Follow up study of vibration induced white finger in chain saw operators

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ABSTRACT The current status of subjects with vibration induced white finger (VWF) was observed in order to follow up the natural course of VWF after the use of chain saws had ceased. The prevalence rate of VWF after the use of chain saws had ceased in all time periods fell to 50.2% after more than 12 years' observation. There was a pronounced tendency for the percentage prevalence to rise as the vibration exposure periods after VWF occurred increased, and a similar pattern was observed concerning the exposure periods before VWF occurred. Numbness of hands and arms takes longer to recover than VWF.

It is well known that vibration disease caused by using manual vibrating tools occurs in many occupations. Many surveys have confirmed the relationship between the vibration of hand held tools and disturbances in the peripheral circulation, nerves, muscles, bones, and joints.¹⁻³ The most prominent component of vibration disease is periodic ischaemic attacks affecting the fingers, known as vibration induced white finger (VWF).^{4,5} Peripheral nerve symptoms such as numbness, paraesthesia, and pain in the arms and hands have also been reported.^{6,7}

The prevalence of VWF among forestry workers using chain saws was reported in 1976⁸ and the results of a longitudinal study involving the same subjects in 1984.⁹ The peak prevalence rate was 62.6%, found in the cohort group beginning in 1958-9. Thereafter, it decreased significantly from the cohort group beginning in 1968-9. In the study periods 1956-80 the prevalence rate was around 10%, 15%, 20%, 25%, 30%, 35%, and 40% after two, three, four, five, seven, nine, and 12 years of exposure respectively. The peak value of the incidence rate by duration of exposure was 8-10% in the 1958, 1962, and 1966 cohort groups. The latent interval for the development of VWF was on average 6.4 ± 3.7 years (6000-7000 hours).⁹

The current status of those subjects who had been affected by VWF⁹ was observed to follow so far as possible the natural course of VWF after the use of chain saws had ceased.

Subjects and methods

A total of 333 workers (24.7% of the total number of forestry workers in the state forest) who were affected by VWF during 1956-80 was followed up to observe the natural course of VWF. These subjects were selected from a total of 1351 forestry workers who had used a chain saw for not less than 100 hours a year during some of the years from 1956 to 1980 in the state forest of Kyushu Island.

VWF was certified by asking each person to complete a questionnaire and by verifying the answers by comparing them with inquiries and the medical records made by the Kumamoto Regional Forest Office and with the results of compulsory annual medical examinations conducted by a physician that began in 1965.¹⁰ The work history of the subjects was confirmed by examining routine production records kept by the regional forest office. Of the total, 1001 workers (68.8%) have been examined by us using various objective measurements, including finger plethysmography and skin temperature measurement.¹¹

In 1982-3 we had verified the current status and history of VWF in 333 workers by direct interviews and measurements including finger plethysmography and skin temperature measurement.¹¹

A life table analysis of the VWF prevalence was carried out to describe the natural course of VWF from the time the use of chain saws ceased.¹² For each worker it was determined whether or not VWF had disappeared. The observation time then ran from the starting date (when the use of chain saws ceased) to the date of disappearance or, if symptoms

Table 1 *Prevalence of VWF from the time of cessation of exposure to vibration*

<i>Time since exposure ceased (years)</i>	<i>No of subjects</i>	<i>Prevalence (%)</i>	<i>Standard error (%)</i>
<2	333	83.5	2.21
-4	275	74.4	2.58
-6	244	64.7	2.82
-8	210	60.4	2.90
-10	177	57.7	2.94
-12	106	52.8	3.17
>12	61	50.2	3.37

Table 2 *Prevalence of VWF since exposure to vibration ceased by age when VWF occurred*

<i>Age group (years)</i>	<i>Time since exposure ceased</i>	<i>No of subjects</i>	<i>Prevalence (%)</i>	<i>Standard error (%)</i>
>40	During exposure	129	89.9	2.84
	≤2 years	116	77.5	3.95
	-4	98	69.6	4.35
	-6	88	60.1	4.66
	-8	76	56.2	4.70
	-10	66	51.9	4.76
40-49	-12	35	48.9	4.94
	During exposure	148	95.3	1.91
	≤2 years	141	77.0	3.93
	-4	114	66.8	4.33
	-6	99	58.1	4.50
	-8	85	54.0	4.52
≥50	-10	73	51.8	4.52
	-12	50	46.6	4.68
	During exposure	79	98.7	1.40
	≤2 years	78	84.8	5.13
	-4	66	78.3	5.01
	-6	60	67.9	5.72
	-8	51	63.9	5.86
	-10	39	63.9	5.86
	-12	22	58.1	6.75

