Use of Doppler in the diagnosis of hypothenar hammer syndrome

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Background

Hand–arm vibration syndrome (HAVS) includes a spectrum of vascular, neurological and musculoskeletal symptoms resulting from exposure to vibrating tools. Hypothenar hammer syndrome (HHS) is a lesion of the ulnar artery as it courses adjacent to the hamate bone and results from either single or repeated episodes of trauma to the hypothenar eminence. There is a need to distinguish symptoms of HHS from those of classical HAVS since precise diagnosis may alter both the clinical and occupational management of the affected employee.

Aims

To highlight the value of simple Doppler assessments of the palmar blood flow to distinguish the condition of HHS from ‘classical’ HAVS.

Method

Among patients assessed for HAVS by the authors during 2006, three were identified as potentially having HHS. Doppler ultrasound of the palmar arches with and without ulnar arterial occlusion was used.

Result

We report three cases in which Doppler ultrasound assessment supports a diagnosis of HHS.

Conclusions

It is our recommendation that such Doppler assessments should form part of the clinical assessment of workers being assessed in connection with exposure to hand-transmitted vibration and in whom symptoms are present that are not typical of ‘classical HAVS’, particularly where there is a history of possible hypothenar trauma.

Key words

Allen’s test; Doppler; hand–arm vibration syndrome; hypothenar hammer syndrome; Raynaud’s phenomenon.

Introduction

Hypothenar hammer syndrome (HHS) resulting from trauma to the ulnar artery as it courses around the hook of the hamate bone in the proximal palm was originally described by Von Rosen [1]. In a common law claim submitted in the UK, the original diagnosis of hand–arm vibration syndrome (HAVS) was called into question on the basis of the findings of Allen's test, which demonstrated absent ulnar input into the palmar circulation [2]. A vascular surgical opinion suggested that damage to the arterial tree was at the level of the palmar arch rather than the ulnar input and the claim was successful on the basis of a diagnosis of palmar arch disease (PAD).

The ulnar artery passes through the Guyon canal, the roof of which is formed by a ligament between the pisiform and hamate bones. As the ulnar artery emerges from Guyon’s canal, it is fixed to surrounding structures over a length of 2–3 cm. Trauma to this area can lead to stenosis or occlusion of the ulnar artery or damage to the ulnar nerve, affecting the blood supply to the superficial palmar arch and most of the fingers. The superficial palmar arch is believed to arise entirely from the ulnar artery in 37% of cases and to be incomplete in 16–22% of patients [3,4].

In HHS, the damage is caused by either single or repeated trauma, when using the hypothenar side of the hand as a hammer, either as part of a work process or recreational activity. Ulnar artery aneurysm in the palm may also be congenital [5], result from endocarditic emboli [6] or penetrating trauma [7]. There is a single case report of an anomalous hand muscle in Guyon’s canal being associated with ulnar artery thrombosis, although smoking and blunt trauma were additional factors [8]. Arteriosclerosis is usually absent, but endothelial antithrombogenicity is likely to be altered by repetitive trauma.

The world literature contains little epidemiological evidence of a causal link between PAD or HHS and exposure to hand-transmitted vibration. Both PAD and HHS are widely regarded as rare conditions, although it has

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been suggested that may be incorrect [9] and that the true incidence of either condition is not known. It is possible that the condition goes widely unrecognized in industry. The classical presentation of HHS is said to be in the dominant hand of middle-aged craftsmen—manual workers who experience repeated trauma to the palm of the hand—and affecting the hand used preferentially for hammering, which may or may not be the dominant hand. Hence, work such as mining, automobile mechanics [10], sawmill work, carpentry [11] and the use of hammers and screwdrivers is likely to be associated with development of HHS. Review of mechanical workshop employees showed that 79 of 127 men were habitual hypothenar hammerers [12], of whom 11 (14%) had symptoms of vascular insufficiency and objective evidence of arterial occlusion, whereas occlusion was found in none of the non-hammerers. Kaji et al. [13] found 24 cases of HHS among 293 subjects diagnosed as suffering from vibration disease and showed that the right hand was involved in 53% of cases, the left in 25% and both in 22%.

Little and Ferguson [12] reported that 62% of 127 vehicle maintenance workers habitually used the hand as a hammer with a 14% prevalence of subclinical ulnar artery occlusion; 9% had HHS of one or both hands, with only two having bilateral disease.

