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A COMPARATIVE STUDY OF VIBRATION HAZARDS AMONG OPERATORS OF VIBRATING TOOLS IN CERTAIN INDUSTRIES

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ABSTRACT

At the time when no measures were yet taken to prevent vibration hazards for operators of chain-saws, rock-drills, and chipping hammers, a study was made on the occurrence and nature of vibration hazards, and on factors in their progression. It seems that when the vibrating energy exceeded a certain level, the waxy white attacks appeared earlier. The area of the waxy white attack can be seen in the parts directly exposed to vibration, and the frequency of the waxy white attack of hands and fingers seems to be influenced mainly by the level of coldness of the body when operating vibrating tools. It seems that the incipient numbness of hands and fingers in early times was influenced more by the exposure to a cold environment than by the level of the vibration energy itself. It seems that the effects on the circulatory system were largely due to the level of the vibration energy at middle to high frequency, and the effects on the nervous system, to the level of the vibration energy at low to middle frequency.

In recent years, with the development of industries in Japan, the use of mechanized tools has greatly extended and, as a consequence, the occurrence of vibration hazards has remarkably increased. However, the vibration disease caused by these mechanized tools is not uniform as regards their occurrence, so that a comparative study of vibration hazards among operators using various sorts of vibrating tools would help towards taking precautionary measures against them.

One of the authors previously made a comparative study of vibration hazards among operators of four types of vibrating tools in certain steel works and it could be established that the vibration disease varied in type[2].

It was also confirmed by the authors that the patterns of the vibratory sensation threshold value made up of three frequencies (250 Hz, 125 Hz and 63 Hz) differ among operators of three kinds of vibrating tools[1].

This report is based on a comparative study both of the occurrence and type of vibration hazards from chain-saws in forestry, leg-typed rock-drills in metal mines and chipping hammers in the iron processing industry, and of the factors causing them.

SUBJECTS AND METHOD

Subjects for the study were workers using vibrating tools: chain-saw A (A Group) – 30 men, chain-saw B (B Group) – 87 men, rock-drill (C Group) – 45 men, and chipping hammer (D Group) – 25 men. Their average age and the years they spent working with vibrating tools are shown in Table 1. The subjects from Group D were about 5 years older than the others, and the exposure was about 4 – 5 years longer in subjects from Groups C and D.

These groups worked in four industrial organizations which were investigated by the authors during the past ten years or so. The investigation was made at a time when no prevention was yet taken against vibration hazards, and there had been few retirements.

First, the working conditions and the commuting conditions of the workers, and the specific characteristics and vibrations of the tools were established for comparison.

Then the workers were subjected to medical examinations. In personal interviews the beginning and development of the waxy white attack, numbness and other complaints were established.

The temperature on the finger skin was measured, the nail press test regarding the peripheral circulatory system[4,5] was carried out, and the threshold of pain sensation and vibratory sensation was established before and after immersing the left hand in cold water for ten minutes[3].

RESULTS AND DISCUSSION

The working and living conditions and commuting methods of the subjects are shown in Table 1, and the specific characteristics and vibrations of the tools in Table 2. The highest vibration energy was produced by the rock-drill, followed by the chipping hammer, chain-saw A, and chain-saw B. The

TABLE 1
Work-and-life conditions and ways of commuting of the examined subjects.

		Group A (forest)	Group B (forest)	Group C (mine)	Group D (iron-works)
Vibrating tools		Chain-saw A	Chain-saw B	Rock-drill	Chipping hammer
No. of subjects		30	87	45	25
Average age		40.8	39.7	39.4	45.1
Vibration	in years	7.2	7.8	12.8	11.7
exposure time	hours/day	3.5	3.5	3.0	3.0
Lodging		5 days a week	5 days a week	None	None
Commuting		Autobicycle	Autobicycle	Lift, walk, automobile	Own car or walking

TABLE 2
Specific character and vibration of vibrating tools.

	Group A	Group B	Group C	Group D
Vibrating tools	Chain-saw	Chain-saw	Rock-drill	Chipping hammer
Type	Rabbit C151E, C151A	Mc-Culloch S-44A, I-380	Leg TY-16	Made at Hiroshima Kógyó, CH-11, N3
Weight with full equipment (kg)	13–15	10–12	27.5	4.5
Vibration*	100–800 Hz	100–800 Hz	20–5000 Hz	Left, 20–5000 Hz
(ref. 0 dB = 10^{-5}cm/s^2)	140–142 dB	135–140 dB	144–157 dB	142–143 dB
Side of hand on handles	Both hands	Both hands	Right hand (left hand on rod)	Right hand (left hand on chisel)
Motive power	Gasoline-engine	Gasoline-engine	Compressed air	Compressed air

*Data of vibration by T. Miwa, S. Yamada, and S. Watanabe

environmental conditions at operation time are shown in Table 3. The degree of coldness during work, with the wind and rain taken into account, was the highest in Group A, followed by Group B, Group D, and Group C.

TABLE 3
Environmental conditions at operation time.

