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Diagnostic aspects of vibration-induced white finger

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Abstract Vibration-induced white finger (VWF) is a secondary type of Raynaud’s phenomenon (RP) caused by exposure to hand-arm vibration. The present review concerns the cold-provoked attack of RP in vasospastic VWF. It concentrates on the most common clinical and laboratory methods used to diagnose RP in vibration-exposed subjects. Some physiological aspects of the attack of RP are mentioned to elucidate the diagnostic principles of the tests. Anamnestic diagnostics by medical interviews and questionnaires as well as cold-provocation tests with detection of finger colour, finger systolic blood pressure (FSP), recovery time of finger skin temperature and recovery time of normal nail colour after nail compression are mentioned. The discriminative capacity and the reproducibility of the tests are discussed. Cold-provocation tests with detection of finger colour or zero FSP during cooling are recommended to be used if an attack of RP has to be registered for diagnostic or medico-legal purposes in individual cases. An abnormal reduction in FSP during cooling makes a history of RP very probable and is a suitable laboratory test for groups of subjects. Both recovery tests may be useful screening tests in field studies of vibration-exposed subject groups.

Keywords Cold-provocation tests · Raynaud’s phenomenon · Vibration-induced white finger

Introduction

Vibration-induced white finger (VWF) is a secondary type of Raynaud’s phenomenon (RP) caused by exposure to hand-arm vibration. VWF without permanent trophic changes in the affected fingers is most often a pure vasospastic disorder without organic arterial obliterations. Its attack looks like those seen in other etiological types of vasospastic RP. The present review concerns the cold-provoked attack of RP in vasospastic VWF. It concentrates on the most common clinical and laboratory methods used to diagnose RP in subjects with VWF. The following methods are mentioned: medical interview, questionnaire and cold-provocation tests to detect finger colour, finger systolic blood pressure (FSP), recovery time of finger skin temperature, and recovery time of normal nail colour after nail compression. Some essential vasomotor responses to cold in the normal finger and in the affected finger are also briefly mentioned to elucidate the diagnostic principles and problems of the tests.

Some characteristic features of Raynaud’s phenomenon and vibration-induced white finger

An exaggerated digital vasoconstrictor response to cold or emotional stress was described by Raynaud in 1862. This pathological response, RP, is characterized by cold-provoked episodes of acral, well-demarcated pallor or cyanosis of the digits and associated with numbness, and is sometimes followed by hyperaemic throbbing during rewarming (Allen and Brown 1932). Thus, it has been widely accepted that the full sequence of colours displayed in the attack is first white, then blue (cyanosis), and finally red in the stage of recovery. The blanched finger does not bleed when cut (Lewis 1929), which indicates that the cutaneous blood vessels at this stage have expelled their contents. Lewis (1929) further noticed that the discoloration started in the finger tip and subsequently spread upward in the finger whereas the recurrence advanced in the opposite direction.


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VWF is RP caused by vibrating hand tools. The prevalence of VWF may range from approximately 2% to about 90%, whereas 1%–7% of non-exposed men have other types of RP, mainly primary RP. Characteristic features of VWF are that the affected workers have often used vibrating tools for several years before VWF appears and that the episodes of RP initially occur in the morning before start of work (Taylor and Pelmar 1975). An attack of RP usually lasts from 5 to 30 min but may last for only 1–2 min in laboratory tests. Many subjects with VWF have experienced spontaneous attacks of RP that are unpredictable. Besides a well-defined exposure to cold the attack may depend on other physical and psychological factors. This may explain why it often seems difficult to provoke an attack of RP in the laboratory. The distribution of affected fingers between the two hands differs in workers using different types of tools. The frequency of attacks and the extent of affected phalanges seem to progress during increasing cumulated exposure periods. VWF is to some extent a reversible disorder that may improve or subjectively cease if exposure to hand-arm vibration is stopped or minimized (Taylor et al. 1975; Pytkkö et al. 1978, 1982; Futatsuka et al. 1985; Olsen and Nielsen 1988). In advanced cases of VWF the episodes of RP may be replaced by a continuous cyanotic appearance of the fingers that in fewer than 1% of workers may lead to malnutrition and atrophy of the skin in the fingertips, resulting in tissue necrosis and gangrene (Taylor and Brammer 1982).