It is necessary to distinguish symptoms of HHS from those of HAVS since precise diagnosis may alter both the clinical and occupational management.

**Clinical assessment**

HHS may initially present as Raynaud’s phenomenon, so assessment must include consideration of the factors distinguishing HHS from classic Raynaud’s phenomenon [14]. Assessment of the ulnar artery and palmar arch by Doppler assists in this differential diagnosis but could also identify cases amenable to treatment, albeit HHS is usually diagnosed too late for recanalization to be a viable option [15]. Spencer Green suggested that the features suggestive of HHS included asymmetrical distribution, usually in the dominant hand, absence of the hyperaemic phase, diminished radial or ulnar pulses and digital ulcers in the area supplied by the affected vessel. Asymmetry is unlikely to be helpful as a distinction from HAVS, in which the initial distribution of Raynaud’s phenomenon classically affects those fingers most exposed to vibration. However, it is frequently the lead hand rather than the dominant hand that is so affected. It is increasingly accepted that hyperaemia is not an essential diagnostic feature for Raynaud’s phenomenon.

Other clinical features of HHS include subcutaneous thickening, tenderness on compression and percussion of the hypothenar eminence or Raynaud’s phenomenon of the last fingers [16]. Pallor and cyanosis may occur but hyperaemic redness has not been described [17]. A hypothenar mass or callous may be palpable [18]. Allen’s test may be useful but Kaji found this to be negative in 17% [13]. Painful finger clubbing has been associated with a palmar aneurysm, the pain disappearing following surgical treatment [19].

The gold standard for diagnosis of HHS is arteriography [20], which would be expected to show obstruction or ‘the corkscrew sign’—with alternating stenosis and ectasia [10]. However, Ferris et al. [21] showed the presence of the typical ‘corkscrew’ segment in the asymptomatic hand of patients with contralateral HHS and a high incidence of bilateral abnormalities on arteriography, even in patients with unilateral symptoms.

**Allen’s test**

Described by Dr Edgar Van Nuys Allen in 1929, ‘Allen’s test’ has been used for many years to assess the adequacy of collateral blood flow at the wrist [22]. It was initially used to identify occlusion of the wrist arteries from thromboangiitis obliterans (Buerger’s disease). Many variations of this test have been described, including testing only one hand at a time, compressing both ulnar and radial arteries manually and releasing them one at a time, watching for rubor on the distal-most digit and assigning a positive or negative result based on the filling time. A filling time <6 s is considered by some to indicate normal flow [23], whereas others accept up to 15 s [24]. Allen had noted that ‘the methods described for demonstrating occlusion of the digital arteries do not always give concise results but are valuable in the examination of suspected cases’. The 1993 Faculty of Occupational Medicine working party report on hand-transmitted vibration [25] recommended Allen’s test as one of the simple screening tests easily performed within the consulting room as part of an HAVS assessment. In April 2004, an evidence review commissioned by the Faculty of Occupational Medicine [26] commented that ‘the value of the Allen test for investigating the patency of hand arteries has been questioned’, reflecting a review of a small number of papers including two that reported only moderate interobserver agreement and considerable interobserver disagreement, respectively. Vu-Rose et al. [27] reported on Allen’s test undertaken on 200 hands of healthy volunteers, with positive results in 5.5% but without a single case in which all four observers agreed on the result. Hirai and Kawai [28] looked at 44 hands and found that arterial compression technique was a significant problem, but that with care they were able to obtain no false positives when compared with angiography. They concluded that the test remained useful if properly performed. Kamienski and Barnes [29] found that full extension of the fingers during the Allen test resulted in incomplete refilling of the hand in 73% of cases. Comparing with other techniques such as echo colour Doppler and palmar arch test
Agrifoglio et al. [30] reported that Allen test may be an inadequate method of assessing the quality of the radial artery in at least 5% of patients. False-positive Allen’s tests occur frequently if the wrist and fingers are hyper-extended [29], although with the wrist and fingers in slight flexion the test accurately predicts the continuity of the palmar arch as assessed by Doppler ultrasound.

**Doppler assessment**

In the occupational health clinic, a quick and simple alternative or adjunct to Allen’s test is a qualitative Doppler ultrasound examination. An 8-MHz probe is used for peripheral vascular studies and is placed over the radial and then the ulnar artery at the wrist in order to confirm arterial blood flow at that level.

The probe is then moved gradually along the course of the ulnar artery as it progresses along the hypothenar border of the hand to become the superficial palmar arch (Figure 1).

