Hand-arm vibration syndrome

What family physicians should know

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Abstract

Objective To provide family physicians with an understanding of the epidemiology, pathogenesis, symptoms, diagnosis, and management of hand-arm vibration syndrome (HAVS), an important and common occupational disease in Canada.

Sources of information A MEDLINE search was conducted for research and review articles on HAVS. A Google search was conducted to obtain gray literature relevant to the Canadian context. Additional references were obtained from the articles identified.

Main message Hand-arm vibration syndrome is a prevalent occupational disease affecting workers in multiple industries in which vibrating tools are used. However, it is underdiagnosed in Canada. It has 3 components—vascular, in the form of secondary Raynaud phenomenon; sensorineural; and musculoskeletal. Hand-arm vibration syndrome in its more advanced stages contributes to substantial disability and poor quality of life. Its diagnosis requires careful history taking, in particular occupational history, physical examination, laboratory tests to rule out alternative diagnoses, and referral to an occupational medicine specialist for additional investigations. Management involves reduction of vibration exposure, avoidance of cold conditions, smoking cessation, and medication.

Conclusion To ensure timely diagnosis of HAVS and improve prognosis and quality of life, family physicians should be aware of this common occupational disease and be able to elicit the relevant occupational history, refer patients to occupational medicine clinics, and appropriately initiate compensation claims.

Hand-arm vibration syndrome (HAVS) is a condition associated with the use of hand-held vibrating tools that has vascular, neurologic, and musculoskeletal features.[1] Its vascular component, also known as *vibration white finger* (VWF), is a type of secondary Raynaud phenomenon and the most well established manifestation of HAVS.[2]

Hand-arm vibration syndrome is substantially underrecognized in Canada.[3] A lack of appropriate and timely diagnosis and referral by primary care physicians appears to be an important reason for treatment delay.[4,5] Workers' lack of awareness and fear of reprisals by employers are additional barriers.[5,6] This underdiagnosis is problematic, as early recognition and management of this condition are crucial for preventing progression and improving prognosis.

Currently, only 2 of the 13 provinces and territories, British Columbia and New Brunswick, have legislation that specifically limits occupational hand-arm vibration exposure. Even in these provinces, it is unclear to what extent the regulations are enforced.[3] Therefore, family physicians play an important role in identifying cases of HAVS early and advocating for appropriate management.

Case description

A 30-year-old man visited his family physician for cold-induced blanching and pain in his fingers, which started in the right third and fourth digits and spread to all digits bilaterally over a period of 3 years. He also mentioned

EDITOR'S KEY POINTS

- Hand-arm vibration syndrome is a common occupational disease that affects workers in multiple industries. However, it is underrecognized in Canada.
- Assessment includes taking an occupational history and performing physical examinations and laboratory tests to rule out other causes. If hand-arm vibration syndrome is suspected, referral to an occupational medicine specialist is required for further investigations.
- Management includes vibration exposure reduction, cold avoidance, smoking cessation, and initiation of a calcium channel blocker.

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This article has been peer reviewed.
Can Fam Physician 2017;63:206-10

La traduction en français de cet article se trouve à **www.cfp.ca** dans la table des matières du numéro **de mars 2017** à la **page e160**.

concomitant finger numbness and tingling. He had no history of cardiovascular or neurologic disease, diabetes mellitus, thyroid disease, arthritis, or connective tissue disease. He also had no history of frostbite or carpal tunnel syndrome (CTS). There was no family history of primary Raynaud phenomenon or connective tissue disease. He was not taking any medications. He was a smoker with a 15 pack-year history. He had worked as an underground miner for 10 years and had used hand-held, high-intensity vibrating tools, including large drills and air chisels, on a regular basis. He had normal vital signs and no remarkable findings on cardiovascular, neurologic, and musculoskeletal examinations. He was referred to an occupational medicine clinic for further assessment of possible hand-arm vibration-induced injury.

