Diagnosis and treatment of hand-arm vibration syndrome

And its relationship to carpal tunnel syndrome

Sonja Falkiner, *DipAppSc (OT), MAppSc (OHS), is Occupational Health and Safety Coordinator, Sydney Children's Hospital and the Royal Hospital for Women, Sydney, New South Wales.*

BACKGROUND Hand-arm vibration syndrome (HAVS) is a condition associated with the use of vibrating tools that occurs mainly in men. It consists primarily of 'occupational' Raynaud disease and digital polyneuropathy. Carpal tunnel syndrome (CTS) is also associated with hand transmitted vibration exposure and can coexist with HAVS.

OBJECTIVE This article examines recent papers on causation, diagnosis, relationship to CTS and treatment. A Medline search was conducted, as was a search of UK, USA and Australian government occupational health and safety websites. Published papers that were single case studies or of poor design were not included.

DISCUSSION There are no 'gold standard' diagnostic tests for HAVS. It can mimic CTS in temperate climates and can occur with CTS. This is the diagnostic challenge when a male worker presents with apparent CTS symptoms. If he has worked with vibrating tools for many years, a diagnosis of HAVS or co-diagnosis of HAVS should be considered before a diagnosis of pure CTS is made. Nonwork risk factors for HAVS are predisposition, smoking, and exposure to vibration outside work. Cessation of exposure (and smoking) and redeployment is a critical part of treatment due to the dose response relationship of HAVS. This contrasts with adequately treated CTS, where the vast majority of workers can return to pre-injury duties. In severe cases, calcium antagonists are also used, but treatment is often ineffective. Few workplaces in Australia manage vibration risk or conduct screening to identify workers with early HAVS who should be redeployed. Local doctors have an important opportunity to diagnose HAVS and to make recommendations to the workplace on redeployment as part of treatment before symptoms become irreversible.

Adverse health effects are strongly associated with hand-arm vibration exposure from use of vibrating tools or from materials being held against a vibrating surface.[1,2] A review of 20 cross sectional studies on hand-arm vibration syndrome (HAVS) by the US Centre for Disease Control[1] found strong evidence of a positive association between high level vibration exposure and the vascular symptoms of HAVS. They also found strong evidence of a dose response relationship.

The strength of this evidence contrasts strongly with the strength of other research that seek to link the repetitive nature of work with a disease effect.[3] A review of literature linking carpal tunnel syndrome (CTS) with work, for example, found that all 52 articles reviewed had flaws in diagnosis, eg. failure to examine any patients and/or flaws in methodology such as applying different diagnostic criteria to different patients.[4] The authors concluded that there was no relationship between CTS and work. For similar reasons, my research concluded that the relationship between CTS and work is limited to very cold temperature work possibly in conjunction with load and repetition.[5]

Hand-arm vibration syndrome has

been reported in many occupations, including forestry and quarry workers, builders, carpenters, mechanics and labourers.[5] Rotatory and percussive tools such as grinders, jack hammers and impact wrenches pose the highest risk.[6–9]

Hand-arm vibration syndrome is far more common in men than women owing to the types of work carried out and the tools used, with UK estimates being 9:1[10]and Swedish estimates being 11:1.[11] Reported prevalence among exposed workers are between 6 and 100%, with an average of 50%,[1] workers in high risk occupations such as forestry workers having prevalences of 80% or more.[1,12,13]

The incidence in the UK, where the risk is widely promoted and reporting is mandatory, has significantly increased with time; 113 new cases were reported in 1993/1994 versus 1009 cases in 2001–2002.[14] Hand-arm vibration syndrome is now the most compensated disease in the UK.[14] The reported incidence in Australia, where the risk is not promoted nor reporting mandatory, is minimal. In New South Wales in 2000, only three cases of HAVS were reported to WorkCover.

Hand-arm vibration syndrome consists of a combination of peripheral neurological, vascular and musculoskeletal signs and symptoms, primarily 'occupational' Raynaud disease and digital polyneuropathy. The vascular and neurological effects are cumulative, and the components often occur and progress independently of each other.[1,8] It is a chronic progressive condition with a mean latency of six years.[1] The threshold value, dose response relationship, and latent period vary from worker to worker due to many work and nonwork factors (Table 1).[1,6].

Technological change has also had an effect on dose, eg. petrol chainsaws in the 1950s were large and awkward to use, so they were only used for a couple of hours per day. In the 1960s, they were made lighter and less cumbersome so could be used 4–6 hours per day. In the early 1970s, HAVS in chainsaw users was publicised and chainsaws were redesigned to minimise vibration levels (in one longitudinal study from Finland, vibration levels fell from 162 m/s^2 to 17 m/s^2). As a result, since the 1980s, longitudinal studies have shown that the prevalence of HAVS in chain saw workers has declined.[1]

Table 1. Factors influencing the development of HAVS

Work factors which influence outcome	Nonwork factors which influence outcome
• total hours of use	• individual susceptibility
• workplace temperature	• use of peripheral vasoconstrictors, such as cigarettes and tobacco
• acceleration of tool	• lifetime exposure to vibration outside work
• state of tool maintenance	• previous hand injury
• grip force used	• predisposing disease, such as diabetes and rheumatoid arthritis
• handle design	
• task rotation	
• rest breaks	

Diagnosis is difficult due to the lack of a 'gold standard' objective test or simple clinical test for HAVS. It can coexist with CTS.[12] The vascular component of HAVS is either absent or less pronounced in temperate climates, making it mimic CTS.[15] Therefore, if a man who has worked with vibration presents with apparent CTS, HAVS should be considered either as a diagnosis or co-diagnosis.