It is then placed over the palmar arch, on the border of the thenar eminence. Variations in anatomy mean that the precise positioning and direction of the probe may vary considerably from one individual to another (Figure 2).

The test is then repeated with the radial arterial flow occluded by direct digital pressure (Figure 3). Loss of Doppler signal on radial compression implies the absence of arterial input from the ulnar artery. The site of that occlusion will be determined by the position of signal loss.

Rather than completely obliterated, it is possible that the ultrasound signal will be altered, which may indicate stenosis, or corkscrew deformity of the ulnar artery.

Taute et al. [31] found that colour-coded duplex sonography enabled distinction between HHS and other causes of digital ischaemia.

**Case series**

**Case 1**

Mr X was a 45-year-old man who worked as a gardener for 15 years. He used a variety of garden equipment including strimmers, hedge cutters, chain saws and lawn mowers. The work tended to be seasonal, with trigger times up to 5 h/day over several months and chain saw usage up to a day a week. He also spent several winters fixing steel lawn edges with steel spikes using a lump hammer held in his right hand. He is dominantly right handed. After 12 years, he noticed episodes of whiteness and discomfort in his right little and ring fingers during cold exposure. Further enquiry elicited a history of sharply demarcated finger blanching affecting the whole of the little finger and the right ring finger to the distal interphalangeal joint. Episodes were confined to cold wet weather conditions and tended to last between 10 and 15 min.

During these attacks, his fingers felt cold and numb but unusually he did not describe any hot aches at the end of attacks. He did not have symptoms of numbness or tingling at any other time or have symptoms affecting his left hand or feet. There was nothing else of note in his medical history and he was not taking any medication. Clinical examination performed in 2006 was unremarkable including normal blood pressure, Tinel’s and Phalen’s tests, normal maximum grip value and manipulative dexterity (Jamar hand grip dynamometer and Purdue pegboard test). He had a positive Allen’s test when releasing the right ulnar pulse. Doppler was used to confirm the presence of radial and ulnar pulses in both wrists. Without occlusion of the artery, a Doppler was used to trace the ulnar pulse from the wrist, along the hypothenar eminence and over the area of the hamate bone where a loud bruit was detected. There
were no significant abnormalities found on sensorineural testing, by vibrotactile thresholds and thermal aesthesiometry. Finger systolic blood pressure (FSBP) was abnormal in his right little finger (FSBP < 60% at 10°C). FSBP was normal in the index, middle and ring fingers of the right hand.

It was concluded that Mr X gave a good history of cold-induced attacks of vasospasm in his dominant right hand, ring and little fingers. His vibration exposure of 15 years was intermittent and variable in magnitude. There was no obvious explanation for asymmetry of symptoms when taking account of his trigger and leading hand postures. For several winters, he was involved in significant hand hammering which may have led to trauma over the area of the hypothenar eminence.

The conclusion was that he suffered from the HHS, vibration exposure having contributed to his presentation. It was recommended that he discontinued hand hammering and avoided using his hand as a hatchet in any way. He was not disabled by his symptoms and further investigations were not pursued. In this case, a Doppler was useful in screening for possible presence of a stenosis or post-stenotic dilatation/aneurysm when HHS is suspected.

Case 2

Mr Y was a 66-year-old naturally right-handed man who had undertaken a variety of jobs during his working life, including using jackhammers, hand-held grinders, a shovel to pack ballast and undertaken sheet metal work, which he described as involving a lot of pushing and hammering with both of his hands. Symptoms had not changed after he ceased work in 1996. He presented with colour changes affecting the index, middle and ring fingers of the right hand. There were no sensory symptoms other than with the episodes of colour change, which were uniform and clearly demarcated and lasted up to 1.5 h. He did not have symptoms affecting his left hand or feet. He had a history of heart disease, for which he was taking medication, but no vasoactive medication other than beta-blockers for a short period around 1995. He smoked 20 cigarettes per day. Alcohol consumption was up to /C24 units/week.

Examination in 2006 revealed coldness of the whole of the right hand. He had normal light touch sensation but diminished pinprick sensation over the tip of each digit of the right hand. Allen’s test suggested absent ulnar filling bilaterally, which was confirmed by Doppler studies as described above, confirming absence of ulnar input from the level of the hamate bone bilaterally.