Sources of information

The Ovid MEDLINE database was searched up to June 1, 2016, for articles pertinent to epidemiology, pathogenesis, symptoms, diagnosis, prognosis, and management of HAVS. Search terms included *hand-arm vibration syndrome, HAVS,* and *vibration white finger*. Reference lists of articles identified were also checked for additional articles. A separate Google search was conducted to obtain gray literature relevant to the Canadian context.

Main message

Epidemiology. Vibration white finger was initially reported by Dr Loriga in 1911 in Italian miners and then in North America in 1918 by Dr Hamilton in Indiana limestone quarry workers.[7] Subsequently, neurologic and musculoskeletal symptoms became recognized as part of HAVS. Hand-arm vibration syndrome has a high prevalence in industries such as construction, mining, forestry, foundry work, automobile assembly, and metalworking trades.[8] The prevalence among exposed workers has been estimated at 50% and varies by intensity and duration of vibration exposure.[9] Although the exact nationwide prevalence of HAVS is unknown, based on extrapolation of data from the United States and United Kingdom, there are an estimated 72 000 to 144 000 cases of HAVS in Canada.[3] The risk of VWF symptoms is further increased in cold climates, such as in Canada, compared with warmer countries.[10]

Workers who have filed claims for HAVS usually report symptom onset in middle age, although symptoms might also occur in younger workers with high-intensity exposure.[6,11] The latency period varies from less than a year to 4 decades depending on the intensity of vibration exposure.[6,12] The different components of HAVS might exist and progress independently.[13]

Pathophysiology. The pathogenesis of HAVS is complex and not fully understood. Hand-arm vibration likely causes local endothelial damage through mechanical trauma and oxidative stress and leads to peripheral vasoconstriction by activating the sympathetic nervous system.[14] Vibration exposure might damage both large (myelinated) and small (unmyelinated and myelinated) nerve fibres of the fingers.[1] Musculoskeletal symptoms might occur through direct vibration-induced damage to musculoskeletal tissues or sometimes secondary to local nerve damage.[15]

High-frequency vibration, such as that produced by certain drills, chisels, milling machines, saws, and cutting, sanding, and polishing machines, is largely absorbed by the fingers and hands and appears to be associated with the vascular and sensorineural symptoms of HAVS.[16] In contrast, vibration of lower frequencies is transmitted to the arms and shoulders and might be associated with musculoskeletal abnormalities in these areas.

Symptoms. Raynaud phenomenon presents as well demarcated pallor or cyanosis of the fingers along with numbness or tingling in cold environments.[17] This is often followed by rewarming pain and hyperemia. In HAVS (**Figure 1**), the phenomenon is typically asymmetrical and affects the dominant hand first.[18] It often starts in the fingertips and spreads with recurrent episodes over time. Generally the thumbs are least affected. Each episode usually lasts 5 to 30 minutes.[2] Frequency, severity, and duration of symptoms increase as the condition advances. Rarely, in late stages, fingers might

Figure 1. Raynaud phenomenon in hand-arm vibration syndrome: *The phenomenon typically affects the dominant hand first.*

become permanently cyanotic and develop tissue necrosis or gangrene.[19] Pain and cold sensation of the hands might become chronic. Recent evidence also suggests a potential association between VWF and secondary cold-induced vasospasm of the feet, which mostly occurs in individuals with severe VWF, likely owing to sympathetic hyperactivity.[20,21]

Other less well characterized HAVS symptoms include those of digital sensory neuropathy—finger tingling, numbness, and paresthesia independent of exposure to cold, with less night waking compared with CTS; and musculoskeletal symptoms, in particular reduced grip strength[15,22] and Dupuytren contracture.[23] The association between vibration exposure and other musculoskeletal outcomes, although reported, is unclear owing to the confounding effect of ergonomic stressors related to manual work.

