FUNDAMENTAL STUDY OF VIBROTACTILE PERCEPTION THRESHOLD ON JAPANESE - EFFECTIVENESS OF NEW EQUIPMENT TO DIAGNOSE WORKERS EXPOSED TO HAND-TRANSMITTED VIBRATION

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1. INTRODUCTION

The Japanese government recently adopted international standard ISO 13091-1:2001, and a new vibrotactile perception threshold (VPT) measurement equipment based the ISO standard has been produced. However, Japanese data measured by the new machine has never been reported. In the present study, we aimed to evaluate the effectiveness of the new equipment by: 1) collecting data from Japanese workers having exposure to hand-arm vibration; 2) comparing VPTs of HAVS free workers with those of contained in ISO 13091-2:2003, and; 3) comparing VPTs between persons with and without HAVS for Japanese workers.

2. APPARATUS AND METHODS

2.1. Apparatus

A new Vibrotactile Perception Thresholds (VPTs) measurement equipment based on ISO 13091-1 standard was produced by Rion Co., Ltd. (Kokubunji, Tokyo) and used in the series of experiments by Bekesy algorithm. Details of the equipment have been described by Nakajima. R. et al. at this conference ("Fundamental study of vibrotactile perception thresholds on Japanese New measurement equipment of vibrotactile perception thresholds").

2.2. Study Subjects

The study subjects comprised twenty-seven Japanese male workers who were exposed to hand-transmitted vibration. Seventeen workers were engaged in road maintenance as public servants (Group 1), and the rest (ten workers) were engaged in forestry work (Group 2).

The mean age of Group 1 was 53.5 years (ranged 43-66 yrs) and the mean period of exposure to hand-transmitted vibration was 20.7 years (range 3-34 yrs). The mean age of Group 2 was 67.7 years (ranged 62-71 yrs) and the mean period of exposure to hand-transmitted vibration was 36.7 years (range 11-50 yrs).

2.3. Methods

Assessments were performed in January and February 2009. The test room temperature was 20-24°C during measurements on Group 1, and 22.7-27.1°C on Group 2. The blood pressure of all subjects was measured and the hand-arm vibration syndrome (HAVS) was assessment on the basis of Stockholm classification by physical examination and by self-reported questionnaire. The upper limbs were also checked for pain and dysesthesia in the HAVS assessment. From the interview and physical examination (and not using EMG), none of the subjects were regarded as suffering from carpal tunnel syndrome.

Vibration perception thresholds of six fingertips (bilateral index, middle and ring fingers) were measured at three frequencies (4 Hz, 31.5 Hz, 125 Hz) using the new equipment.

2.4. Statistical Analysis

First, Group 1 data were compared with the reference values in ISO 13092-2 by using z-test. Second, VPTs were compared between Group 1 and Group 2 by using non-paired t test. By dividing at the mean age or period of exposure to HAV, VPTs comparisons were made for each condition, respectively. All tests were two-tailed and the statistical significance was set at $P < 0.05$. All statistical analyses were performed by SAS software Version 9.

3. RESULTS

Four (24%) workers in Group 1 and nine (90%) in Group 2 reported they had some dysesthesia in fingers. These dysthesia were regarded as being related to vibration exposure, because diseases which might cause dysthesia had been excluded by examination and interview. Also, one (6%) worker in Group 1 and eight (80%) in Group 2 reported that they had Raynaud's phenomenon in the questionnaire. For the purposes of the present work we roughly defined Group 1 as 'Without HAVS' and Group 2 as 'With HAVS', i.e., because workers in Group 1 had little dysesthesia. Moreover, Raynaud's phenomenon could not be observed among subjects in the physical examination.

Table 1. Comparison of VPTs between the subjects and ISO 13091-2 50 percentile reference at three frequencies.

