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Clinical assessment of suspected damage from hand-held vibrating tools

by Lena Ekenvall, MD, PhD¹

EKENVALL L. Clinical assessment of suspected damage from hand-held vibrating tools. *Scand J Work Environ Health* 13 (1987) 271–274. The case history is still the cornerstone in the clinical assessment of suspected vibration injury. Objective tests to verify the symptoms are needed for legal reasons in insurance cases and for research purposes. The minimum requirement of a test used to obtain objective signs of Raynaud's phenomenon is that patients with vibration-induced white finger be evaluated along with symptom-free, but vibration-exposed, subjects for reference. The measurement of systolic blood pressure in the finger after local finger and general body cooling is a test that has been evaluated in this way, as has restitution of finger temperature after local cooling and ischemia combined with general body heating. If neurological symptoms are present, electroneurographic examination is essential since carpal tunnel syndrome, a treatable condition, is common in vibration-exposed patients. Measurements of vibration and temperature thresholds are complementary examinations. The so-called vibrogram may be a method with which to obtain objective neurological signs of vibration injury, but the test needs further evaluation. Until more is known of the pathophysiological mechanisms behind the disease, the patient's description of his symptoms, combined with a detailed exposure history, will remain essential for a diagnosis of vibration injury — irrespective of the results of the tests used.

Key terms: cold provocation test, diagnosis, electroneurography, nerve injury, nicotine, Raynaud's phenomenon, sensibility, symptom scale, vibration syndrome.

Long-term use of vibrating tools often leads to the development of vibration syndrome. The most well-known of the symptoms included in the syndrome is Raynaud's phenomenon (38), ie, attacks of white fingers induced by cold [called vibration-induced white finger (VWF) when caused by work with hand-held vibrating tools]. Hand-arm vibration also affects the nerves of the hands (50, 51, 52). Decreased sensitivity to vibration (53), temperature (29), or touch (11, 58) has been found in vibration-exposed workers. The frequency of carpal tunnel syndrome or other neuropathy (1, 9, 19, 34, 61) is also increased among vibration-exposed workers. Hand-arm vibration may affect muscles (20, 21, 32, 51) and contribute to osteoarthritis (23). Symptoms from the central nervous system have been discussed as being caused by work with vibrating tools (36, 37), but most researchers deny any causative connection between vibration exposure and such symptoms (8). An increased hearing loss seems to exist among vibration-exposed workers with Raynaud's phenomenon when these workers are compared with symptom-free workers from the same occupations with similar exposure times (31, 49).

This paper deals with the clinical assessment of Raynaud's phenomenon and neurological symptoms in workers exposed to hand-arm vibration.

Evaluation of a patient with suspected vibration injury

Case history

Case history is the cornerstone of the clinical assessment of suspected vibration injury. Questionnaires can be used in screening surveys of exposed groups, but they cannot replace direct contact between the physician and the patient. A detailed exposure history and the patient's description of symptoms are essential. The information on exposure to vibrating tools must include the number of years in exposed work, type(s) of tools used, and, if no objective registration can be obtained, the patient's estimation of daily exposure time.

The medical history should be recorded with special emphasis on causes other than hand-arm vibration for the existing symptoms (10, 12). The physical examination should include a neurological examination (sensibility and motor function of the hands), palpation of the radial artery (due to the possibility of thoracic outlet syndrome) and ulnar artery (Allen's test). The patient's smoking habits should be noted.

Vasospastic disease

Any cold-induced symptoms should be graded according to an internationally known symptom scale. The Taylor-Pelmeur symptom scale (55) — now appearing in a revised version (22) — is the best known of these assessment schemes, but other scales are sometimes used (46, 54). Those including symptoms from the

¹ Clinic of Occupational Medicine, Karolinska Sjukhuset, Stockholm, Sweden.

Reprint requests to: Dr L Ekenvall, Clinic of Occupational Medicine, Karolinska sjukhuset, S-104 01 Stockholm, Sweden.

central nervous system cannot be used internationally, since such symptoms are not recognized by all researchers as belonging to the vibration syndrome (54). The existence of different symptom scales is unfortunate, since no test for Raynaud's phenomenon is ideal or universally accepted. One internationally accepted and consistently used symptom scale would greatly facilitate the comparison of epidemiologic studies, dose-effect studies, and studies on different diagnostic procedures.

Cold provocation tests are often used to obtain objective signs of Raynaud's phenomenon. Time-consuming, drastic, and, for the patient, very uncomfortable cooling procedures are needed to provoke an attack in the laboratory (28, 46). Therefore researchers have tried to find tests that, without provoking an attack, can demonstrate a changed reactivity to cold (27, 28, 33, 41, 43). Men working with vibrating tools, irrespective of whether they have VWF or not, seem to have an increased reactivity to cold in comparison to unexposed healthy referents (12, 24). Thus any test used to diagnose VWF must be evaluated with vibration-exposed but healthy persons as reference.

The measurement of systolic blood pressure in the finger after general body and local finger cooling (13, 42, 44, 45) is the test preferred in our laboratory. It gives few falsely positive results in exposed (or unexposed) referents, but about 25 % falsely negative results in patients with a reliable history of VWF (15, 57). The test results might be influenced by the patient's smoking habits in that nonsmokers have a higher frequency of normal test results (14).

