QUALITATIVE AND QUANTITATIVE CHARACTERISTICS OF PAIN SYNDROME IN HAND-ARM VIBRATION SYNDROME

Vasily Shirokov, Inna Krivtsova, Helena Bakhtereva, Olga Shirokova, and Margarita Granovskya
Federal State Scientific Institution «Ekaterinburg Medical Research Centre for Prophylaxis and Health Protection of Industrial Workers», Russia

1. INTRODUCTION

Among all chronic occupational diseases in Russia, Hand-Arm Vibration Syndrome (HAVS) makes up 25. 8 %. Now a classification of syndrome for vibration-induced hand disorders is used in Russia in which the leading syndromes are peripheral, vascular and neurologic disorders. The musculoskeletal pathology is included in this classification [1, 2]. The diagnosis confirmation requires some investigative methods of analyzing all three components of HAVS: vascular, sensory, neurological and musculoskeletal.

For patients with HAVS, the most common complaints are pain, tingling or numbness of fingers, chillness of hands (heightened sensibility to cold) and fingers albication (white fingers). The perception of pain is always subjective. For specification of sensory symptoms in hands, several electro-physiological methods are used: electroneuromyography (ENMG) and quantitative sensory testing (QST). Study of the relationship between qualitative and quantitative indicators of pain may contribute to the study of mechanisms of pain perception [3]. In clinical medicine, neuropathic and nociceptive pain mechanisms are distinguished for determining adequate analgesia methods. Neuropathic and nociceptive mechanisms were determined in the development of pain syndrome in various diseases of the peripheral nervous system. Researching the character and neurophysiologic mechanisms of pain syndrome in occupational diseases is an actual problem nowadays [4, 5].

The aim of this study was to investigate the correlation between electrophysiological methods and pain questionnaires in patients with vibration-induced hand disorders.

2. APPARATUS AND METHOD

For qualitative and quantitative characteristics of pain, all the patients were investigated with a clinical bedside examination, electrophysiological methods and pain questionnaires. The questionnaires (pain scales) consisted of several validated instruments which were used to examine intensity of pain, quality of pain and neuropathic pain: Visual Analog Scale (VAS) [6], specialized questionnaires screening for neuropathic pain - Douleur Neuropathique in 4 questions (DN4) [7] and Pain Detect (PD) [8]. DN4 questionnaire: If the patients score is equal to or greater than 4, the test is positive (sensitivity: 82.9%; specificity: 89.9%). Pain Detect: If the patient score is equal to or less than 12, a neuropathic pain component is unlikely (<15%); 13-18 points, the result is ambiguous, although a neuropathic pain component can be present; and equal to or greater than 19, a neuropathic pain component is likely (>90%). The questionnaire tool correctly classified 83% of patients to their diagnostic group with a sensitivity of 85% and a specificity of 80%.

ENMG was carried out using an electromyograph (Neurosoft, Russia), and nerve conduction velocity (NCV), latency, and the amplitude of the M-wave were determined. QST was carried out using a neurosensory analyzer, Model TSAII (Medoc, Israel), and thermal thresholds (WS), vibration sensitivity , cold sensitivity (CS), thermal pain (HP) and cold pain (CP) were determined. Statistical processing of the results was done by Statistica 6.0. Parametrical and nonparametric methods of the statistical analysis were used, depending on character of distribution of the data (age, length of service, results of questionnaire and electrophysiological methods). Quantitative variables are presented as M± m.

A group of 26 miners at a bauxite mine (from workers in the Sverdlovsk region, Russia) aged from 35 to 57 (mean age 48.3±0.9 y) with upper limb disorders were examined. Their participation was voluntary, and the subjects gave their informed consent. Major specific risk factors were: use of vibrating equipment and tools (110-120 decibel), intensive manual work, air temperatures of about 6-12°C and high use of watering. The durations of exposures were between 10 and 33 years (24±1.1 y).

Patient symptoms were obtained during physical examinations conducted by a physician, who also conducted a neurological examination to detect polyneuropathies. Among this group of workers, 15/26 (57%) were with HAVS, and 7/26 (9%) had occupational musculoskeletal disorders. Among the 15 patients with HAVS: 5 had vascular disorders, 3 had neurological disorders, 7 had an expressed degree of illness-the combination of vascular and neurological disorders with a musculoskeletal pathology.

3. RESULTS

From the results of the VAS, the intensity of pain syndrome was characterized by high point scores, and was therefore interpreted as "strong". High values from the questionnaires screening for neuropathic pain (DN4 and PD) point to a high probability of presence of neuropathic pain

component. On the PD, the average score among all was more than 13 points. On the DN4, all got more than 4 points. The results of ENMG were: 24/26 patients had symptoms of axonal-demyelization process (multifocal neuropathy), 1/26 patients had decrease of the medianus nerves conductivity, 1/26 patients had normal indicators and 3/26 patients (with occupational musculoskeletal disorder) had combination of multifocal polyneuropathy with the syndrome of the cubital canal. Signs of carpal tunnel syndrome in this group of patients ware not found. Temperature threshold c vib hanges (all thermal sensitivity tests and ration sensitivity) occurred in all patients.