	Group A (forest)	Group B (forest)	Group C (mine)	Group D (iron-works)
Working place with vibrating tool	In the mountain, outdoors	In the mountain, outdoors	In the pits	In the plants
Influence of weather	Wind and rain	Wind and rain	None	Wind
Incline of labourers' footing (degree)	Highest: 35 mean: 20–30	Highest: 30 mean: 15–25	Almost horizontal	horizontal
Average temperature (°C)				
winter	−2–2	−4–1	17–20	−2–2
summer	20–25	20–25	17–20	19–25
Average humidity (%)				
winter	67–78	56–82	90–100	78–82
summer	76–86	68–79	90–100	75–78
Noise level while using the tool (phon)	100–110	100–110	117–118	114–115

The curve of the cumulative number of years of the use of the tools until the beginning of the waxy white attack, which is shown in Figure 1, shows a large incline in the first few years in Groups A, C and D. Thus it seems that the high occurrence ratio of the waxy white attack during the early period of active work may be caused when the vibrating energy exceeds a certain level in these three sorts of tools.

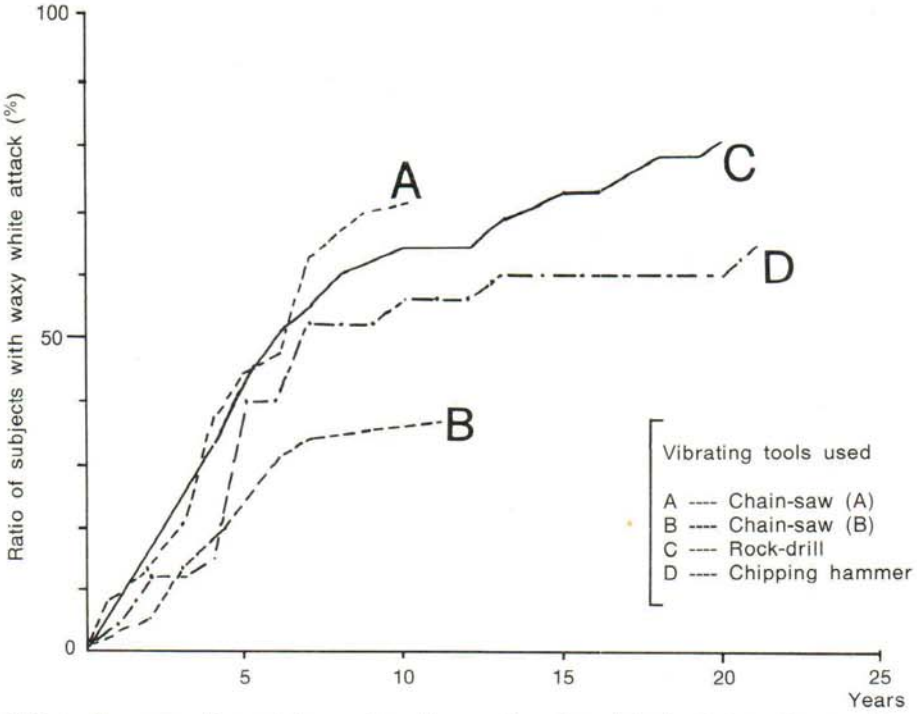

FIG. 1—The curve of cumulative number of years of work until the beginning of waxy white attack of hands and fingers.

The area and frequency of the waxy white attack of hands and fingers are shown in Figure 2. The area of the waxy white attack can be seen in the parts directly exposed to vibration, and the frequency of the waxy white attack of hands and fingers appears to be influenced mainly by the level of the coldness of the body when operating vibrating tools.

The curve of the cumulative number of years of their use until the beginning of the numbness of hands and fingers, which is shown in Figure 3, shows the largest incline in Group A, followed by Groups B, D, and C.

The beginning of numbness was late in appearance among operators of rock-drills, which had the highest vibration energy and in which low frequency was dominant. This seemed to be due to the fact that at this workshop environmental temperature was 17–20 °C throughout the year, while at the others it dropped to −4 – 2 °C in winter. It seems that the beginning of the numbness of hands and fingers in early times was more influenced by exposure to vibration of middle to high frequency in a cold environment than by the level of the vibration energy itself. Moreover, it appeared that with less severe environmental coldness the beginning of the numbness of hands and fingers would aggregate sooner or later when the vibration energy reached an extremely high level.

Vibrating tools (group)			Chain-saw (B)	Rock-drill (C)	Chipping hammer (D)
No. of subjects			87	45	25
No. of sufferers from w.w.a.			33 (100%)	36 (100%)	16 (100%)
Area of w.w.a.	Side of hand	Only right			
		Only left			
		Both			
Frequency of w.w.a.		1~several times a month			
		Several times a week			
		1~several times a day			

0 20 40 60% 20 40 60 80% 20 40 60 80 %

FIG. 2–The area and frequency of waxy white attack (w.w.a.) of hands and fingers.

