Effects of Whole-Body Vibration on the Lumbar Vertebral Column: Experimental Infrared Thermographic Studies

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Although the causal relationship between long-term exposure to whole-body vibration and damage to the spinal cord is still not clearly resolved, numerous investigations have pointed out their close association.

The aim of this study was to investigate the extent to which infrared thermography is suitable for determining reactive, acute effects of whole-body vibration on the vertebral column and for documenting the effects of different frequencies of defined acceleration.

Eight persons were subjected to sinus-wave vibrations ranging from 2 to 12 Hz in steps of 1 Hz. All experiments involved an exposure time of 10 and 30 min.

Our studies have shown that immediate effects of whole-body vibration can be visualized and quantified with the aid of infrared thermography. In response to the stimulus vibration, there is a drop in temperature over the lumbar vertebral column. The temperature drop following vibration exposure varied widely at the individual frequencies investigated, and no uniform frequency could be established that resulted in maximal effects in all test persons. Thus, according to our thermographic data, there seems to be no interindividual uniform resonance frequency of the spinal cord.

Introduction

In industry, one frequently encounters mechanical vibratory effects, which pose a possible burden on such workers as excavators, caterpillar drivers, etc. The possible burden depends on parameters like intensity, frequency, and direction of vibration as well as body areas exposed and duration of exposure.[1] As can be seen from several review articles on the present state of knowledge of the effects of whole-body vibration, a profound knowledge of these parameters is of particular relevance for assessing the effects of vibration and their possible consequences for exposed humans.[1–3]

A screening study of tractor drivers showed that degenerative changes occurred in their lumbar spinal area more frequently than in nonexposed persons due to the high vibrational burden caused by agricultural vehicles.[4] This study parallels many other studies indicating an increased risk to the spine and peripheral nervous system after intense long-term whole-body vibration.[5]

Low-frequency, high-energy vibrations in the range of 1–20 Hz are considered particularly pathogenic.[6] The body is able to compensate for higher-frequency vibrations more effectively, whereas an increased stress resulting from vibrational excess occurs in the resonance frequency range. This applies particularly to vibration exposures in an upright-seated position: In this most frequently encountered posture, the potentially noxious agent acts directly on the spinal cord without attenuation.

A major problem in determining harmful effects to the vertebral column and surrounding tissues is that until now many studies have relied on anamnestic, subjective information given by exposed persons.[5] However, subjective accounts may not necessarily correlate with the symptoms and extent of damage. Causal relationships between the noxious agent and pattern of symptoms as well as etiopathogenetic aspects can be established only to a limited extent in this way. More objective methods of investigation, such as conventional x-ray diagnosis, have the great disadvantage that only structural changes resulting from long-term exposure can be determined and in general these changes are irreversible. It is thus desirable to have an objective method of investigation that allows the effects of whole-body vibration on the spinal cord to be determined functionally before structural changes occur.

Problematics

The aim of this study was to investigate the extent to which infrared thermography is suitable as a noninvasive and nonstressful procedure

- for determining reactive, acute effects of whole-body vibrations on the spinal vertebral column
- for documenting the effects of different frequencies of defined acceleration
- for checking whether there are intra- and interindividual preset frequencies that have particularly strong effects.

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