Review Article

The Study on Hand-Arm Vibration Syndrome in China

Wang LIN*, Zhang CHUNZHI, Zhang QIANG, Zhang KAI and Zeng XIAOLI

Institute for Occupational Health and Environmental Medicine, Jinng Medical College, 45, Jianshe Road, Jining City, Shandong 272013, PR China

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Abstract: To review the main achievement and problems of study on hand-arm vibration syndrome in China. The epidemiological and clinical study indicate that HAVS was reported from almost provinces in China, the prevalence of VWF ranges from 2.5% to 82.8% in the workers with vibrating tool use. The exposure-response relationship between prevalence of VWF and intensity and duration of exposed to hand-transmitted vibration has confirmed. Diagnostic criteria of HAVS has been established and performed by Chinese government in 1985, and it was revised by government as a national standard for occupational health in 2002. The “hygienic standard for hand-transmitted vibration in workplace” as a national standard and the “methods of measurement and assessment for hand-transmitted vibration” as a recommend standard were published by government also. The limited value of exposed to hand-arm vibration was 5.0 m/s² that is energy equivalent frequency-weighted acceleration for a period of 4 h (ahw(4)). There are some problems in this field of China need to further study in the future.

Key words: Hand-arm vibration syndrome, Vibration white finger, Limited value of exposure to hand-transmitted vibration, China

Introduction

The hand-arm vibration syndrome (HAVS), sometimes we called local vibration disease or hand-arm vibration disease (HAVD), is an occupational disease induced by long-term use of vibrating tools and stationary tools that transmit vibration through a work-piece. The vibration transmitted from vibratory tools to local and distant organs of operators can lead to disorders of the peripheral circulatory and nervous systems as well as injuries of the muscular-skeletal system, it’s major and typical clinical feature is vibration-induced white finger (VWF). HAVD has been recognized one kind of legal occupational disease since 1957 in China. In this paper, we briefly review and present the main achievement and problems of the study in this field of our country.

Epidemiological Studies

The development of HAVS depends on many factors, including the level of acceleration (vibration energy) produced by the tool, the length of time the tool is used each day, the cumulative number of months or years the worker has used the tool, and the ergonomics of tool use. The tools most commonly associated with HAVS are powered hammers, drills, chisels chain saws, sanders, grinders, riveters, breakers, compactors, sharpeners, and shapers. In China, an estimated 2.0 million workers use vibrating tools. The prevalence of HAVS in a work population that has used vibrating tools ranges from 2.5% to 82.8%. And it was found in almost provinces from the northern area to the southern dialects of our country.¹ ¹ ¹. The prevalence of HAVS is usually expressed as the prevalence of VWF. Some studies reported the latency of VWF. The latency of the VWF is defined as the time from...
first use of a tool to the first appearance of the VWF.

Table 1 shows several data of the results from Epidemiological cross-sectional studies of HA VS in China. The prevalence of VWF, which is most typical vascular symptoms of HA VS, in Table 1 ranged from 2.5% to 82.8%. To evaluate the relative significance of these prevalence values, they must be compared with background rate of the vascular symptoms among worker population that have not been exposed to hand-arm vibration. According to some of studies in China, the prevalence of vascular symptoms among control workers who had not been exposed to hand-arm vibration and had worked at the same site as the exposed workers, ranged from 0% to 8.0% with a mean prevalence of 2.6%. Most of the studies listed in Table 1 had prevalence rates of VWF that were well above background rates. More than half of the studies had WVF prevalence rates that were greater than 30%.

Epidemiological studies of HAVS clearly confirm an association between VWF and exposure to hand-arm vibration from hand-held vibrating tools. These studies also provide clues to HAVS prevention. The measurement results of vibration from holding tools taken at the time of the close-sectional medical evaluation indicate the clear exposure-response relationship between HAVS and hand-arm vibration.

