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HUMAN RESPONSE TO VIBRATION

ABSTRACTS

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B. T. Flodmark and G. Lundborg 1997 *Occupational and Environmental Medicine* **54**, 880–887. Vibrotactile sense and hand symptoms in blue collar workers in a manufacturing industry. (8 pages, 2 figures, 6 tables, 47 references) (in English).

Authors' Abstract. Objectives—To study whether vibrotactile sense combined with questionnaires (subjective complaints) and a clinical examination (including scoring of the Stockholm workshop scale (sensorineural staging)) could serve as a screening procedure, in the health care service, for sensorineural symptoms. A group of blue collar workers exposed to vibration in a manufacturing industry (rock crushing plants) was used as the study group. Another group of workers not exposed to vibration but subjected to heavy manual work served as the control group. Methods—Vibrotactile sense was determined. The index and the little fingers of both hands were investigated. A clinical examination was performed. Questionnaires were used for exposure data and for assessment of symptoms. Results—Important findings were that impairment in vibrotactile sense correlated with impairment in grip force, cold sensitivity, and other sensorineural symptoms—such as numbness and tendency to drop items. Clinical findings such as Phalen's test and two point discrimination were related only in those workers with the poorest vibrotactile sense. There was a relation between vibrotactile sense and the Stockholm workshop scale (sensorineural staging) for the sensorineural symptoms. Muscle and joint problems were more often seen in workers with decreased vibrotactile sense. Conclusions—Tactilometry for assessment of vibrotactile sense is a useful tool in assessing and evaluating the severity of vibration induced neuromuscular symptoms and verifying the patients' clinical complaints. Heavy manual work without exposure to vibration may contribute to impairment of vibrotactile sense. The relation between impairment in vibrotactile sense and grip strength indicates that impaired sensory feedback may contribute to muscle weakness.

Topics: Vibration syndrome (vibration-induced white finger, muscle, nerve); Vibration sense (thresholds); Diagnostic applications.

T. Ikeda and M. Takahashi 1997 *Acta Otolaryngologica* **117**, 815–818. Active posture control during experimental motion sickness in guinea-pigs. (4 pages, 4 figures, 3 tables, 15 references) (in English).

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Authors' Abstract. This study evaluated active posture control in guinea-pigs under motion sickness stimulation. Twelve guinea-pigs, which received training to stay on a moving perch, were divided into two groups: a motion sickness group and a control group. The motion sickness group was given a combined stimulation of turntable rotation and optokinetic drum rotation, and the control group was given turntable stimulation alone. Motion sickness was evaluated by conditioned taste aversion to saccharin solution. Active posture control was evaluated by the angle of nose tip displacement and the staying duration (length of time that guinea-pigs stayed on the turntable). The consumption of saccharin solution increased in the control group but did not increase in the motion sickness group. The motion sickness group showed a significant increase in the mean angle of nose tip displacement and a significant decrease in the staying duration on the turntable. These results indicate that active posture control was disturbed by motion sickness stimulation.

Topics: Non-human subjects; Motion sickness (causes).

H. Oka and T. Irie 1997 *Medical Progress through Technology* **21**, (Supplement) 1–4. Mechanical impedance of layered tissue. (4 pages, 4 figures, 2 tables, 6 references) (in English).

Authors' Abstract. The human body is a medium which consists of various tissues such as skin, fat, muscle and bone. Each of the tissues has their own biomechanical properties. We have measured biomechanical impedances by applying a random vibration (30–1000 Hz) to the layered model human tissues to study the occurring mechanism of impedances measured at the skin surface. The data showed that the top tissue layer and the underlying layer both contribute to the impedance, depending on the thickness of the top layer. The contribution of the underlying layer was clearer over the frequency range from 30–400 Hz. Quantitatively we found the following: the impedance measured at the surface was roughly expressed as the model which is connected in series by the impedances of the top and underlying tissues. The contribution of the underlying tissue decreased according to the increase of the thickness of the top tissue, and disappeared over a certain thickness (18 mm in this paper).

