

Theses on the topic:
Vibration disease from local and / or general
vibration exposure

Academic 2021/2022

Vibration disease
Definition

- specific occupational disease
- due to systemic, prolonged exposure to vibrations generated by work tools and machines
- it is characterized by gradual development in three stages
- polymorphic clinical picture with vascular, peripheral nervous and musculoskeletal disorders

Classification

According to the type of vibration:

- **Vibration disease caused by local vibration**
- **Vibration disease caused by general vibration .**

According to the degree of disability:

- **Vibration disease I stage**
- **Vibration disease stage II**
- **Vibration disease III stage**

In the clinical and labor-expert practice intermediate stages are also used:

- **VD I-II stage**
- **VD II-III stage**

- **Definition of Vibration-** the mechanical oscillations of an object about an equilibrium point.

FACTORS AFFECTING VIBROPATHOGENICITY

- Frequency and intensity of the vibrations, duration of exposure

- Additional unfavorable factors - static and dynamic muscle tension, backlash of the working tool, unfavorable microclimate, cold exposure, noise, toxic noxies and others.

Frequency - up to 80%

LOCAL VIBRATION DISEASE

Occupations at risk

- miners, stonecutters, drillers, woodcutters, shapers, tweezers, turners, operators of pneumatic drills, asphalt breakers and others

Histomorphology

- hypertrophy of smooth muscle cells and thickening of the intima of the digital arteries,
- perivascular fibrosis to complete stenosis and occlusion of the small arteries
- thrombosis of aa. digitales and a. ulnaris at the site of its passage in the wrist area
- demyelination of peripheral nerves
- loss of nerve fibers
- perineural fibrosis
- increased number of Schwann cells and fibroblasts with collagen formation and small regenerating axons without myelin sheath
- connective tissue collagen growths,
- destruction of skin elastic fibers, sweat glands, nerve endings and receptors

Pathogenesis

Increased vascular tone and vasoconstrictor activity due to:

- **NEURAL DYSFUNCTION:**
- central reflex disorders and dysfunction of the hypothalamus and limbic system
- autonomous imbalance
- receptor dysfunction (functional predominance of alpha2-adrenoceptor activity) and dysfunction of the peripheral nerve endings, mediating vibrations, pain, touch, discrimination
- overstimulation of Vater-Pacini bodies
- mechanical damage to small blood vessels, vasoregulatory receptors and nerve endings
- lesion of perivascular nerves containing the potent vasodilator calcitonin gene-related peptide (CGRP) and reduced axon-reflex vasodilator response
- **VASCULAR HYPERACTIVITY IN THE INITIAL AND HYPOREACTIVITY IN THE ADVANCED STAGES OF THE DISEASE**
- **LOCAL ACRAL VASODISREGULATION**

- endothelial damage, dysregulation and dysfunction
- increased oxidative stress with increasing superoxide anions
- shear stress
- reduced smooth muscle response to nitric oxide
- **IMPAIRED BLOOD VISCOSITY AND CELLULAR ACTIVATION**
- blood and plasma hyperviscosity
- activation of blood cells with reduced erythrocyte deformability, leukocyte and platelet activation, hyperaggregability and increased thrombosis
- hemorheological disorders - increased blood viscosity
- neuro-humoral dysregulation and dysfunction

HEALTH EFFECTS of local vibration exposure

- **Vascular** (peripheral vascular spasm, Raynaud's phenomenon, peripheral vascular thrombosis)
- **Nervous** (peripheral autonomic, sensory and rarely motor)
- **Musculoskeletal** (myotendinitis, epicondylitis, insertiopathy, periarthritits, bone cysts, osteoarthritis, etc.)

Microcirculatory and vascular disorders

Digital organic microangiopathy:

- "Phenomenon of lace pattern" and / or pale, redness, bruising of the skin of the hands, especially in cold weather.
- Raynaud's phenomenon ("dead" or "white" fingers) - paroxysmal pallor of the distal phalanges of the fingers with a sharp demarcation from seconds to several minutes, usually provoked by cold or emotional stress. Cyanosis and / or arterial hyperaemia follow. It is accompanied by coldness, stiffness and paresthesias.
- Cutaneous dystrophic ulcers of the fingers to sclerodactyly in the third stage.