Diagnosis. Hand-arm vibration syndrome is a diagnosis of exclusion. Primary Raynaud phenomenon and other causes of secondary Raynaud phenomenon should be ruled out. Primary Raynaud phenomenon often occurs before 30 years of age, especially among women and those with a positive family history.[17] Common causes of secondary Raynaud phenomenon include autoimmune rheumatic diseases (eg, systemic lupus erythematosus, rheumatoid arthritis, dermatomyositis, scleroderma); hematologic diseases (eg, cryoglobulinemia, cold agglutinin disease); peripheral vascular diseases; thoracic outlet syndrome; vasoconstricting medications such as β-blockers, ergotamine, and clonidine; occupational or environmental exposure such as vinyl chloride monomer or frostbite; and other associated conditions such as CTS and hypothyroidism. Carpal tunnel syndrome, which often exists in patients with HAVS and for which hand-arm vibration might be an independent causal factor,[24,25] should be considered in those presenting with sensorineural symptoms.

History and physical examination. As there is no single test with sufficient accuracy for diagnosing HAVS, thorough history taking and physical examination are required. Among compensation boards in Canada, the most common initial diagnostic criterion for HAVS is having at least 2 years of hand-arm vibration exposure immediately before onset of vascular disease.[3]

History of work-related and non–work-related vibration exposure, including cumulative duration, intensity, and type of vibration tool used, should be obtained.[26,27] Other occupational risk factors, such as workplace temperature, rest breaks, posture, and grip force, might also be obtained.[18] History of smoking, which is a risk factor for VWF, should be elicited.

To monitor progression, vascular and sensorineural components of HAVS are categorized into stages according to the Stockholm Workshop Scale (**Table 1**),[19,28] an internationally accepted system based on the frequency and extent of symptoms. A standardized colour chart has been used for more accurate diagnosis of VWF.[29,30]

Physical examination includes assessment of cardiovascular, neurologic, and musculoskeletal systems.[13,31] Vital signs should be measured and a precordial examination should be performed. The Allen test assesses radial and ulnar circulation and the Adson test is used to rule out vascular thoracic outlet syndrome. Examination of sensation, including pinprick, 2-point discrimination, or monofilament tests, and upper extremity strength, including grip strength, should be conducted. Tinel and Phalen tests might be performed to diagnose CTS. Palmar thickening and finger contractures should be noted.

Investigations. The following laboratory tests should be conducted to rule out other causes of Raynaud phenomenon and neuropathy: complete blood count, erythrocyte sedimentation rate, and measurement of antinuclear antibody, rheumatoid factor, cryoglobulin, cold agglutinin, random glucose, thyroid-stimulating hormone, vitamin B12, and red blood cell folate levels.[16]

If HAVS is suspected, patients should be referred to an occupational medicine specialist for further

Table 1. Stockholm Workshop Scale; each hand should be graded separately: *A) Classification of cold-induced Raynaud phenomenon in HAVS[19]; B) Sensorineural stages of HAVS.[28]*

A)		
STAGE	GRADE	DESCRIPTION
0	None	No attacks
1	Mild	Occasional attacks affecting the tips of ≥ 1 fingers
2	Moderate	Occasional attacks affecting distal and middle (rarely also proximal) phalanges of ≥ 1 fingers
3	Severe	Frequent attacks affecting all phalanges of most fingers
4	Very severe	As in stage 3, with trophic changes in the fingertips

B)	
STAGE	DESCRIPTION
0SN	Exposed to vibration but no symptoms
1SN	Intermittent numbness with or without tingling
2SN	Intermittent or persistent numbness, reduced sensory perception
3SN	Intermittent or persistent numbness, reduced tactile discrimination or manipulative dexterity

HAVS—hand-arm vibration syndrome, SN—sensorineural.

investigations, especially if symptoms are severe or if work-related compensation is sought. Although there is currently no standardized diagnostic test for HAVS,[2] additional investigations might be ordered by specialists to objectively measure severity, rule out other causes, and guide management. Objective evidence of the condition might also facilitate compensation claims and the implementation of workplace modifications.