It was concluded that this man gave a history of both exposure to hand-transmitted vibration and using the hand as a hammer. Doppler studies were convincing for HHS, although the findings could also represent a normal vascular anomaly. It is unlikely that HHS accounts for the totality of his symptoms given the unilateral symptoms not affecting the little finger. However, it seems likely that the impairment of palmar arch circulation from HHS predisposed other digits to the effects of hand-transmitted vibration. In this case, the duration of symptoms and relative lack of functional disability compared with the effects of his heart disease argued against further investigation and treatment of the ulnar arterial obstruction.

Case 3

Mr Z was a 42-year-old male who had worked as an aerial fitter for ~12 years prior to onset of symptoms, undertaking up to 12 such installations per working day. The work involved drilling five holes per installation, usually in brick walls using a cordless electric powered hammer drill. He used that and a hand-held hammer in his right hand only. Prior to the onset of these symptoms, he was healthy and on no medication. He had suffered a previous neck injury, without any neurological sequelae. There was no relevant family medical history, including of Raynaud’s phenomenon. He smoked 20 cigarettes per day.

While on holiday in 2001, he became aware of coldness in the end of his right thumb, which was numb. The symptoms became worse suddenly in about 2002, without any obvious precipitating factors. He then noticed whiteness of the thumb and the whole of the right hand. He was unable to recall accurately the extent of the whiteness on the first occasion. He developed a tendency to feel the cold and clumsiness of the right hand. Although he changed jobs in 2003, with no further exposure to hand-transmitted vibration after that time, the colour change symptoms continued to deteriorate. In 2006, he reported whiteness of the whole of the right hand, lasting a couple of hours or sometimes all day. When white, he felt tingling and hypersensitivity in the hand. The whiteness could be either uniform or blotchy and occurred daily in the winter. Engineering assessment concluded that the daily A(8) exposure was likely to be significantly <2.8 m/s² and possibly as low as 1.1 m/s².

He had been fully investigated (autoantibody screen, nerve conduction studies, magnetic resonance imaging scan and X-rays of cervical spine), which revealed no abnormality. Doppler studies were reported as showing damping of the signals over the distal digital arteries, but there was no report of previous Doppler assessment of the ulnar and radial arteries or of the palmar arches. Previous assessments had concluded that the symptoms were attributable to HAVS.

Clinical examination performed in 2006 was unremarkable. The colour and temperature of his hands appeared normal, and there was no abnormality in the area of the hypothenar eminence. Radial and ulnar pulses were palpable on each side. There was no evidence of Dupuytren’s fibrosis.

Pinprick, light touch and vibration sensations were normal throughout both upper limbs apart from being reported as feeling more sensitive than usual from the
level of the right wrist distally. Two-point discrimination was reduced in the right hand. Doppler studies revealed normal signals over the radial and ulnar arteries and superficial palmar arches. The signal over the right superficial palmar arch was obliterated by pressure on the right radial artery. The left palmar arch was normal on radial occlusion. Ultrasonic artery occlusion did not alter the palmar arch signal on either side.

Mr Z described symptoms that were more widespread than expected with HAVS, with deterioration since the cessation of exposure to hand-transmitted vibration, and colour changes sometimes lasting all day, arguing against a diagnosis of Raynaud’s phenomenon. Doppler studies showed obliteration of the superficial palmar arch signal in the right palm by pressure on the right radial artery. It was concluded that a diagnosis of HHS would account for the totality of Mr Z’s symptoms, as well as explaining the features that do not fit with a diagnosis of HAVS. Although Doppler studies had been undertaken previously, these had not included assessment of the ulnar arterial input to the palmar arch, which were considered to be confirmatory of the diagnosis.

Discussion

It remains conjectural as to whether or not exposure to hand-transmitted vibration causes damage to the ulnar artery around the level of the wrist although some studies have suggested such an association [13,32–34]. HHS has also been reported to result from either single or repeated trauma to the heel of the hand. The aim in reporting this case series was to demonstrate the benefit of using a Doppler in the differential diagnosis of HAVS and HHS. In the three reported cases, we conclude that trauma had contributed to the development of symptoms initially considered to be related solely to the effects of hand-transmitted vibration. This can be useful in ensuring appropriate advice be related solely to the effects of hand-transmitted vibration to the development of symptoms initially considered to be confirmatory of the diagnosis. In the three reported cases, we conclude that trauma had contributed to the development of symptoms initially considered to be related solely to the effects of hand-transmitted vibration. This can be useful in ensuring appropriate advice.

Conflicts of interest

None declared.

References


