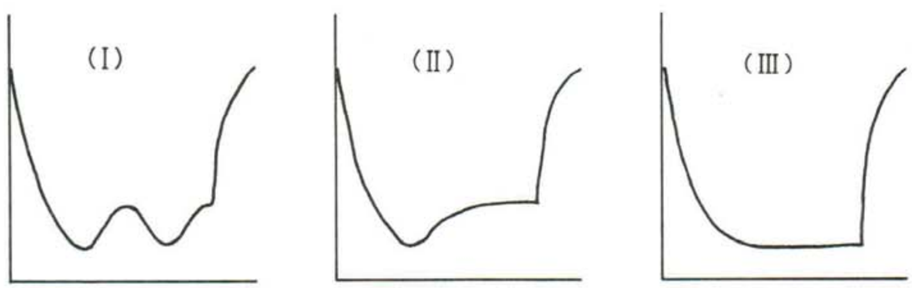

FIG. 2 – Patterns of the skin temperature reaction of blood vessel. The reaction was divided by a mathematical model into three patterns as follows: oscillatory (I), intermediate (II), and non--oscillatory (III) pattern. Twenty-one patterns were sampled at random from checkers and bank clerks. Pattern (I) had 13 checkers and 3 bank clerks, pattern (II) 6 and 6, respectively, and pattern (III) 2 checkers and 12 bank clerks. Pattern (I) is closely related to the disturbances of the autonomic nervous system.

Electroencephalographic findings

Rolando's EEGs were observed in 23 checkers in total, including 5 with a typical tremor, 12 with a slight tremor and 6 without tremor. Changes in the distribution of α-, β_1- and β_2 waves under photic stimulations at any frequency were analysed by the function of D(f) and linear regression. The intensity of tremor was correlated with changes in the distribution of each wave. The function of D(f) was defined by the following equation:

$$D(f) = \sqrt{\frac{A(\alpha,\ f,\ R) - A(\alpha,\ f,\ L) + \ldots + A(\beta_2,\ f,\ R) - A(\beta_2,\ f,\ L)}{3}}$$

where $A(\alpha,f,R)$ denotes the height of the right α wave integrated by a frequency analyser under the effects of light flickering of f-Hz.

The value of D(f) at rest was put as D(0). Linear regression equations were:

$$D = 0.0377\ f + 1.488\ (\text{Tremor} -)$$
$$D = 0.0896\ f + 1.587\ (\text{Tremor} \pm)$$
$$D = 0.1333\ f + 1.543\ (\text{Tremor} +)$$

Differences between the right and left under the effects of light flickering of 12- and 15 Hz were obvious, and the excitability of the left hemisphere was higher than of the right one.

Preventive counter-measure

It was presumed that occupational tremor might be induced mainly by two causative agents: heavy loads on the right finger tips and arm, and single-handed machine operation.

Physical load on a finger tip was estimated by Nishiyama[4] at about 1 476 to 10 080 kg per an eight-hour working day. Machine operating under these conditions was easily bound to bring about neuromuscular fatigue and formed the cause of occupational cervicobrachial disorders as well as of tremor.

In order to diminish physical loads on fingers and arms new machines were given to 68 healthy workers who had no history of occupational health hazards. The machines were electronic desk computers.

The incidence rate of tremor in these 68 subjects was estimated at 7.35%, and the rate in 246 checkers who handled an electric register was calculated as 19.73% by person-years observation.

A single-handed operation of machine was also a serious cause of tremor. There was only one case of tremor in the cohort of typists who handled a mechanical typewriter with both hands. The incidence rate of occupational cervicobrachial disorders in checkers was compared with that in typists, and an evident difference was obtained. The rate in checkers was estimated at 9.3%, and that in typists 5.3% by person-years observation.

DISCUSSION

Clinical pictures of finger tremor in checkers showed two components: postural tremor and intention tremor. They also showed fluctuations with rhythmical waxing and waning similar to those in EEG. The findings did not resemble any tremor originating from organic neurological abnormalities for example, parkinsonism. In fact, all subjects in the present paper had no history of a neurological disease or thyroidism.

On the basis of observations on head injury Ohye[5] suggested that tremor might be induced by muscular fatigue. Moreover, he explained a role of the cortical motor area and reticular formation in the induction of tremor.

As an important factor of occupational cervicobrachial disorders muscular fatigue might also be a cause of tremor. However, it was impossible to explain the provocation of tremor by indifferent agents. Clinical experience has shown a possibility to detect an essential mechanism of tremor other than muscular fatigue.

Finger tremor observed in checkers appeared even when they were writing letters, holding a glass in hand or combing hair in daily life with the exception of work loads. Frequently tremor could also be observed during considerable reductions in working hours or after the prohibition of work loads. Particularly, it was very noticeable that neutral agents such as irritation, rage, cool ambient air, fall in temperature and high humidity provoked tremor.

It was therefore concluded that a dominant focus such as increased excitability may be formed in the central nervous system and play a role of trigger in inducing tremor.

Incidences of subjective symptoms related to the disturbances of the autonomic and central nervous system as shown in Tables 1 and 2, clinical findings such as abnormal palmar perspiration, difficulty in falling asleep, oscillatory response of peripheral blood vessels, and an increase in the prevalence rate of tremor in proportion to the severity of disorders, all of these evidently showed that tremor was closely associated with the disturbances in the hypothalamus, limbic system and cerebral cortex, and that a latent dominant focus was formed in these regions including reticular formation as Anokhin[1] described.