**Physiological aspects of vasomotor responses to cold**

Thermoregulatory needs are the main determinants of finger blood flow. Direct cooling of the hand from 30–37 °C to about 15 °C causes a continuous decrease in local blood flow rate. This vasoinhibition is augmented by additional body cooling. Direct finger cooling below 15–18 °C induces cutaneous vasoinhibition as described above. However, periods of vasodilatation occur from 5–10 min after finger cooling is initiated (Lewis 1930). This alternating vasoinhibition and vasodilation, named “hunting reaction”, are caused by intermittent opening of the arteriovenous anastomoses by unknown mechanisms. The hunting reaction is most prominent in warm subjects and at low cooling temperatures and may purposefully afford a local protection against skin damage (Greenfield 1963). Prolonged vasodilatation occurs in the finger when intense local cooling is interrupted (Lewis 1930; Greenfield 1963).

The visible signs of an attack of RP reflect cessation of cutaneous blood flow caused by a primary closure of the main arteries of the affected finger. The underlying mechanism has been suggested, among others, to be an overactivity of the central sympathetic nervous system (Raynaud 1862) or a local digital vascular fault (Lewis 1929) but is still under debate. The attack is preceded by exaggerated reduction in finger blood pressure but nearly normal reduction in finger blood flow. The hunting reaction may be present, but perhaps in an altered form, in subjects with VWF (Lewis 1929). The attack is followed by nearly normalized finger blood pressure and sometimes an exaggerated increase in finger blood flow.

**Anamnestic diagnostics – medical interview and questionnaire**

A medical interview is widely accepted as the best available method of diagnosing RP and VWF and is most often used as a method of reference. The interview should be performed by a physician who has been trained by an expert. It is suggested that the interview comprises “passive” or neutral questions concerning possible finger symptoms according to the principle that the subjects themselves should describe their symptoms. From this description the physician has to assess if the subject has a convincing history of RP. The minimum requisites for the anamnestic diagnosis of RP and VWF in a medical interview have been proposed as follows by a working group (Olsen et al. 1995): (a) RP; cold-provoked episodes of well-demarcated blanching (whiteness) in one or more fingers; (b) VWF; first appearance of RP after start of professional exposure to hand-arm vibration and no other probable causes of RP; (c) current activity of VWF; currently active VWF if episodes have been noticed during the past 2 years.

The nosographic sensitivity and specificity of the medical interview are 100% if the interview is defined as the true method of reference, and no other method will be allowed to have such a high discriminative capacity. However, the diagnostic signs of finger colour have been observed by cold-provocation tests in subjects without anamnestic RP, in subjects judged to have ceased RP, and in anamnestically non-affected phalanges in subjects with VWF (Tiilikä 1970; Pytkkö 1974; Brubaker et al. 1983; Olsen 1988). These findings demonstrate the existence of anamnestically non-symptomatic RP in vibration-exposed subjects with or without a positive history of VWF. Thus, the medical interview is not a true method of reference under all circumstances. This implies that the true specificity of objective tests is probably higher than estimated with the interview as a reference. The medical interview has been found to have high 5-year reproducibility in diagnosing RP at a given time in forestry workers with an initial prevalence of VWF of 33%, the kappa coefficient being +0.94 (Olsen 1988).

The severity of RP is proposed to be graded according to the revised Taylor-Pelmar stage assessments, termed the Stockholm Workshop scale for VWF 1986 (Gemne et al. 1987). The advantages of the Stockholm Workshop scale have been experienced by independent users to be far greater than any limitations (Olsen et al. 1995). It was recommended that the scale be used in clinical work and epidemiological studies. The description of the scale might require clarification concerning...