Few workplaces in Australia manage vibration risk or screen to identify workers with early HAVS who should be redeployed. Therefore, local doctors have an important opportunity to diagnose HAVS and to recommend immediate redeployment to tasks with no exposure as part of treatment.

Diagnosis of HAVS

Diagnosis is based on symptom and exposure history, examination and testing.

Symptom history

Neurological

Workers usually present with tingling, numbness, poor dexterity and finger pain, which need to be distinguished from other neurological conditions such as peripheral neuropathy due to diabetes, etc. and nerve compression such as CTS. The reduced fine motor coordination, dexterity and grip strength found in control studies of patients with HAVS[11,19] are due usually to sensory loss[8] and are usually worse in the dominant hand.[20] These symptoms are initially intermittent but later become continuous if exposure continues.

One group found workers had significant motor and sensory changes in the median nerve at and distal to the wrist, but not in the ulnar nerve or forearm.[20] Two groups found these workers had impaired vibrotactile sense, abnormal cold intolerance and increased temperature thresholds when compared to matched controls.[20,21] This suggests injury to both the median nerve at the carpal tunnel and receptors and digital nerves in the fingertips.

A higher prevalence of CTS has been reported in vibration exposed workers than in controls in a number of studies, with increased likelihood of the ulnar nerve being involved in vibration related CTS than in idiopathic CTS.[18] The UK Industrial Injuries Advisory Council[12] found work with vibration is associated with double the risk of developing CTS. Unlike HAVS, CTS is more common in women than men, the reported ratio being 3:1.[22] An increased incidence of CTS with increasing age has been reported in men, whereas in women it peaks at menopause and then declines.[5]

As HAVS and CTS often coexist, this should be considered before diagnosis is made and treatment offered. Hand-arm vibration syndrome and CTS have similar sensorineural symptoms[12] which are summarised in Table 2.

Vascular

'Occupational' Raynaud disease, also known as 'vibration white finger' – local finger blanching caused by vasospasm of the skin venules[23] – is the vascular component of HAVS. Typically, in early HAVS, the tip of one or more fingers temporarily blanches and numbs when exposed to cold, and on rewarming, hyperaemia and pain are experienced. Tingling and numbness may precede blanching. Symptoms are usually asymmetrical, unlike in primary Raynaud disease.

Later, with continued exposure, the extent, duration and frequency of blanching increases, although the thumb and palms are not usually effected. Rarely, peripheral circulation slows to the extent that fingertips become cyanotic. Other very rare causes of occupational Raynaud phenomenon are past use of vinyl chloride (a carcinogen now eliminated from the workplace) and frostbite[24] (which previously occurred in industries such as fishing). These vascular symptoms of HAVS usually have a longer latency than its neurological symptoms, and must be distinguished from primary Raynaud disease, which is associated with other medical conditions such as rheumatoid arthritis, has a prevalence of between five and 11% in the general population,[7] and usually effects both hands (and feet) equally.

A higher prevalence of vascular symptoms are found in cold countries, reflecting the role of external temperature.[17] Control studies have found that vascular symptoms may be absent or milder in warm climates or where workers in cold climates work indoors in warm temperatures, making HAVS mimic CTS.[15] Cold temperature work is also associated with a greater risk of developing work related CTS.[5]

Table 2. Sensorineural symptoms of HAVS and CTS

Symptom/sign	HAVS	CTS
Median nerve signs hand +/- forearm	Y	Y
Ulnar nerve signs	Y	Y, but rare
Night waking with neurological symptoms	N	Y
Reduced grip strength in later stages	Y, but no muscle wasting	Y, with thenar wasting
Occupational Raynaud disease	Y	N

Table 3. Tests for HAVS

Test category	Screening tests used
Vascular	Allen's test, cold provocation test* and cold challenge plethysmography*, doppler ultrasound and radioactive clearance methods may be used to measure digital blood pressure and flow Thermography is sometimes used to assess skin temperature distribution**
Neurologic	Light touch, pin prick, thermal threshold testing, vibration perception threshold, two point discrimination testing, nerve conduction study, EMG, Tinel's and Phalen's Tests† may all be used for screening and diagnosis of sensory impairment
Musculoskeletal	Grip and pinch strength
Haematologic	Sedimentation rate, blood viscosity, uric acid, rheumatoid factor, antineuclear antibodies, cryoglobulins, serum protein electrophoresis.
Urinalysis	Proteinuria, glycosuria

* test conditions for cold stress tests are not yet standardised, limiting their vailidity[25]
** technological change continually improves resolution with thermography[3]
† a recent review examined the validity and accuracy of using bedside tests (Tinel's and electrodiagnostic) to diagnose the neurological component of HAVS. It concluded that no bedside test could distinguish HAVS from CTS[27]

Musculoskeletal

Complaints of upper limb pain are common in HAVS,[8] but are probably attributable to the effects of heavy manual work that often accompanies vibration exposure and osteoarthritic change.[8,12,17]

Exposure history

Work and nonwork history

Estimate the vibration dose based on tools used and exposure times at work (and home).[6] Impact and rotatory vibration poses the greatest risk.[14,8] One study found workers tended to over estimate exposure duration.[8] Questions on prolonged exposure to cold at work should be included.