Table 3 *Prevalence of VWF since exposure to vibration ceased by duration of exposure before VWF occurred*

	<i>Time since exposure ceased</i>	<i>No of subjects</i>	<i>Prevalence (%)</i>	<i>Standard error (%)</i>
<2 years	During exposure	35	91.4	4.92
	-2 years	32	77.1	7.71
	-4	27	74.3	7.97
	-6	26	65.7	8.64
	-8	23	57.2	9.04
	-10	18	57.2	9.04
-6 years	-12	12	57.2	9.04
	During exposure	153	92.2	2.26
	-2 years	141	79.1	3.54
	-4	121	70.6	3.93
	-6	108	58.9	4.33
	-8	90	56.9	4.33
-10 years	-10	82	54.1	4.36
	-12	57	47.5	4.61
	During exposure	111	94.6	2.12
	-2 years	105	80.2	4.09
	-4	88	68.4	4.84
	-6	74	62.8	4.99
>10 years	-8	66	57.1	5.11
	-10	55	54.0	5.15
	-12	27	52.0	5.35
	During exposure	54	100.0	0
	-2 years	54	74.1	7.41
	-4	43	68.9	7.52
	-6	40	60.3	7.65
	-8	35	56.9	7.61
	-10	25	54.8	7.67
	-12	10	49.3	8.83

Fig 1 Prevalence of VWF from time exposure to vibration ceased by exposure period after the onset of VWF.

did not disappear, to the end of the corresponding follow up period. The standard error of the estimates of the rate of prevalence was calculated using Greenwood's formula.¹³ The statistical significance of the percentage prevalence curves was assessed by the difference in the chi-squared goodness of fit statistic using the Mantel-Haenszel procedure.¹⁴

Results

The rate of prevalence of VWF fell continuously after the use of chain saws ceased to a final value of 50-2% after more than 12 years observation (table 1). In addition to the 333 cases studied here, in 21 cases (5.9%) VWF had disappeared before the use of chain saws ceased. A similar pattern was observed in the prevalence of VWF by age (table 2). The VWF group which was more than 50 years old at onset had a higher percentage prevalence ($0.10 > p > 0.05$) at all times than the younger VWF groups.

Fig 2 Prevalence of VWF by VWF scores.

Regarding percentage prevalence with respect to vibration exposure periods before the occurrence of VWF (table 3), a similar pattern was observed. There was a pronounced tendency ($p < 0.05$) for the prevalence to increase as the periods of exposure to vibration after the onset of VWF lengthened (fig 1).

In all cases the changes in the VWF score, determined by using Taylor's method,¹⁵ during the study periods were remarkable (table 4). On the other hand, it was noteworthy that 22 severe cases (19.8%) of VWF remained in the 6-10 years' group and 28 cases (25.0%) in the more than 10 years' group after the use of chain saws ceased. It was also observed that the percentage prevalence depended significantly on the severity at the time the use of chain saws ceased; 22.1% for the cases with scores of 5 or less, 35.1% with scores of 6-8, and 60.8% for those with scores of 9 or more after ten years'