In all epidemiological studies and clinical data support the conclusion that workers who use vibrating tools can lead to developing of HAVS, that is chronic and progressive disorder that normally requires months or years of vibration exposure to manifest itself. These data also indicates that the quantitative relationship between the magnitude of the vibration exposure and the latency and severity of the disorder is not precisely known.

### Studies of Diagnostic Indication and Diagnostic Criteria for HAVS

The signs and symptoms characteristic of HAVS are also observed individually or in various combinations in some other disorder. No single sign or symptom is specific to HAVS alone. Several tests can be used to help substantiate a clinic diagnosis of HAVS. Following screening tests and laboratory tests were reported in China, including digital skin temperature measurement and cold water provocation test (immersion of digits and hands with recording of digital temperatures and recovered time after cold test), Doppler test (peripheral segmental blood flow and pressure in arms), digital plethysmography (at rest and following cold stress), microscope test of digital micro blood circulation (forms and functions of blood capillary in the fingers) for vascular assessment; including pain sense and vibration perception threshold test, two-point and depth-sense discrimination test, EMG test (to record the sensory and motor nervous conductivity of median and ulnar nerves), short-latency somatosensory evoked potentials (SLSEP), brainstem
auditory evoked potentials (AEP), visual evoked potentials (VEP) and heart rate variability tests for neurological assessment (the functions of peripheral, center nervous system and autonomic nervous system); and including grip strength (dynamometer), pinch test (thumb and fingers), X-rays tests for muscular-skeletal assessments.

In addition, some of biochemical and immunology indications were studies also. That are including hematological total and differential, sedimentation rate, blood viscosity, rheumatoid factor, antinuclear antibodies, serum protein electrophoresis and serum nor-adrenalin concentration analysis.

In all these studies, the indications have some changed in the patients with HA VS and in the workers exposed to hand-arm vibration compared with control groups. But it is different value to confirm diagnostic of HA VS1, 5–7, 9).

In China, the diagnostic criteria of occupational segmental vibration disease (GB4869-85) has been established and performed by Chinese government in 1985. And than, in 2002, it was revised by government as a national standard for occupational health (GBZ7-2002)4). According to the new standard, name of the disease was changed from segmental vibration disease to hand-arm vibration disease (HA VD). The obligatory examinations of GBZ7-2002 are the measurement of skin temperature and cold water test (10°C, 10 min); pain sensory threshold and vibratory sensory threshold measurements to determine the slight patient without VWF. If muscular atrophy in hand must take the examination of conduction velocity of medium nerve to define the neuron damage or not.

The classification of the clinical stages of HA VD is basis on severity of peripheral neural and peripheral vascular involvements caused by hand-transmitted vibration. The staging classification was shown in Table 2.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Signs and symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1 (Mild)</td>
<td>Occasional attacks of VWF that affect only the tips of one or more fingers or periodic numbness and pain in fingers with it’s threshold values increase or swellings, warps of finger phalanges with borderline decrease in motor and sensory conduction velocities.</td>
</tr>
<tr>
<td>Stage 2 (Moderate)</td>
<td>Occasional attacks of VWF that affect the digital and middle (rarely also proximal) phalanges of one or more fingers; or slight atrophy of hands muscular and abnormality of EMG with neuron damages.</td>
</tr>
<tr>
<td>Stage3 (Severe)</td>
<td>Frequent attacks of VWF affecting all phalanges of most fingers even all hands; or severe atrophy of hand/arm muscles even deformity of hands, affecting function of hands or very pronounced EMG changes.</td>
</tr>
</tbody>
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The stage is determined separately for each hand.

Table 2. Staging classification for hand-arm vibration disease

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The “Hygienic standard for hand-transmitted vibration exposure in the work environment” (GB 10434-89), was published by Chinese government as a national standard in 19892); and the “Methods for the measurement and the assessment of human exposure to hand-transmitted vibration”(GB/T14790-93) was published also as a recommended standard by government in 19933).