Vascular assessments might include digital plethysmography, which detects differences in finger pulse waveforms before and after cold water stress, and thermometry or thermography, which detects recovery of finger temperature after cold provocation.[17] Upper extremity arterial Doppler ultrasound might also be performed to rule out large vessel obstructive lesions. Nerve conduction testing, which assesses the function of large myelinated nerve fibres proximal to the fingers, helps rule out median and ulnar nerve compression. Quantitative sensory tests, such as current perception threshold, vibration perception threshold, and temperature perception threshold, might also be performed to measure function of small digital nerve fibres. For assessment of musculoskeletal features, grip strength is assessed using a grip dynamometer. The Purdue Pegboard Test is often used to assess overall dexterity and hand function.

Management. Compensation claims should be initiated after discussion with patients, especially as it might lead to better recognition and control of workplace vibration exposure. Attention should be paid to VWF, the vascular component of HAVS, as it is recognized by all compensation boards in Canada.[3] Reduction of hand-arm vibration exposure is the best management strategy for HAVS and might increase the likelihood of work continuation.[1] If exposure cannot be avoided, it might be reduced through engineering control, personal protective equipment, and work practice changes.[32] Well-maintained low-vibration tools and antivibration gloves approved by the International Organization for Standardization can be used.[8] Exposure might also be reduced by introducing breaks during vibration exposure (eg, for 10 minutes every hour) and minimizing grip force to what is required for safe operation of the vibrating tool.

Avoidance of cold exposure and use of protective clothing might prevent Raynaud phenomenon attacks.[8] Smoking cessation should be encouraged. In more severe cases, medical treatment with a calcium channel blocker might be helpful. For patients with chronic hand pain associated with HAVS, pain management should be a priority.

Prognosis. Hand-arm vibration syndrome might lead to disability and poor quality of life. In Canada, individuals diagnosed with HAVS had significantly lower physical and mental quality of life scores compared with population averages ($P<.001$).[33] Hand-arm vibration syndrome has been linked to reduced daily functioning,[4] lower levels of well-being,[34,35] and psychological stress.[36] Timely recognition and management of this condition might help reduce progression and improve functional outcomes. The likelihood of improvement is higher for those with fewer years of exposure, those with milder stages of HAVS, and those who are younger.[37] A dose-response relationship has been established between cumulative lifetime hand-arm vibration exposure and symptoms of HAVS.[38] With appropriate management, approximately half of workers with early VWF had symptom improvement after 6 years.[39,40]

Case resolution

The occupational medicine specialist ordered laboratory tests for other common causes of Raynaud phenomenon, the results of which were negative. Digital plethysmography revealed moderate to severe dampening of right finger waveforms and moderate dampening of left finger waveforms after cold water immersion. Extremity arterial Doppler ultrasound, nerve conduction testing, current perception threshold of the fingers, grip strength, and the Purdue Pegboard Test results revealed no substantial abnormality. The investigations confirmed the presence of the vascular component of HAVS, which was moderate to severe in nature. Neurologic and musculoskeletal components of HAVS were not detected. The patient was encouraged to reduce hand-arm vibration exposure, avoid cold exposure, and quit smoking. A trial of a calcium channel blocker was recommended. A compensation claim was submitted. His symptoms will be monitored and work modification and retraining might be considered if his clinical condition continues to worsen.

Conclusion

This case shows that even younger individuals might be affected by HAVS if they are exposed to daily high-intensity vibration and that different components of HAVS might occur separately. Family physicians should consider the possibility of HAVS, a common occupational disease, when patients with hand-arm vibration exposure, especially of more than 2 years' duration, present with Raynaud phenomenon or neurologic symptoms of the hands. Appropriate and timely assessment, referral, and compensation initiation are crucial for improving the prognosis and quality of life of workers.

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Contributors
Both authors contributed to the literature review and interpretation, and to preparing the manuscript for submission.

Competing interests
None declared

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