Topics: Biodynamics (body tissues).

B. Cheung, K. Money and M. Eizenman 1998 *Aviation, Space, and Environmental Medicine* **69**, 121–128. Oculomotor response to linear acceleration as induced by counter-rotation in supine subjects. (8 pages, 4 figures, 3 tables, 19 references) (in English).

Authors' Abstract. Background: horizontal nystagmus occurs in response to sinusoidal linear acceleration directed along an upright subject's *Y* (interaural)-axis, and is proposed to be mediated by an utricular otolith mechanism. Hypothesis: the otolith organs, composed of the utricles and saccules, provide a unique set of signals for any linear acceleration in 3-dimensional space. A supine subject under alternate changing directions of linear acceleration as induced by counter-rotation will receive alternate stimulation along the Y as well as the Z (dorsoventral)-axis. We hypothesized that alternate horizontal and vertical nystagmus would be elicited as a result of the changing direction of linear acceleration. Methods: a group of eight subjects in the supine position were exposed to counter-rotation at 0·16, 0·25, and 0·33 Hz. Vertical and horizontal eye movements were recorded simultaneously using the El-Mar eye and head tracking system. Results: horizontal nystagmus was observed in all supine subjects. The direction of the slow phase of nystagmus changed with directional changes in linear acceleration. Reversals in the direction of eye movements lagged behind the reversals in the direction of the acceleration. However, only two subjects exhibited alternating horizontal and vertical nystagmus as a result of changing axis of linear acceleration, from "along the Y-axis" to "along the Z-axis". Conclusions: we propose that the nystagmus induced in the supine subject was provoked by linear acceleration and largely an otolith-mediated reflex. The lack of vertical response could be due to the relative paucity of vestibular afferents information along the dorsoventral axis.

Topics: Perceptual mechanisms (vestibular); Vibration sense (sensory mechanisms); Motion sickness.

Y. Xu, E. Bach and E. Ørhede 1997 *Occupational and Environmental Medicine* **54**, 741–745. Work environment and low back pain: the influence of occupational activities. (5 pages, 0 figures, 4 tables, 35 references) (in English).

Authors' Abstract. Objectives—To find associations between the prevalence of low back pain and occupational activities. Methods—Interviews of a random sample of 5185 19–59 year old Danish employees analysed by logistic regression. Results—Increased risk of low back pain were found for "vibration affecting the whole body" (odds ratio (OR) = 1·28), "physical hard work" (OR = 1·28), "frequently twisting or bending" (OR = 1·71), "standing up" (OR = 1·20), and "concentration demands" (OR = 1·28). In the analysis of dose–response relations between low back pain and the risk factors, the one year period prevalence increased with increasing exposure time during a working day to each of the risk factors. The prevalence proportion ratio for those reporting to be exposed for most of the working time were 1·30 for vibrations affecting the whole body, 1·54 for physically hard work, 1·48 for frequently twisting or bending, 1·29 for standing up, and 1·13 for concentration demands. These associations seemed to be stronger in the subjects who worked for 37 h or more per week. The population attributable fractions were 15·1% for frequently twisting or bending, 15·0% for standing up, 7·6% for concentration demands, and 4·4% for physically hard work. Conclusions—Vibrations affecting the whole body, physically hard work, frequently twisting or bending, standing up, and concentration demands proved to be risk factors for the occurrence of low back pain, even after controlling for

age, and sex, educational level, and duration of employment in a specific occupation.

Topics: Physiological effects (muscle and nerve, skeletal); Injury and disease.

M. J. Griffin and M. W. Brett 1997 *Aviation, Space, and Environmental Medicine* **68**, 1115–1122. Effects of fore-and-aft, lateral and vertical whole-body vibration on a head-positioning task. (8 pages, 4 figures, 3 tables, 15 references) (in English).

