Journal of Sound and Vibration (1997) **208**(5), 891–894

HUMAN RESPONSE TO VIBRATION

ABSTRACTS

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M. V. Jensen, F. Tüchsen and E. Ørhede 1996 *Spine* **21**(20), 2352–2355. Prolapsed cervical intervertebral disc in male professional drivers in Denmark, 1981–1990. A longitudinal study of hospitalisations. (4 pages, 0 figures, 1 table, 13 references) (in English).
Authors' Abstract. This study of professional drivers is a part of a longitudinal record linkage study of all economically active men in Demnark, identified on 1 January 1981. Information about the main occupation was identified in 1980. The cohort was followed for first hospitalization with prolapsed cervical intervertebral disc until 31 December 1990. The objective was to examine the risk of prolapsed cervical intervertebral disk in all Danish professional drivers, and to analyze exposure of the male drivers in a sample of all Danish male drivers. Only a few studies on occupation and prolapsed cervical intervertebral disk have been published. These studies suggest that professional driving may be a risk factor for development of prolapsed cervical intervertebral disc. Drivers are exposed to whole-body vibrations, heavy lifting, and a sedentary position. Other potential exposures are accelerations and decelerations and whiplash accidents. Such exposures may be involved in the causation of prolapsed cervical intervertebral disc. A standardized hospitalization ratio was calculated for each subgroup of drivers using all economically active people as the standard. Additional exposure information was extracted from a national survey on the work environment. Almost all men in occupations involving professional driving had a statistically significant elevated risk of being hospitalised with prolapsed cervical intervertebral disc. Professional driving is a risk factor for prolapsed cervical intervertebral discs.
Topics: Injury and disease (chronic); physiological effects (skeletal).

Y. Nakatsuchi, A. Tsuchikane and A. Nomura 1996 *Medical Engineering and Physics* **18**(7), 575–583. The vibrational mode of the tibia and assessment of bone union in experimental fracture healing using the impulse response method. (9 pages, 7 figures, 0 tables, 29 references) (in English).
Authors' Abstract. This study attempts to clarify the use of the impulse response method in the assessment of fracture healing. The vibrational mode as well as the effect of simulated callus consolidation on the vibrational parameters of excised human tibia were studied. Two separate vibrations were found, one vibrating strongly in the lateral direction and the other vibrating weakly in the antero-posterior direction. The ability to identify the primary vibrational mode in the lateral direction would make the impulse response method suitable for use in clinical practice. The callus consolidation process was simulated by the sequential consolidation of an adhesive material in an experimentally produced fracture gap. The change in hardness of the epoxy was found to correlate well with the change of resonant frequency of the bone. The resonant frequency demonstrated a steady increase during the initial phase of consolidation of the adhesive, up to about 40% of its final hardness. With the addition of various constructs for fracture fixation to the *in vitro* model such as a plate, Ender's pins, a Russell–Taylor intramedullary nail, or an Orthofix external

0022–460X/97/500891 + 04 $25.00/0/sv971257

fixator, the relationship between the consolidation of the "callus" and the change in resonant frequency of the bone was not disturbed.
Topics: Diagnostic applications; biodynamics (response).

S. Uimonen, M. Sorri, K. Laitakari and T. Jämsä 1996 *Medical Engineering and Physics* **18**(5), 405–409. A comparison of three vibrators in static posturography: the effect of vibration amplitude on body sway. (5 pages, 4 figures, 3 tables, 16 references) (in English).
Authors' Abstract. In static posturography, proprioception is often disturbed using vibrators applied bilaterally to the calf muscles. The effect of vibrator amplitude on body sway was compared in static posturography using bilateral vibrators on the calf muscles of 30 healthy male military conscripts at frequencies of 50 and 90 Hz. Postural stability was measured in terms of BSV (body sway velocity), and maximal displacements of the centre of force (MAXY, MAXX) in the anterior–posterior and lateral directions. In comparing the effects of vibration to base stance without vibration, BSV seemed to be the most sensitive parameter. A vibration of 50 and 90 Hz significantly influenced BSV values with the two most eccentric loads, an effect which could not be confirmed using any other parameter. This result could be obtained even with a small amplitude (around 0.7 mm free/0.3 mm fixed) in our healthy subjects. The BSV effects may be even more pronounced in clinical work with patients with postural disorders. Thus, when proprioceptive stimulation is used in posturographic measurements, differences in the tested magnitude of the simulation amplitude with a constant frequency will significantly affect postural stability, even in healthy subjects.
Topics: Body posture; physiological effects (postural function, muscle and nerve).

R. Chan, D. K. Rogers and D. I. McCloskey 1996 *Neuroscience Letters* **214**(2–3), 205–207. Postural stability of the head in response to slowly imposed, small elastic loads. (3 pages, 1 figure, 0 tables, 14 references) (in English).
Authors' Abstract. To examine postural stability of the head, slow, undetectable rotations of small amplitude were imposed about a vertical axis while human subjects maintained a stationary body. Six normal subjects were used. The rotations were imposed through an elastic linkage, and lasted 4 s. The amplitude of head rotation was small, approximately 0·002 rad. The imposed perturbations commenced from an unloaded resting position with the head facing forward, under four conditions: (1) relaxed, eyes closed; (2) relaxed, eyes open; (3) still, eyes closed; and (4) still, eyes open. The terms "relaxed" and "still" refer to the prior instructions given to the subjects regarding how they were to hold their head. There was a near linear relationship between average torque and average head angle. The effective stiffness of the head on the neck was notably low, approximately 10 Nm rad^{-1}. Two-way analysis of variance (ANOVA) demonstrated ability to increase mean stiffness between "relaxed" and "still" conditions by 51% ($P < 0{\cdot}02$). Visual input did not change mean stiffness significantly. Therefore, for the rotations to have been imperceptible, either the visual shifts must have been imperceptible, or the eyes must have counterrotated.
Topics: Physiological effects (postural function, muscle and nerve).

