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HUMAN RESPONSE TO VIBRATION

ABSTRACTS

Prepared by M. J. and J. Griffin, Human Factors Research Unit, Institute of Sound and Vibration Research, University of Southampton, Southampton SO17 1BJ, England

H. Vanharanta, D. D. Ohnmeiss and C. N. April 1998 *The Clinical Journal of Pain* **14**(3) 239–247. Vibration pain provocation can improve the specificity of MRI in the diagnosis of symptomatic lumbar disc rupture. (9 pages, 4 figures, 3 tables, 25 references) (in English).

Authors' Abstract. Objective: The purpose of this study was to determine if vibration pain provocation could be combined with magnetic resonance imaging (MRI) to increase its specificity in identifying symptomatic disc disruption identified by discography. Design: Prospective single-blind study. Setting: Data were collected at a spine speciality clinic at a diagnostic imaging center. Patients: A total of 206 discs in 78 patients (41 males, 37 females; average age 39·7 years; range 18–73 years) were evaluated by MRI, spinous process vibration and discography. Interventions: A hand-held prototype vibrator was applied to the spinous process of each intervertebral disc level to be evaluated. The type of pain provoked with vibration as well as with discography was recorded as painless, dissimilar to clinical pain or similar/extract reproduction of clinical pain. The discograms and MRI scans were scored on a 0–4 scale. A system was designed for combining the vibration results with MRI. Outcome measures: The results of the vibration and MRI were compared with the results of computed tomography to determine how well the results of the evaluations agreed. Results: Vibration pain provocation agreed with discographic pain provocation in 70·9% of the discs. The specificity of MRI compared with discographic findings was only 55·7%. However, this figure improved significantly to 81·3% when relying on the vibration pain provocation in discs with mild or moderation disruption. The sensitivity of the combined evaluation was 85·9% and the accuracy 83·0%. Conclusions: A small-held vibrator could produce pain provocation similar to those obtained by discography. Results of this non-invasive pain provocation method can improve the specificity and accuracy of MRI identifying symptomatic disc lesions.

Topics: Diagnostic applications.

P. Castellini, L. Scalise and E. P. Tomasini 1998 *Journal of Clinical Laser Medicine and Surgery* **16**(6), 269–272. Teeth mobility measurement: a laser vibrometry approach. (44 pages, 6 figures, 0 tables, 6 references) (in English)

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Authors Abstract. Objective: This work presents a new technique based on the assessment of the mobility degree through the application of dynamic loads and the the measurement of the tooth displacement with a laser Doppler vibrometer. Summary Background Data: Measurements of the mobility degree have been made, up to now, by the application of static loads and the measurement of the consequent displacement. The results obtained with the measurement technique proposed by Muhlemann have been validated by O'Leary *et al*. and by Persson and Sweson. This approach, however, has not been clinically disseminated both because of the high cost of the equipment and, above, all, because of the difficulty in performing the measurements. Methods: The ratio between the maximum of the tooth displacement and the input force peak has been considered as the mobility degree index. Dynamic loads have been applied and measured of teeth, with a small hammer and a load cell. The consequent displacement of tooth has been measured with a Laser Doppler vibrometer that allows easy to use and versatile non-contact measurements with high accuracy and sensitivity ($< 0{\cdot}1$ mm/s). Results: An introductory *in vitro* study has been carried out on real teeth extracted and mounted on structures with different- stiffness silicone cast (stiffness of the support is one of the parameters responsible for teeth mobility), in order to evaluate the technique. An *in vivo* study has also been carried out on different teeth of healthy patients. It is possible to observe the agreement between the O'Leary results and ones obtained in this work. The practicality of the procedure has also been demonstrated. Conclusions: Good correspondence between data available in literature and results obtained has been demonstrated. The use of the technique here proposed could allow having a deeper knowledge of the behavior of the periodontal teeth system: the tooth mobility under dynamic loads. With this new technique, it will be possible to measure quickly pathological mobility of the tooth, before it becomes evident and problematic.
Topics: Diagnostic applications; biodynamics (impedance).

A. Kavounoudias, R. Roll and J.-P. Roll 1998 *NeuroReport* **9**(14), 3247–3252. The plantar sole is a 'dynamometric map' for human balance control. (6 pages. 3 figures, 0 tables 25 references) (in English)
Authors' Abstract. This study investigated the role of the plantar cutaneous information in controlling human balance. We hypothesized that the cutaneous afferent messages from the main supporting zones of the feet have sufficient spatial relevance to inform the CNS about the body position with respect to the vertical reference and consequently to induce adapted regulative postural responses. Skin mechanoreceptors of anterior and/or posterior areas of one or both soles of 10 standing subjects were activated by superficial mechanical vibration with high frequency and low amplitude. Variations of the subject's center of pressure (CoP) were recorded. Spatially oriented whole-body tilts were observed for every subject. Their direction depended on the foot areas stimulated and always opposite to the vibration-stimulated pressure increase. These responses are found to be subserve a postural regulative function and we suggest that co-processing of the various cutaneous messages followed a vector addition mode.
Topics: Physiological effects (postural function).