Table 1.

Details of Symptoms	n=26	%
Painful cold	26	100%
Pain in articulations of hand	26	100%
Numbness	25	96%
Pins and needles	24	92%
Neck pain	24	92%
Tingling	21	80%
Electric shocks	11	42,3%
Angiospasm (blanching)	10	38,4%
Burning	4	15%
Itching	4	15%

There was a statistically significant correlation (Spearman Correlation) between the level of pain on the VAS and the questionnaire results on neuropathic pain. There was a direct correlation between the level of pain on the VAS and the PD ($r=0.603$; $p=0.001$), and between the inverse between the VAS and the DN4 ($r=-0.554$; $p=0.003$). All 26 patients responded positively to DN4 (6.4 ± 0.2), but the number of patients with points in the PD over 13 was 19 (73.1%). The levels of pain on the VAS ($r=0.543$; $p=0.004$) and the PD ($r=0.479$; $p=0.013$) were directly correlated with sleep disorders. However, no significant correlation was observed between the questionnaires on neuropathic pain and the duration of service. There was a direct correlation between positive results on the neuropathic component of pain (PD) and parameters of the QST: such as Ws ($r = 0{,}631$; $p = 0.001$), Cs ($r = -0{,}406$; $p = 0.040$) (Table.2). Statistically significant correlation was revealed between the indices ENMG (NCV-nerve conduction velocity) and DN4 ($r = 0{,}406$; $p = 0.040$), NCV and QST (vibration sensitivity $r = 0{,}447$; $p = 0.022$).

Table 2.

	CS	WS	CP	HP
Pain Detect	r = -0.406 p= 0.044*	r =0.63 p= 0.001**		
M-amp			r =0.406 p= 0.044*	r =-0.614 p= 0.001**

4. DISCUSSION

The analysis of pain and patient complaints indicates suspected presence of both the neuropathic and nociceptive pain components (Table.1). The results suggest there may be correlations between the QST and pain questionnaire results, that subjective perceptions of pain might be represented by a certain pattern in the QST results. These connections could help clarify the pathophysiologic mechanisms leading to the perception of pain. Lack of correlation between the data of DN4 and the duration of work exposures is probably connected to the fact that only long-service miners having a work-related disease were involved in the investigation. That is why correlation was done between questionnaires results and the neuro-physiological methods. During the analysis of QST and ENMG data, we found correlation only between NCV and VS. It may indicate damage to A-beta fibers. The observed changes of WS and CS are of some interest. The results confirm the difficult structure of a chronic pain syndrome in vibration-induced hand disorders. Extensive use of pain questionnaires and quantitative sensory testing allow components of a chronic pain syndrome to be specified, and can contribute to optimizing therapeutic tactics. All the received data need to be further studied and analyzed.

REFERENCES

1. *Classification of Vibration Disease from Local Vibration Exposure. Guidelines (Methodical Recommendations)*. Moscow, 1985, 29.

2. Izmerov, N. F., Monaenkova, A. M., and Tarasova, L.A. (1996). *Occupational Disease. Guidelines for Doctors* (2 volumes) – Moscow. Medicine, 480.

3. Lang, P. M., Rüger, L. J., Abahji, T., Hoffmann, U., Crispin, A., and Irnich D. (2009). "Correlation between quantitative sensory testing and questionnaires on neuropathic pain for chronic ischemic pain in peripheral arterial disease," Schmerz., **23**, 251-8.

4. Moloney N., Hall T., Doody C. (2010). "An investigation of somatosensory profiles in work related upper limb disorders: a case-control observational study protocol," Musculoskelet. Disord. **11**, 22.

5. *A Review of the Literature Published Since 2004 with Potential Relevance in the Diagnosis of HAVS*. (HSE, London 2009).

6. Wall, P. D., Melzack, R., eds. (1999). *Textbook of Pain* (Churchill Livingstone, London, 4th ed.).

7. Bouhassira, D., Attal, N., Alchaar, H., et al. (2005). "Comparison of pain syndromes associated with nervous or somatic lesions and development of a new neuropathic pain diagnostic questionnaire (DN4)," Pain, **114**, 29-36.

8. Freynhagen, R., Baron, R., Gockel, U., and Tolle, T. (2006). "Pain detect: a new screening questionnaire to detect neropathic components in patients with back pain," Curr. Med. Res. Opin., **22**, 1911-20.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to the staff of the Federal State Scientific Institution Ekaterinburg Medical Research Center for Prophylaxis and Health Protection of Industrial Workers (Olga Chudinova, and Galina Samohvalova).