Frequencies (Hz)	50 percentile ISO Reference (dB)	Right (dB)			Left (dB)		
		Index	Middle	Ring	Index	Middle	Ring
4	77.5	86.2*	86.1*	86.9*	85.4*	86.4*	86.7*
31.5	100.3	104.4*	103.0	103.8	101.7	103.6	103.7
125	107.8	110.6	110.0	11.7	109.8	111.5	110.4

Non-paired t-test. * P <0.05

3. RESULTS

3.1. Comparison of VPTs with ISO Reference

Table 1 shows a comparison of VPTs between the Group 1 subjects and the 50th percentile of the ISO 13091-2 reference thresholds at six fingertips (bilateral index, middle, ring) and three frequencies. The mean VPT values for the subjects were statistically significantly higher than ISO references on all fingers at 4Hz. In contrast, no significant difference was observed at 31.5Hz and 125Hz with one exception (right index finger). Moreover, VPTs of Group 1 subjects ranged within 2.5 and 97.5 percentile of the ISO references at all three frequencies (data not shown). Moreover, older people or those who had longer exposure periods to HAV had not significantly higher VPTs (data not shown).

3.2. Comparison of VPTs between Groups 1 and 2

Figure 1 indicates the comparison of VPTs between Group 1 and Group 2 subjects for the right middle fingers. Group 2 consistently had statistical significantly higher VPTs than those of Group 1 for bilateral six finger data at three frequencies. In subgroup analysis, those who have Raynaud's symptom (n=9), dysesthesia (n=13) had significantly higher VPTs than those have no symptoms in some fingers and at some frequencies. In contrast, older people or those who have longer exposure periods to HAV had not significantly higher VPTs (data not shown).

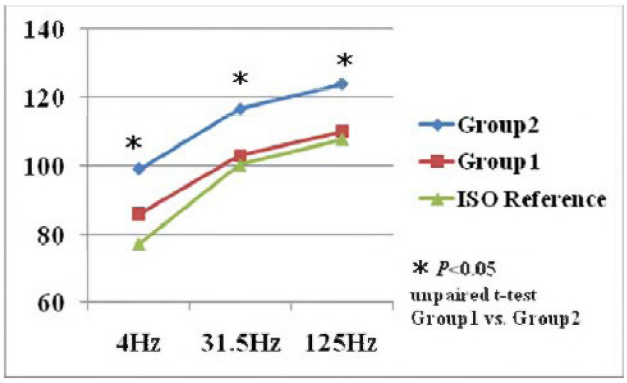

Figure 1. A comparison of VPTs between Groups 1 and 2 at three frequencies for the right middle finger

4. DISCUSSION

In the first analysis, significantly higher VPTs of Group 1 subjects were observed compared with ISO 13091-2 reference thresholds at 4Hz. However, this significance disappeared at 31.5 and 125Hz. Generally, as getting older, VPTs increased at higher frequencies. The mean age of Group 1 subjects was relatively higher than the ISO 13091-2 standard group (53.4 years versus 30 years). The reason for the inconsistent result at 4 Hz remains unclear. On the other hand, VPTs of Group 1 subjects ranged within the 2.5 and 97.5 percentiles of the ISO 13091-2 references. These results suggest this equipment can generally evaluate workers without HAV properly in accordance with the ISO 13091-2 standard. In the second analysis, Group 2 consistently had higher VPTs than Group 1, with statistical significance for all conditions. Moreover, these significances remained in the additional analyses relating to HAVS, Raynaud's symptom, and dysesthesia. These results suggest this equipment can discriminate VPTs of workers with HAVS from those without HAVS. Because of the small number of study subjects, the test sensitivity and specificity could not be calculated.

5. CONCLUSIONS

VPTs of HAVS-free workers were measured by a new ISO 13091-based equipment, and the results fitted the reference values of the ISO 13091-2 standard. The VPTs derived from subjects with HAVS were consistently significantly higher than those without HAVS. These results provide suggestive evidence that the new equipment can evaluate appropriately workers having exposure to hand-arm vibration with or without HAVS.

REFERENCES

ISO 13091-1 (2001). *Mechanical Vibration - Vibrotactile Perception Thresholds for the Assessment of Nerve Dysfunction-Part I: Methods of Measurement at the Fingertips* (International Organization for Standardization, Geneva).

ISO 13091-2 (2003). *Mechanical Vibration - Vibrotactile Perception Thresholds for the Assessment of Nerve Dysfunction-Part 2: Analysis and Interpretation of Measurements at the Fingertips* (International Organization for Standardization, Geneva).