E. Zamyslowska-Szmytke 1998 *International Journal of Occupational Medicine and Environmental Health* **11**(3), 247–254. Efficacy of vibration, electric current and thermal perception tests in diagnosis of hand–arm vibration. (8 pages, 2 figures, 2 tables, 15 references) (in English)

Authors' Abstract. Vibration perception test is usually proposed as a useful tool for qualitative assessment of neurological disturbances induced by hand–arm vibration syndrome (HAVS). The increased mean vibration perception threshold (VPT) is an early manifestation of this syndrome. However, we have identified a group of exposed subjects with normal VPT who showed electric current and or thermal sensitivity impairment. The use of three tests instead of a single vibration test increased by 27% the number of persons with detected quantitative skin sensory disorders. The intensity of quantitative disorders of vibration and electric current sensitivity was closely related to the duration of vibration exposure. The thermal perception was diminished in subjects working for a longer period of time, but there was no relationship between intensity of disorders and the duration of exposure. In an early stage of hand–arm vibration syndrome (prevention of HAVS) the use of three tests helps to identify a larger number of workers at risk who should undergo thorough diagnostic examinations. In our study, the proportion of identified workers increased from 27% (32 subjects with vibration sensory impairment) to 45% (53 persons with disorders detected in one, two or even three tests).

Topics: Vibration syndrome (sensory disorders).

E. A. Roy and M. Hollins 1998 *Somatosensory and Motor Research* **15**(2), 134–145. A ratio code for vibrotactile pitch. (12 pages, 6 figures, 1 table, 40 references) (in English)

Aurthors' Abstract. Subjective impressions of pitch for 80 different sinusoidal vibrotactile stimuli delivered to the index finger were measured by free magnitude in four subjects. In three of the subjects, pitch at a given frequency decreased as stimulus amplitude increased. The data of these subjects were well described by a model of pitch based on the relative levels of activation of the three major tactile channels. The main element in this model was ratio of P channel activity to the sum of the activity levels of the P, NPI, and NPIII channels. Activity levels of the channels were estimated on the basis of the psychophysical literature, including a study of vibrotactile loudness using the same subjects and stimuli as those employed here. A fourth subject, whose pattern of loudness judgements had previously been shown to differ from those of the other subjects, did not confirm to this pitch: her data revealed significant increases in pitch with increases in amplitude, and appear to reflect an inability to combine signals across vibrotactile channels. Pitch changes resulting from vibrotactile adaptation were directionally consistent with our ratio model: pitch was slightly increased by adaptation to a 25 Hz stimulus, and slightly decreased by 200 Hz adaptation.

Topics: Vibration sense (sensory mechanisms).

G. Andersson, K. Persson, L. Melin and H. C. Larsen 1998 *Acta Otolaryngologica* **118**, 481–485. Actual and perceived postural sway during balance specific and non-specific proprioceptive stimulation. (5 pages, 2 figures, 2 tables, 19 references) (in English)

Authors' Abstract. A group of patients with balance complaints ($n = 16$) was compared with a group of normal subjects ($n = 17$) by means of posturography, subjective assessments of balance, anxiety and unteadiness when standing on a force platform with eyes closed. Postural instability was induced by vibratory stimulation of the calf muscles (20, 40, 60, 80 and 100 Hz). As a control condition, the arm (biceps) was stimulated at similar frequencies. In order to control for arousal, blood pressure and heartbeat were assessed. Furthermore, questionnaire responses on psychological measures were collected. Results showed clear differences between the groups in terms of imbalance and self-reports. However, the two groups displayed similar increases of imbalance during calf stimulation and no increase during arm stimulation. Patients generally rated less increase of unsteadiness when the calf was stimulated than did the controls. No differences in arousal were found between the groups or within conditions. Results are discussed in terms of the proposed desynchrony between symptoms and complaints.

Topics: Physiological effects (postural function).

M. Hollins and A. Sigurdsson 1998 *Pain* **75**(1), 59–67. Vibrotactile amplitude and frequency discrimination in temporomandibular disorders. (9 pages, 2 figures, 0 tables, 25 references) (in English)

Authors' Abstract. The purpose of this study was to determine whether the elevation in vibrotactile detection threshold, found in many individuals with temporomandibular disorders (TMD), is paralleled by suprathreshold impairments. Participants with TMD were compared with pain-free control subjects in their ability to discriminate on the basis of differences in amplitude and frequency between vibratory stimuli delivered to the face. The TMD group was significantly impaired with respect to frequency discrimination, but not amplitude discrimination. This dissociation suggests that the cortical processing of vibrotactile signals may be affected in TMD patients. TMD participants' estimates of the intensity of their spontaneous and palpation-evoked pain did not significantly correlate with performanced on either discrimination task; this finding makes it unlikely that impaired vibrotaction in TMD is primarily the result of a pain-dependent gating of tactile signals.

Topics: Vibration sense (thresholds); perceptual mechanisms.

NOTE: copies of all papers in this section will be found in the Human Response to Vibration Literature Collection at the Institute of Sound and Vibration Research, University of Southampton. Persons visiting the Institute may use the papers.

*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, SO*17 1*BJ, England.*