Rusinov[6] succeeded in experimentally forming a dominant focus in the hypothalamus of the rabbit, and observed some changes in heart beats, blood pressure, and respiration. He reported a characteristic electroencephalographic response induced by proper electrical stimuli during neurosurgical operation in a patient with a brain tumour. He concluded that brain tumour might have a nature of a dominant focus.

Although peripheral circumstances satisfactorily explained the formation of a dominant focus in the central nervous system, it was really difficult to prove the existence and the site of the focus except by a surgical approach. Therefore, an electroencephalographic study was made. Gastaut and co-workers[2] reported that conditioned response in the left Rolando's EEG was formed on the basis of grasping the right hand as unconditioned stimuli and that generalization of excitation over the contralateral region was noticed during conditioning.

Machine operating requires conditioned behaviour and operant conditioning from the viewpoint of brain physiology. Simultaneously, a stable behaviour must be based on a dominant focus which plays a proper role in maintaining a working posture, on accurate handling of machine and wakefulness.

Linear regression analysis clarified an obvious correlation of the intensity of tremor with an increase in excitation under photic stimulations. However, the increased excitation of the left Rolando's area during photic stimulations never evoked finger tremor. According to the experimental study of Sokolova[7], it should be considered as a reinforcement of a latent dominant focus by light flickering. Light flickering itself was a model of indifferent agent. Increase in the excitation level of Rolando's area under photic stimulations might explain neurophysiological characteristics of the focus established.

On the basis of clinical experience the author has defined "latent dominant" as an increased excitability not accompanied by tremor. In animal experiment Anokhin reported that a latent dominant focus might be formed in the adrenergic part of reticular formation[1]. It may be concluded from what has been discussed above, that the dominant focus is localized in the space including reticular formation, hypothalamus, limbic system, and cerebral cortex. Moreover, it may be concluded that tremor can be induced by reinforcing the focus and generalizing excitation under the influence of suitable trigger agents.

The tremor was extremely resistant to treatment and persisted for a long time. In some cases it frequently appeared over a period of one year. Yamaguchi and Hori[8] could observe a pathological dominant focus in the rabbit which persisted over 100 days. The dominant focus as a background of occupational tremor and cervicobrachial disorders may be identified with the pathological one. The treatment consisted of acupuncture, physical exercise, paraffin bath, hot pack, hot bubble bath, and sufficient rest. The treatments were necessary to the restoration of blood circulation, the depression of pains in musculature, and the recovery of working ability. Above all, physical exercise was especially important and effective in the treatment of tremor.

CONCLUSION

Finger tremor was an important physical sign of occupational cervicobrachial disorders in female cash register operators. The tremor might be caused by heavy work loads on the right neck-shoulder-arm regions and by single-handed machine operation.

The tremor was induced even at an early stage when workers had no subjective complaints, but its prevalence increased in proportion to the severity of the disorders.

By preventive counter-measures, reduced work loads and substitution of electronic for electrical machines a decrease in the prevalence of tremor was obtained. However, the use of electronic machines which operate at a high-speed was also a cause of tremor.

The provocation of tremor by some indifferent agents such as irritation, rage, cool ambient air, humidity, etc. was a characteristic feature of its pathology. The experience showed that a latent dominant focus may be formed in reticular formation, hypothalamus, limbic system, and cerebral cortex.

The tremor was extremely resistant to treatment, and persisted for longer than one year. In order to obtain a satisfactory recovery of cervicobrachial disorders as well as tremor the therapy should aim at the extinction of the dominant focus.

REFERENCES

1. *Anokhin, P.K.* Biology and Neurophysiology of the Conditioned Reflex and Its Role in Adaptive Behavior, Pergamon Press, Oxford, 1974, p. 460.
2. *Gastaut, H., Jus, A., Morrell, F., Storm, V.L.W., Bekkering, D., Kamp, A. and Werre, J.* Electroencephalographic characteristics of the formation of conditioned reflexes in man. Zh. Vyssh. Nervn. Deyat. Im. I.P. Pavlova, **7** (1957) 25–38.
3. *Kishikawa, Y. and Umeda, G.* Relation between working behavior and clinical pictures of neck--shoulder-arm disorders (Part II). Analysis of changes in peripheral circulatory dynamics. Abstract of 48th Congress of Japanese Association of Industrial Health, 1975 p. 360–361.
4. *Nishiyama, K.* Working conditions of checkers and their health hazards. Report of the Committee of National Labor Union of Chain Stores, 1973, p. 25.
5. *Ohye, C.* Clinical picture and a basis of tremor. Rinsho Seiri, **4** (1974) 7–15.
6. *Rusinov, V.S.* Electrophysiological investigation into sites of stationary excitation in the central nervous system. Zh. Vyssh. Nervn. Deyat. Im. I.P. Pavlova, **8** (1958) 473–481.
7. *Sokolova, A.A.* Electrical activity of the optical and motor regions of the cerebral cortex in rabbits during reinforcement of the dominant site in the motor region by light stimulations. Zh. Vyssh. Nervn. Deyat. Im. I.P. Pavlova, **8** (1958) 593–601.
8. *Yamaguchi, K. and Hori, Y.* Long lasting retention of cortical dominant focus in rabbit. Med. J. Osaka Univ., **26** (1975) 39–50.
9. *Yoshimura, H. and Iida, T.* Studies on the reactivity of skin vessels to extreme cold. Part I. A point test on the resistance against frost bite. Jpn. J. Physiol., **1** (1950) 147–159.