Table 4 Changes in VWF score during the study period

		Before exposure to vibration ceased				After exposure to vibration ceased				
Score	Frequency	1-2 times a year	1-2 times a month	1-2 times a week	More than	None	1-2 times a year	1-2 times a month	1-2 times a week	More than
Within 2 years after stoppage	0					54 (96.4)				
	Scores of 5 or less	2 (3.6)	3 (5.4)	3 (5.4)						
	Scores of 6-8	2 (3.6)	3 (5.4)	7 (12.5)					1 (1.8)	
	Scores of 9 or more	4 (7.1)	16 (28.6)	14 (25.0)	2 (3.6)					1 (1.8)
2-6 years	0					60 (88.2)				
	Scores of 5 or less	1 (1.5)		1 (1.5)						
	Scores of 6-8		5 (7.4)	12 (17.6)			1 (1.5)			
	Scores of 9 or more	4 (5.9)	12 (17.6)	25 (36.8)	8 (11.8)		3 (4.4)	2 (2.9)		2 (2.9)
6-10 years	0					28 (25.2)				
	Scores of 5 or less		3 (2.7)	4 (3.6)	2 (1.8)		2 (1.8)	4 (3.6)		
	Scores of 6-8	2 (1.8)	4 (3.6)	7 (6.3)	2 (1.8)		5 (4.5)	7 (6.3)	1 (0.9)	
	Scores of 9 or more	8 (7.2)	19 (17.1)	42 (37.8)	18 (16.2)		21 (18.9)	21 (18.9)	15 (13.5)	7 (6.3)
> 10 years	0					16 (14.3)				
	Scores of 5 or less	1 (0.9)		1 (0.9)			1 (0.9)		1 (0.9)	
	Scores of 6-8	1 (0.9)	2 (1.8)	7 (6.3)	2 (1.8)		6 (5.4)	7 (6.3)		
	Scores of 9 or more	3 (2.7)	14 (12.5)	38 (33.9)	43 (38.4)		23 (20.5)	30 (26.8)	14 (12.5)	14 (12.5)

Fig 3 Prevalence of VWF and numbness from time exposure to vibration ceased.

Table 5 Change in severity of numbness during study period

Change of severity	No (%)
Unchanged	291 (48.8)
Aggravated	97 (16.2)
Improvement:	
Present	119 (19.9)
Absent	90 (15.1)

observation (fig 2).

The rate of prevalence of numbness of the hands and arms fell continuously after the use of chain saws ceased to a final value of 81.8% after more than 12 years' observation. Numbness seems to be slower to recover than VWF (fig 3). Of all the subjects who had been affected by numbness and pain in the hands and arms, 35.0% showed disappearance or improvement during the study period (table 5). The rate of prevalence of numbness does not seem to be affected by age or duration of exposure to vibration.

Discussion

Earlier studies had suggested that stage 3 of VWF was irreversible and this may still be correct,^{16,17} but there is still some debate as to whether or not earlier stages of VWF are reversible. Agate, using a self administered questionnaire, found that a few workers reported their first attack of VWF some months after they had stopped working with vibrating tools.¹⁸ In 36% of workers who already had VWF the vascular disturbances were said to have progressed rather than to have improved after the cessation of work. Jepson reported that there was no abatement once symptoms occur even after stopping work with vibrating tools.¹⁹ Stewart and Goda observed

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that five years after work involving exposure to vibration ceased, 30% of the workers no longer experienced attacks of VWF.²⁰ Among forestry workers using chain saws in Sweden, a six year follow up showed that prevalence of VWF had decreased from 48% to 38%.²¹ In England a similar study indicated improvement among forestry workers in recent years.²² Pyykkö *et al* observed that in 1972, 40% of the lumberjacks in one forestry district had VWF, but in 1980 the prevalence had decreased to 7%.²³ They suggested that the recovery period was similar to the latent interval.

In the present study we observed that VWF disappeared in only 6.9% of forestry workers when they had continued exposure to vibration. This, however, was affected by the severity of VWF; thus in 31.0% of VWF cases with scores of 5 or less and 4.6% of cases with scores of 9 or more, the symptoms disappeared. In 52.8% of workers who already had VWF, attacks of VWF were no longer experienced within 12 years after work involving exposure to vibration ceased according to a life table analysis. The reversibility of VWF seems to depend on its severity. We observed that at the end of the study period, prevalence in the patients with scores of 5 or less at the start was only 14.3% whereas it was 56.5% in patients with scores of 9 or more. Furthermore, it seemed that the reversibility of VWF was influenced by age and by the vibration exposure periods after VWF had occurred. These results suggest that a prolonged period is required before the abnormal reactivity of the peripheral circulation subsides and the pathological changes in the vessel walls regress. It should be emphasised that early detection and treatment in the early stages of VWF seem to be the most effective measure against irreversibility. Some other factors which seem to influence the course of VWF are protection against attacks by, or example, keeping warm under cold conditions and medical care for peripheral circulatory disturbances.²⁴

Numbness of the hands and arms seems to be more resistant to improvement. The origin of the numbness is thought to be complex, and after the use of chain saws ceases the muscle work load of the forestry work itself and aging may induce or aggravate the symptoms. In general, forestry workers with VWF showed symptoms of peripheral neuropathy more often than subjects without. It was observed that the peripheral neuropathy was more difficult to follow up than the VWF because of its complex nature.

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