Hypotenar hammer syndrome:

- It is caused by repeated blunt trauma to the palm and microtrauma of the hypothenar eminence by local vibrations
- The position of a. ulnaris on the hypothenar at the crossing point with os hamatum makes it susceptible to recurrent trauma
 - The formation of an aneurysm or thrombosis of the a. ulnaris is possible

Clinical picture

- Pain on the hypothenar and pallor
- Paresthesias in the hypothenar
- Cold fingers (IV and V)
- Increased sensitivity on the hypothenar
- Allen's abnormal test

Diagnosis

- **If the Allen test is positive:**
 - Doppler sonography
 - Combined study of pulse oximetry and plethysmography
 - When duplex Doppler is positive:
 - Arteriography
 - High-contrast magnetic resonance angiography
- **Allen test:**
 - Strong squeezing of the hand in a fist to push the blood from the vessels of the hand
 - The investigator presses aa. ulnaris and radialis
 - The patient opens the hand (without hyperextension of the wrist and fingers).
 - The investigator releases a. ulnaris and monitors the time to restore capillary circulation (between 5 and 15 sec.)

Vibration-induced neuropathies

- Distal symmetrical polyneuropathy in the upper extremities
- Mononeuropathy of the n.medianus, n.ulnaris or n.radialis
- Cervical radiculopathy

Distal symmetrical polyneuropathy in the upper extremities

- **Autonomic** - distal sympathetic neuropathy: numbness, tingling in fingers and hands; change in skin color - redness, bruising, spotting, pale hands; impaired cutaneous vasomotor reactivity; microcirculatory disorders; vascular dysfunction; dystrophic skin and nail changes
- **Sensory:** paresthesias, distally increasing hypoaesthesia for pain and touch, hypopalesthesia, impaired discrimination
 - **Motor:** muscle weakness, hyporeflexia, hypotrophy of muscle groups
- Mononeuropathy of n. medianus in carpal tunnel syndrome
- Clinic - tingling, burning, discomfort in the fingers (I to III, rarely IV), sometimes irradiation to the forearm, weakness, malnutrition of the tenor, vasomotor and dystrophic disorders
- **Diagnosis:** EMG - conduction rate of the median nerve

N.ulnaris mononeuropathy in cubital canal syndrome

- Clinic - numbness, burning, discomfort in the fingers (IV and V), sometimes irradiation to the ulnar side of the forearm, weakness in opposition of the fingers, hypotrophy of the hypothenar, Diagnosis: EMG - conduction velocity study on the n.ulnaris

Mononeuropathy of the n.ulnaris in Guyon's syndrome in the wrist

Vibration disease from local vibration exposure

- Physical status -especially important for neurological, orthopedic, angiological systems
 - Muscle strength of the arm in a fist, tests of Phalen, Tinel and Allen.
 - Objective functional tests and research:
- algesiometry
- thermesthesiometry
- palesthesiometry
- thermistor thermometry
- capillaroscopy
- distal Doppler sonography,
- laser Doppler flowmetry

- alternating dynamometry
- ENMG
- radiography
- threshold audiometry

- Blood tests:
 - erythrocyte sedimentation rate
 - serum electrolytes
 - creatinine
 - glucose
 - TSH, T4
 - uric acid
 - rheumatoid factor
 - antinuclear antibodies,
 - cryoglobulins

Objective findings

- peripheral autonomic and vascular disorders:
 - distal hypothermia
 - spontaneous hyperhidrosis
 - change in skin color of palms and fingers
 - pallor / whitening of the fingers

- sensory disorders:
 - reduced vibration sensation
 - distally increasing hypoaesthesia for touch and pain in the chest.