The GB10434-89 stipulated a limited value of acceleration level of exposure to hand-transmitted vibration is 5.0 m/s² that is energy equivalent frequency-weighted acceleration for a period of 4 h (ahw(4)).

The limited values of exposure to different acceleration levels and exposed times in detail shown in Table 3.

<table>
<thead>
<tr>
<th>Frequency weighted acceleration m/s²</th>
<th>Exposed time per day h</th>
</tr>
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<tbody>
<tr>
<td>5.00</td>
<td>4.0</td>
</tr>
<tr>
<td>6.00</td>
<td>2.8</td>
</tr>
<tr>
<td>7.00</td>
<td>2.0</td>
</tr>
<tr>
<td>8.00</td>
<td>1.6</td>
</tr>
<tr>
<td>9.00</td>
<td>1.2</td>
</tr>
<tr>
<td>10.00</td>
<td>1.0</td>
</tr>
<tr>
<td>&gt;10.00</td>
<td>&lt; 0.5</td>
</tr>
</tbody>
</table>

Studies on Hygienic Standard of Exposure to Hand-Arm Vibration

The standard and recommendation for control and prevention of HAVD are based mainly on clinical experiences and retrospective epidemiological studies. The limited values can protect 90% workers who have been exposed to hand-transmitted vibration in their occupations for periods of time up to 25 yr from onset of VWF. These experiences and studies are limited, however, because no two industrial situations are exactly alike. Measuring methods and results may vary greatly
from one work to another. In addition, no controlled laboratory studies on the production of HAVD in human subjects have been, or ethically should be, conducted. Progress in knowledge about HAVD control will depend on epidemiological and clinical studies more deeply and carefully collected under standardized situations of industrial use.

The Problems of Needing Study in the Future

We hold that the following problems of this field need to further studies:

1. Response-exposure relationship between VWF and hand-transmitted vibration is quite clear, but the relationship between prevalence, severity of vibration-induced neuropathy, muscular-skeletal system injury and hand-arm vibration exposure need to get more epidemiological and clinical data. In these studies, all factors known to have a significant influence on the development of HAVS require to consider and to control.

2. Clinical and objective tests (including the biomarkers) for determination of types and stages of HAVS. A pressing research need is the development of laboratory and clinical tests for objectively identifying the signs and symptoms of early stages of HAVS. The tests must be both sensitive and specific. To be clinically practical, they must be easy to perform and noninvasive.

3. Etiology and pathogenesis of HAVS. Although it is well established that the use of vibrating tools is associated the development of HAVS, it has not been fully explained how the vibration energy causes organ, tissue, and cellular changes and damage. A rational approach to the prevention and treatment of HAVS will require fundamental data on the mechanisms involved in changes in the arteries, muscles, nerves, connective tissue, and tendons associated with HAVS. New therapeutic or prophylactic drugs need to study deeply.

4. Exposure schedule and exposure monitoring. Adhering to an optimum exposure/non-exposure schedule during the workday can be a successful approach to hazard control. The research needs are studies on best system of work schedule for workers health. The measurement of the acceleration and frequency of the vibration produced by a tool is not a simple task. A pressing need exists for investigators to evaluate the health effects from both frequency-weighted and un-weighted acceleration measurements over the extended frequency range. Particular attention should be paid to the high-frequency component for the possible pathophysiological effects on the hand-arm system.

5. Ergonomics of the work task. Some important ergonomic factors that affect the impact of the vibrating tool on normal hand-arm function are (A) the grip force exerted on the tool handle to hold and control the tool, (B) the muscular force required at the tool or workpiece interface to do the work, and (C) the amount of flexion, abduction, and rotation at the wrist, elbow, and shoulder joints required to guide the tool properly. These factors may reduce the pathophysiological consequences of the vibration exposure task. This aspect of the HAVS problem has not received much research attention. We should be to improve the ergonomics of the work task basis on above factors.

References