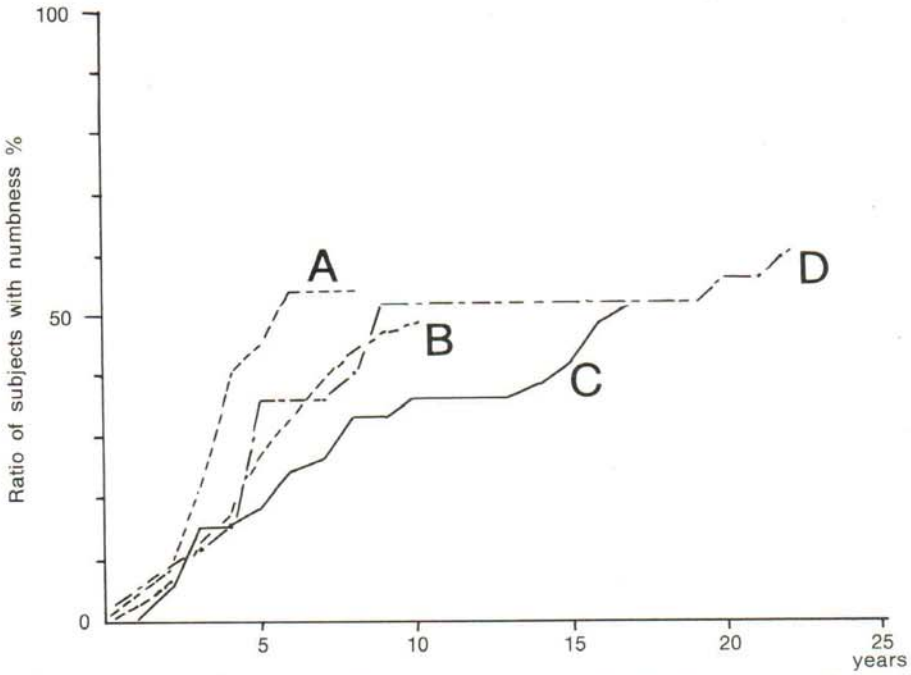

FIG. 3.–The curve of cumulative number of years of work until the beginning of numbness of hands and fingers.

The abnormal findings of the peripheral circulatory system and the peripheral nervous system in the cold water immersion test of one hand are shown in Figure 4. Among the results of the objective examinations of the

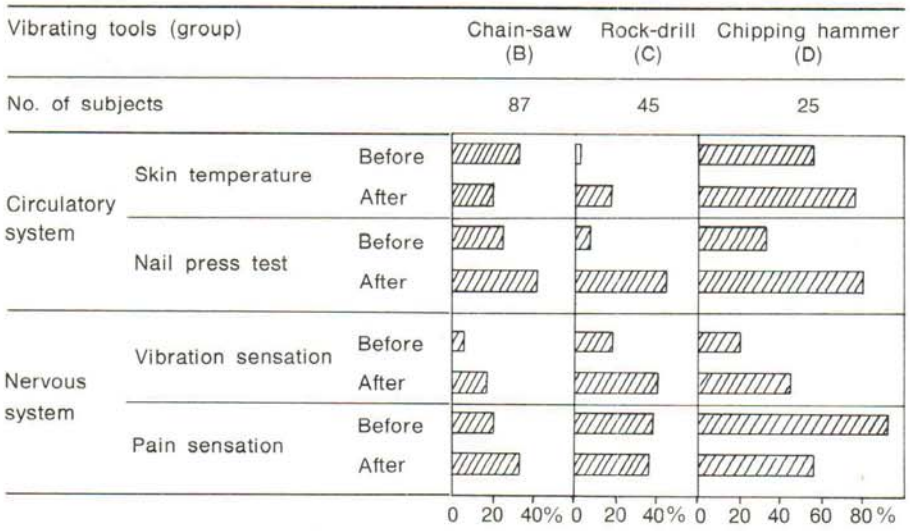

FIG. 4.–Abnormal findings of peripheral circulatory and nervous system before and after cold water immersion test.

peripheral circulatory system the abnormal findings of skin temperature were worst in Group D, to become better in Groups B and C. The difference between Groups B and C was rather large before the cold water immersion, but decreased after the immersion. The abnormal findings of the nail press test showed almost the same tendency as the skin temperature. Among the results of the peripheral nervous system, the abnormal findings of the threshold of pain sensation were worst in Group D, to become better in Groups C and B. The difference between Groups C and B was small. The abnormal findings of the threshold of vibration sensation were of the same order, although not so clear as those of the pain sensation.

There was a distinct difference among the three kinds of tools (chain-saw, rock-drill and chipping hammer) studied by the authors. The chain-saw produces a vibration which is of high energy at middle to high frequency and of low energy at low frequency, but the rock-drill and the chipping hammer produce a vibration which is of high energy at low frequency as well.

The results of the objective examinations were much influenced by the age of the workers and the years of their service. Taking them into account, it seems that the results of the circulatory system were largely influenced by exposure to vibration of high energy at middle to high frequency and by the handling of vibrating tools in a cold environment, and the results of the nervous system, by the level of the vibration energy at low to middle frequency.

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