Authors' Abstract. Background: the performance of tasks in which the head must be positioned close to objects in a moving vehicle may be impeded by the presence of vibration. Hypothesis: it was hypothesized that the extent to which a head positioning task would be impeded by whole-body vibration would depend on the frequency, direction and waveform of the vibration and the posture of the body. Method: there were 12 subjects who participated in a laboratory experiment in which they judged the difficulty of looking through a pair of sights while exposed to low frequency vibration. We investigated 4 variables: vibration axis (fore-and-aft, lateral, vertical), vibration frequency (11 frequencies in the range 0·5–5·0 Hz), vibration waveform (sinusoidal vibration, one-third octave bands of random vibration), seating conditions (wearing a 4-point harness, sitting without back support). Results: we found that all variables affected the perceived task difficulty. Frequencies of horizontal vibration in the range 1–4 Hz caused most difficulty. Task difficulty was greatest with random vibration, especially with low frequency vibration in the horizontal axes. The wearing of a 4-point harness greatly reduced the perceived task difficulty during exposure to low frequency fore-and-aft vibration but increased task difficulty with higher frequencies of lateral vibration. Conclusions: increased motion predictability and the provision of suitable support to the upper body (e.g., a harness, back support, front support) can reduce the difficulty of head positioning tasks during exposure to some types of oscillatory motion.

Topics: Biodynamics (transmissibility); Subjective assessment (general); Non-vertical vibration (fore-and-aft, lateral); Body posture.

K. Tomida, I. Morioka, O. Kaewboonchoo, H. Yamamoto, N. Miyai, N. Ishii and K. Miyashita 1998 *Industrial Health* **36**, 20–26. Evaluation of finger skin temperature by cold provocation test for diagnosis of vibration induced white finger (VWF). (7 pages, 2 figures, 6 tables, 18 references) (in English).

Authors' Abstract. Clinical data of workers (40–69 yrs) operating chain saws for a ten year period from 1986–1995 were analyzed to assess the evaluation standard of finger skin temperature for a cold provocation test (10°C 10 min). Screening points of finger skin temperature for screening 191 workers with a vibration induced white finger (VWF) were obtained from receiver operating characteristic (ROC) curves. The screening points at 5 min and 10 min after a cold provocation were approximately equal to 50th percentiles of 217 workers with no

symptoms (NS group). The screening points of recovery rates at 5 min and 10 min after a cold provocation almost agreed with 50th percentiles in NS group. A new evaluation standard was prepared in reference to these screening points and finger skin temperatures by fraction in NS group. The new one will be useful for the health care of workers operating vibrating tools under present working conditions.

Topics: Vibration syndrome (diagnosis).

G. Bartlett, J. D. Stewart, R. Tamblyn and M. Abrahamowicz 1998 *Muscle and Nerve* **21**, 367–374. Normal distributions of thermal and vibration sensory thresholds. (8 pages, 1 figure, 5 tables, 48 references) (in English).

Authors' Abstract. The distributions of sensory thresholds were estimated in a healthy population while controlling for potential covariates. Using the method of levels and the two-alternative forced choice, thermal and vibration thresholds respectively were measured in the hand and foot of 148 subjects. Age was uniformly distributed between 20 and 86 years. Independent effects of age, gender, height, and skin temperature were estimated using multiple linear regression. Parametric and nonparametric methods were used to estimate the distributions of interest. Significant age-related increases were observed for all vibration thresholds ($P < 0{\cdot}0001$), and for thermal thresholds in the foot ($P < 0{\cdot}0002$). Percentiles were estimated for thermal thresholds in the hand and age-adjusted continuous distributions were calculated for all other thresholds. Height was positively associated with vibration thresholds in the foot ($P < 0{\cdot}003$), and appropriate corrections were made. Our results provide reference values for thermal and vibratory sensory thresholds in a healthy population, allowing for the accurate diagnosis of disordered sensory function.

Topics: Perceptual mechanisms (vibration, temperature); Vibration sense (thresholds); Subject type (age, size).

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Contributions to the Literature Collection are invited. They should be sent to Professor M. J. Griffin, Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton, Southampton, SO17 1BJ, England.