T. F. Münte, E. M. Jöbges, B. M. Wieringa, S. Klein, M. Schubert, S. Johannes and R. Dengler 1996 *Neuroscience Letters* **216**(3), 163–166. Human evoked potentials to long duration vibratory stimuli: role of muscle afferents. (4 pages, 2 figures, 1 table, 14 references) (in English).
Authors' Abstract. Tonic vibratory stimuli of 1000 ms duration and different frequencies were delivered to muscles of the forearm of young human subjects. Evoked potentials (EPs) were recorded from 29 scalp channels and revealed phasic highly lateralised and focally

distributed EPs during the first 100 ms of the recording epoch that could be adequately modelled with a single point dipole source located in the vicinity of the central sulcus contralateral to the stimulated arm. A later negativity with an onset of about 400 ms and a duration of about 800 ms was found to be symmetrically distributed over fronto-central regions. This negativity is interpreted in terms of cortical activation beyond the primary sensory fields and could be related to the kinaesthetic phenomena experienced during muscle vibration.
Topics: Physiological effects (muscle and nerve).

F. Hlavacka, T. Mergner and M. Krizkova 1996 *Brain Research Bulletin* **40**(5/6), 431–435. Control of the body vertical by vestibular and proprioceptive inputs. (5 pages, 3 figures, 0 tables, 11 references) (in English).
Authors' Abstract. The study examines the influence of vestibular and leg proprioceptive cues on the maintenance of the body vertical in human stance. Vestibular body orientation cues were changed by applying bipolar currents to both mastoid bones (bosine-bell wave form of 3·3 s duration, 1 mA current intensity). Proprioceptive input was modified by vibrating the tibialis anterior muscle (at $f = 90$ Hz, step of 5 s duration and 1 mm amplitude). Furthermore, the vestibular stimulus was paired with the muscle vibration using three different temporal relationships between the stimuli. Body lean responses were analyzed in terms of sway trajectories of the center of foot pressure on the body support surface (horizontal plane). With the anode on the right mastoid, vestibular body lean response was essentially straight towards the right side, and the anode on left mastoid towards the left side. Vibration of right tibialis anterior muscle induced an almost straight body lean forward and to the right. Upon combined stimulation, responses with complex trajectory resulted, which depended on the stimulus interval. These responses reflected a superposition of the individual vestibular and proprioceptive effects. The results show that the body vertical is under the continuous control of leg proprioceptive and vestibular inputs, which sum linearly. We present a concept according to which these inputs are used for establishing a reference system for the control of the body vertical.
Topics: Body posture; physiological effects (postural function, muscle and nerve).

A. H. Owen 1996 *The Journal of Craniomandibular Practice* **14**(2), 139–153. Rationale and utilization of temporomandibular joint vibration analysis in an orthopedic practice. (15 pages, 16 figures, 12 tables, 41 references) (in English).
Authors' Abstract. Temporomandibular joint vibration analysis (JVA) is the electronic recording of TMJ sounds, or, more accurately, vibrations occurring in the joint. Utilizing vibration transducers called accelerometers, a characteristic wave pattern is created for the various types of internal vibrations (conditions). Whereas the human ear cannot hear many of the frequencies that occur in the TMJ's, the accelerometers record all frequencies with equal efficiency. Once a vibration has been recorded, then it can be compared to other types of vibrations. This may make it possible to categorize the various types of internal conditions, and then, to monitor the joint status throughout treatment. Sample patients are shown with the initial and then progress joint vibration analyses. This electronic device may help answer the questions of whether orthodontic treatment helps, harms, or has any affect on the internal health of the TMJ. It may also be used to monitor different types of orthodontic treatment to help determine whether or not one type is more beneficial to the TMJ.
Topics: Diagnostic applications.

E. Klinenberg, Y. So and D. Rempel 1996 *The Journal of Hand Surgery* **21A**, 132–137. Temperature affects on vibrotactile sensitivity threshold measurements: implications for carpal tunnel screening tests. (6 pages, 1 figure, 2 tables, 22 references) (in English).
Authors' Abstract. This study examines the effect of skin temperature on fingertip vibrotactile sensitivity measurements and the resulting implications for carpal tunnel syndrome screening tests. Twenty subjects (11 men, 9 women) were tested for fingertip vibrotactile thresholds using the method of limits at four different frequencies (31·5, 125, 250, and 500 Hz) and six temperature categories (17–20°C, 20–23°C, 23–26°C, 26–29°C, 29–32°C, 32–35°C). Vibrotactile sensitivity thresholds increased with decreasing fingertip skin temperature. Furthermore, the relationship was a function of vibration frequency. Higher frequencies were more affected by temperature than lower frequencies, with significant effects beginning at 29°C. These temperature-related effects may lead to possible false positive results in screening for carpal tunnel syndrome or other neuropathies. To minimize potential temperature-induced misclassification errors during these screening tests, fingertip skin temperature should be recorded before measurement and probably maintained above 29°C during the measurement.
Topics: Vibration sense (thresholds); combined stress (vibration and temperature).

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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.