- trophic disorders:
 - nails, skin, bones, Finger clubbing
 - hearing disorders

Criteria for the diagnosis of Vibration disease from local vibrations

- sufficient average daily (min 4 hours) and total (min 5 years) exposure to local vibrations
- constellation of peripheral autonomic, vascular, sensory, trophic and musculoskeletal disorders in the upper extremities and hearing disorders
- exclusion of other diseases and conditions with similar symptoms
- elimination test

Differential diagnosis

Raynaud's phenomenon

Connective tissue diseases:

- Scleroderma
- Mixed connective tissue disease
- Systemic lupus erythematosus
- Sjögren 's syndrome
- Dermatomyositis
- Polymyositis
- Rheumatoid arthritis
- Medications and toxins
 - B - blockers
 - Ergotamines
 - Clonidine
 - Chemotherapeutic agents
 - Polyvinyl chloride
 - Cyclosporins
 - Interferon
 - Estrogen
 - Narcotic substances
 - Cocaine
 - Nicotine
- Diseases of the large arteries:
 - Vasculitis
 - Atherosclerosis
 - Thromboangiitis obliterans
 - Embolism
- Paraproteinemia
- Hyperviscosity syndrome (Polycythemia vera)
- Cryoglobulinemia
- Neuropathy
 - Carpal tunnel syndrome
 - Thoracic outlet syndrome
- Adverse factors of the working environment and ecology
 - Cold exposure (frostbite)
 - Microtrauma
 - Acrocyanosis
 - Central cyanosis

VIBRATION DISEASE OF GENERAL VIBRATING EFFECT

ETIOLOGY

- **Vibration ***
- Excessive noise
- Systematic static work
- Heavy physical work
- Work with weights (physical / dynamic load)
- Unfavorable microclimate
- Psycho-emotional strain

* *The disease is caused by a complex of risk factors of the work process and the work environment with a leading importance of vibration.*

Occupations at risk:

vehicles operators, such as drivers of buses, trains, trucks, agricultural heavy equipment, cranes, wheel loaders, caterpillars, excavators, heavy equipment operators and others.



CLASSIFICATION OF VIBRATION DISEASE

- **first stage - initial**
- **second stage - unfolded**
- **third stage - decompensated**
- **intermediate stages : I - II and II - III stages**

Pathogenesis of vibration disease

- direct damage to microvessels, perivascular connective tissue and free nerve endings
- neurocirculatory disorders
- autonomic dysfunction (sympathetic hyperactivity / parasympathetic depression)
- receptor dysfunction - damage to mechanoreceptors (Pacini bodies and Merkel discs)
- neuro-humoral dysfunction

Clinical picture of VD from general vibrations

Polyneuritis syndrome (with sensory and autonomic symptoms)

- lower limbs (initially and most affected)
- In the lower and upper limbs with increased and lowered sensory, autonomic and motor symptoms

Radicular and polyradicular - usually vertebrogenic with leading sensory and autonomic dysfunction

- **Osteoarticular degenerative / dystrophic syndrome**
- osteoarthritis in: lumbar region, elbow, shoulder joint; aseptic necrosis of carpal bones

Musculoskeletal syndrome

- tendovaginitis, radial epicondylitis, shoulder peri-arthritis

Cerebral syndrome or *cerebral dysregulatory syndrome*

Central otoneurological syndrome

Hypothalamic syndrome

- general cerebral symptoms,
- autonomic dysfunction
- vestibular-vegetative disorders; vestibular hyperreactivity
- autonomic, neuropsychiatric, neuroendocrine and neurotrophic disorders

NON-SPECIFIC HEALTH EFFECTS

- Hemorrhoids
- Hernia
- Digestive disorders
- Urinary disorders

Investigation methods

- Doppler sonography of the main cerebral vessels and limbs,
- EEG,
- otoneurological investigation methods
- evoked auditory potentials, radiographs of the lumbar / cervical spine,
- CT
- investigation methods seen in VD by local vibrations

Criteria for the diagnosis of VD from general vibrations

- sufficient average daily (min 5 - 6 hours) and total (min 8 years) exposure to general vibrations
- demonstration of a combination of at least 2 syndromes specific for VD caused by general vibrations
- precise differential diagnosis : exclusion of other diseases and conditions with similar symptoms
- elimination test