The measurement of temperature restitution after a hand has been cooled during ischemia and general body heating is a test that, on a group basis, demonstrates a difference between VWF patients and healthy referents (35, 60). A similar test, but without body heating, separates VWF patients and vibration-exposed referents on a group basis (24). Other cold provocation tests have also been used, eg, the cold pressor test (43), the nail compression test (27), and the measurement of finger blood pressure after local cooling, general heating, and the oral administration of alcohol (4).

Other techniques used have been angiography or fluorescein angiography to visualize spastic or organic lesions in finger arteries. Plethysmography, flow measurement with Doppler ultrasound or the laser-Doppler technique can be used to study blood flow in the fingers. None of these techniques has been systematically evaluated in VWF.

As yet, no test can separate VWF from primary Raynaud's disease on an individual level. A person with long-term exposure to vibrating tools, who has developed attacks of white fingers, must be considered as having VWF if no other cause for the symptoms can be demonstrated. VWF can be safely excluded if the symptoms started before the vibration exposure. Agate (2) described cases of white fingers developing in patients who had stopped working with vibrating tools,

but recent studies have consistently shown an amelioration of vasospastic symptoms after the cessation of work with vibrating tools (18, 48). Thus symptoms starting more than a short time after the cessation of exposure have probably not been induced by vibration.

Neurological symptoms

Neurological symptoms, mainly in the form of paresthesias in the hands and arms, are even more common in vibration-exposed patients than in unexposed referents (6, 25). Paresthesias directly after the use of a vibrating tool are common. Sleep-disturbing paresthesias nightly are typical for carpal tunnel syndrome and common in cases of vibration syndrome. Loss in manipulative skill may also occur (5) and must be separated from sensibility disturbances caused by vasospastic reaction in the cold. A separate scale for the classification of neurological symptoms in the hand-arm vibration syndrome has now been devised (7).

Since carpal tunnel syndrome is common in vibration-exposed patients (3, 9), electroneurographic and electromyographic examinations are necessary for all patients with symptoms consistent with this syndrome. Since the patients often cannot localize the symptoms to median innervated areas only, electroneurography must not be restricted to typical cases.

The vibrogram, ie, the measurement of vibration sensitivity in the finger pulp at different vibration frequencies, has lately been shown to be a sensitive technique to demonstrate early carpal tunnel syndrome (39, 40). The technique has been used for vibration-exposed patients (26) but needs further evaluation in symptom-free vibration-exposed workers before it can be recommended for routine clinical use. The measurement of temporary vibration threshold shift after acute vibration exposure separates patients with symptoms from healthy referents on a group basis better than the determination of permanent vibration thresholds (37). Measurements of temperature thresholds give many pathological results for vibration-exposed patients with neurological symptoms (16, 29, 30) and therefore indicate that damage to small myelinated and unmyelinated nerve fibers is common in the vibration syndrome. Further evaluation of this technique is also necessary. Temperature and vibration thresholds (possibly after acute vibration exposure) are comparatively easy to measure quantitatively and might be used for screening exposed groups, even outside the hospital, to detect sensory disturbances early. Vibration thresholds are, however, dependent on skin temperature (59). Skin temperature is lower in VWF patients than in healthy referents even without any induced cold stimulus (17) and thus must be controlled. Moreover, the thresholds are changed by vibration exposure, and any testing must be performed with a standardized latency period since the last work with exposure to vibration.

Treatment of vibration syndrome

In the case of the appearance of the vibration syndrome, vibration exposure should be stopped or minimized since there is evidence that vasospastic symptoms improve or disappear in many cases after the cessation of exposure. Many years seem to be needed before an amelioration of the symptoms can be expected however (18, 47). Since VWF attacks are induced by cold, it is probably rational to advise the patient to avoid occupations involving exposure to cold. There is some evidence that nicotine might aggravate vasospastic symptoms (14, 56), and the avoidance of nicotine is recommended.

Apart from carpal tunnel syndrome, which can often be successfully treated with an operation, there exists no treatment for the neuropathy that appears with the vibration syndrome. There are indications that neurological symptoms do not easily disappear after the cessation of vibration exposure (25, 48). If this possibility can be verified, patients with signs of neuropathy must avoid vibrating tools at an early stage.

Suggestions for the "minimum examination" necessary for suspected vibration syndrome

As stated in the preceding text, the case history is the cornerstone of the diagnosis of suspected vibration syndrome. Detailed exposure data, the patient's description of symptoms, and a physical examination to exclude other possible causes for the symptoms are essential. Circulatory and neurological symptoms should be classified according to symptom scales, preferably internationally accepted ones. Objective tests to verify Raynaud's phenomenon are necessary for legal reasons in insurance cases and for research purposes.

If neurological symptoms are present, an electro-neurographic examination (measurement of motor and sensory conduction velocities and sensory amplitudes in the median and ulnar nerves on both sides) is essential since carpal tunnel syndrome, a treatable condition, is common in vibration-exposed groups. The measurement of sensory thresholds might be used as complementary examinations. Until more is known of the pathophysiological mechanism behind the symptoms of the vibration syndrome, the patient's description of symptoms, combined with a detailed exposure history, will remain essential for the diagnosis — irrespective of the results of the tests used. A patient who has a typical history of Raynaud's phenomenon and/or paresthesias and has been exposed to hand-arm vibration daily for many years, when no other reason for the symptoms can be found, must be considered as having vibration syndrome.

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