Smoking history

Smokers are more likely to develop HAVS than nonsmokers[3] and are twice as likely to experience severe circulatory problems[23] and recover more slowly after ceasing exposure. Smokers with HAVS are younger, have had a lesser exposure time than nonsmoker controls,[23] and if they continue to smoke after ceasing exposure, the vascular component of their HAVS may worsen.[23] Smokers are also more likely than nonsmokers to develop CTS. A study of 1464 industrial workers found those with CTS had a 19% greater lifetime use of tobacco and a 26% greater current tobacco use than nonsmokers.[25]

Examination and testing

Examination

A comprehensive physical examination is recommended, with a focus on peripheral neurological and peripheral vascular status. Screen for old injuries that could have peripheroneurovascular effects such as burns, trauma, and frostbite; other disorders or substance use that could cause similar signs or symptoms such as peripheral vascular disease, rheumatoid arthritis, cold haemagglutination syndrome, diabetic polyneuropathy and use of tobacco and alcohol.[1]

Testing

There are no 'gold standard' objective tests for HAVS – different authors use no or different diagnostic tests. Tests most commonly employed are listed in Table 3.[1]

Treatment

Treatment is directed at removal from all exposure and use of measures to increase peripheral circulation and to compensate for sensory loss if required. None of the literature read mentioned use of any physical therapies as treatment for HAVS. Treatment consists of:

- Cease all exposure and advise patients to cease smoking. In early stages, HAVS may be reversible if all vibration exposure and smoking is ceased.[1,14,16,27] The UK Health and Safety Executive and the US National Institute of Occupational Health and Safety recommend any worker with blanching proximal to the distal phalanx of one or more fingers should cease work with vibration.[10,1] The worker should also cease all exposure in leisure pursuits. In advanced stages, even if exposure ceases, HAVS usually does not improve and may progress,[16] resulting in loss of hand function and occasionally fingertip necrosis.[1] Such workers are unable to work and should receive workers compensation, and may also require assistance in the activities of daily living. Smokers with HAVS are twice as likely as nonsmokers to experience severe circulatory problems,[3] and are likely to recover more slowly after ceasing exposure.[23] If they continue to smoke after ceasing vibration exposure, their smoking will aggravate the vascular component of HAVS.[23] Workers with HAVS should therefore, be actively encouraged to cease smoking.
- Trial calcium antagonists (in addition to removal from exposure) are usually considered in older subjects and/or if Raynaud symptoms are severe, as they have been successfully used in clinical trials to treat occupational Raynaud disease.[28,16] The recommended regimen is nifedipine 10–20 mg per day for a 2–4 week trial.[16]
- Advise patients to keep peripheral and core body temperature high and avoid cold exposure to reduce frequency of blanching attacks. 'Antivibration' gloves are available, but scientific studies have found that few, if any, attenuate vibration and some even amplify vibration at <100 Hz.[29,24] Gloves that are beneficial protect relevant workers against cold (and damp) as these factors trigger attacks of occupational Raynaud disease.[15] Selecting gloves (and other protective equipment) should be undertaken by an occupational health and safety expert as poor glove selection may reduce sensation/adhesion to the tool, meaning greater grip force is required, increasing risk of muscle and joint injury.
- Injury avoidance – workers with severe sensory loss should be advised to visually protect their hands from injury and to regularly inspect their hands for injury.

Conclusion

If a male patient presents with apparent CTS, it is important to consider a diagnosis or co-diagnosis of HAVS if he has had vibration exposure at work, as both conditions are associated with hand transmitted vibration exposure. Diagnosis of HAVS is made difficult by there being no 'gold standard' diagnostic tests, no simple clinical tests, and by the similarities to CTS with which it can occur in combination. This is especially so in temperate climates, where the vascular symptoms of HAVS are either absent or less pronounced, making it mimic CTS.

Treatment of mild cases with cessation of all exposure (and smoking) may reverse the condition. In severe cases, calcium antagonists are also used, but treatment is often ineffective, HAVS may worsen and the result can be extreme disability.

Few workplaces in Australia do anything to manage vibration exposure or conduct screening to identify workers with early HAVS. Therefore, general practitioners have an important opportunity to diagnose HAVS and make recommendations to the workplace on immediate redeployment of the worker as part of treatment before HAVS symptoms become irreversible.

Conflict of interest: none.

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Correspondence

Email: falkinerso@sesahs.nsw.gov.au