Umeå University Medical Dissertations, New Series No 1780

Seated postural reactions to mechanical shocks

Laboratory studies with relevance for risk assessment and prevention of musculoskeletal disorders among drivers

Tobias Stenlund

Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av medicine doktorsexamen framläggs till offentligt försvar i Aulan, Vårdvetarhuset, fredagen den 18 mars, kl 9.00.
Avhandlingen kommer att försvaras på svenska.

Fakultetsopponent: Professor emeritus, Fysioterapeut, Rolf Moe-Nilssen
Institutt for global helse og samfunnsmedisin, Det medicinskt-odontologiska fakultet, Universitetet i Bergen, Norge.

Department of Community Medicine and Rehabilitation, Physiotherapy
Umeå University
Umeå 2016

Organization
Umeå University
Department of Community Medicine and Rehabilitation, Physiotherapy

Document type
Doctoral thesis

Date of publication
26 Feb 2016

Abstract

Professional drivers of off-road vehicles, driving on irregular terrain such as in forestry, agriculture and mining, are exposed to whole-body vibration and mechanical shocks. These driver groups have reported severe musculoskeletal problems in the spine, but the association to seated postural reactions is not fully understood. One assumption is that unexpected shocks may create excessive load on spinal joints. The driver's posture and exposure to mechanical shocks are required to be included in work risk assessments, but muscle activity and body kinematics are not included. The overall aim of this thesis was to describe and analyse seated postural reactions to mechanical shocks and to evaluate measuring of seated postures with relevance for risk assessment and the prevention of musculoskeletal disorders among drivers.

The thesis includes four studies, all laboratory-based using a repeated-measures design. Postural reactions were recorded from 23 (Paper I) and 20 (Paper II & III) young, healthy male participants who were seated on a movable platform. The platform delivered mechanical shocks with peak accelerations up to 14 m/s² in lateral directions during different conditions. Furthermore, twenty participants (Paper IV) were tested by four testers for analysis of test-retest reliability within and between testers measuring seated postures. Kinematics were here detected by means of a motion analysis system (MoLab™) and described for the spine as angular displacements or range of motion (ROM) using a three-segment model of neck, trunk and pelvis (Paper I–III) and as a more specific model (Paper IV). Surface electromyography (EMG) was recorded bilaterally on the following muscles; trapezius upper part, upper neck, erector spinae and external oblique (Paper I–III).

The general findings show that EMG amplitudes normalised to maximum voluntary contractions (MVC) did not exceed 2% in the trapezius, 8% in the upper neck and erector spinae and 18% in the external oblique. The EMG amplitudes and the angular displacements in the neck were significantly reduced from the first compared to the fifth mechanical shock. Adding a cognitive task significantly increased angular displacements. The largest ROM with approximately 20° in each segment was found during a double-sided mechanical shock (shock that changes direction). The reliability within one tester measuring seated postures was mostly considered good and superior to the reliability between several testers, but still insensitive to changes of less than 10°.

Exposure to single-sided or double-sided mechanical shocks with accelerations up to 14 m/s² seem not to cause postural reactions to such an extent that overload of muscles or joint structures should be expected. There seems to be a quick adaptation that causes an improved readiness. The external obliques were most active when restoring equilibrium and seem important for stabilising the whole spinal column. Stability training, in order to improve neuromuscular control of the external obliques could, therefore, be a possible recommendation. The angular displacement in the neck increases if the subject solves a cognitive task of why such activities should be avoided when driving in difficult terrains. Since accurate descriptions of the spinal posture seems difficult even when advanced technical equipment is used, simpler models seem more appropriate. The results show that postural control is maintained even when exposed to considerable mechanical shocks. On the basis of these results, there is no need to change established risk assessment models.

Keywords Postural balance; Posture; Electromyography; Musculoskeletal pain; Whole-body vibration; Reliability; Kinematics; Biomechanics

Language
English

ISBN
978-91-7601-410-3

ISSN
0346-6612

Number of pages
64 + 4 papers