

Postural control deficit in acute QTF grade II whiplash injuries

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Abstract

Study design: Experimental in vivo study.

Objective: The objective was to investigate the balance control in patients with acute QTF grade II whiplash injuries of the cervical spine.

Summary of background data: Tetra-ataxiometric posturography in chronic pain patients after whiplash injuries of the cervical spine has revealed an impaired regulation of balance. However, so far it is unclear if this is caused by the accident or other factors that are associated with the pain chronification process.

Methods: 40 patients with acute QTF grade II whiplash injuries and 40 healthy matched controls were examined on a posturography platform. The stability index ST_{Σ} and the Fourier analysis FA_{Σ} (0.10–1.00 Hz) were established for eight standing positions and sum scores were calculated. The pain index was established using a visual analog scale ranging from 0 to 100. A follow-up examination was conducted for the patients after 2 months.

Results: The patients with acute whiplash injuries of the cervical spine achieved significantly poorer results for both ST_{Σ} and FA_{Σ} than the healthy controls. There were no differences between the eight standing positions for both ST_{Σ} and FA_{Σ} . After 2 months, 17 patients had no change in the pain development, 21 patients showed an improvement in pain intensity and 2 patients had deteriorated. The subgroup of patients with improvement in pain intensity showed a significant improvement in balance control concerning the FA_{Σ} compared to patients with unchanged pain intensity.

Conclusion: Patients with acute whiplash injuries have a reduced balance control as compared to matched controls. This study gives an indication that post-traumatic neck pain is associated with impairments of postural control.

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1. Introduction

Besides neck pain and restricted movement, patients who have suffered whiplash injuries of the cervical spine frequently complain of an impaired regulation of balance [1–5]. While the diagnostic and therapeutic endeavours have so far focused on the neck pain and the restricted movement

of the cervical spine, balance disturbances have been given less attention.

Regulation of balance is a complex function of the sensorimotor system. Information that is received by the sensory systems from the environment has to be centrally translated into motor responses. Several sensory systems such as the visual, vestibular and peripheral somatosensory systems exert an effect on the regulation of balance [6–8]. It is assumed that in patients with whiplash injuries, the function of the peripheral somatosensory system is impaired because of damage to the proprioceptors of the neck, and that this results in an impaired regulation of balance [2,7,9,10].

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Posturography was developed in order to determine the functional capability of the regulation of balance. Using a measuring platform, weight shifts are determined with force sensors while the weight is borne on the lower extremities. Information can thus be gained on the balance and stability of the subject.

Posturographic investigations in patients with chronic symptoms after whiplash injuries of the cervical spine unanimously demonstrate a poorer regulation of balance in the whiplash group as compared to healthy subjects [11–16]. However, it has not yet been fully established what causes the persistent whiplash associated disorders (WAD) and the resulting impaired regulation of balance [12]. In patients with chronic cervical spine pain, structural injuries such as facet joint pathologies and intervertebral disc lesions have been reported with an incidence of up to 84% [17,18] and are discussed as being the cause of postural control system distortion [7,9]. However, it is not precisely known whether these are direct consequences of the accident or result of secondary degenerative changes. There is only one study which describes that chronic pain patients with and without whiplash injury differ in their regulation of balance [16]. Furthermore, chronic pain and psychological effects are discussed to affect the central nervous system's modulation of proprioceptive afferent information [19]. Not only accident-related causes but also degenerative and psychological causes are thus conceivable.

Against this background, it would be interesting to know whether postural disturbances also occur shortly after a whiplash injury. At that time, degenerative and psychological factors are unimportant in comparison to the accident-related factors in the determination of the causes. There are no posturographic investigations in patients with acute whiplash injuries in the literature to date. The present study will thus investigate the regulation of balance in a patient group with acute whiplash injuries of the cervical spine compared to a matched pair non-whiplash control group in order to answer the following questions:

1. Are there differences in the regulation of balance between patients with acute QTF grade II whiplash injuries of the cervical spine and healthy subjects?
2. Does the elimination of the visual, somatosensory or vestibular system lead to a decrease in balance control?
3. Does the patients' regulation of balance change over a period of 2 months after the accident?

2. Materials and methods

2.1. Subjects

QTF grade II whiplash injuries of the cervical spine (patients with neck pain and musculoskeletal signs) were the only inclusion criterion that was defined for the study. Patients with QTF grade I whiplash injuries of the cervical spine (patients with neck pain, stiffness or tenderness only), patients with QTF grade III whiplash

injuries of the cervical spine (neck pain and neurological signs) and QTF grade IV whiplash injuries of the cervical spine (patients with neck pain and fracture or dislocation) were excluded from this analysis. Furthermore patients who had suffered previous injuries of the cervical spine or who had muscular, neurological or mental disorders were excluded from participation in the study. Patients who had degenerative diseases or pain of the cervical spine or the lower extremities were also excluded. The control group, which consisted of healthy subjects and was made up of medical students and hospital staff, was established by forming matched pairs with regard to year of birth and gender. They were not matched with regard to body weight, which is inversely proportional to stability [20,21], as this was automatically taken into account by the software of the posturographic system that was used. The work has been approved by the appropriate ethical committees and the subjects gave informed consent to the study.

2.2. Study procedure

Using a standardised procedure, the patient group was examined on a posturography platform (Tetrax IBS[®], Neurodata GmbH, Vienna, Austria) within the first week (Pat 1) after the trauma (median (3 days); range (1–6 days)) and 8 weeks after the date of the first examination (Pat 2) [20]. On both measurement dates the patients were questioned about subjective balance disturbances. At the first examination all patients were given a prescription for a physiotherapy program two times a week for a period of 5 weeks. The physiotherapy program consisted of soft-tissue treatment, joint mobilization and measures for strengthening and stabilization of the cervical spine. The control group was only examined on one occasion (Norm). The examination was conducted by an investigator who was blinded with regard to history, clinical findings and status (patient/subject).

The TETRAX IBS[®] system measures the subject's dynamic weight distribution via four independent pressure sensors (left heel = A; ball of the left foot = B; right heel = C; ball of the right foot = D) which are incorporated in two foot platforms (see Fig. 1). A detailed description of the system is available elsewhere [20]. For the measurement, the subject stands barefoot on the measuring plates, which are positioned in parallel at hip width, assuming an upright, relaxed position with arms hanging loosely. For the controlled modification of sensory input from the visual, vestibular and somatosensory systems and for the assessment of the compensatory ability within the postural system eight different position tests were performed (Table 1). Each of the posturographic tests took 30 s.

2.3. Parameters for analysis

1. *Stability index* (ST), calculated as the square root of the sum of the squared differences between adjacent pressure fluctuation signals, sampled at a rate of 32 Hz. ST describes the state of general stability and is an indicator of a person's stability [16]. The higher the score, the greater the sway and instability [20]. A sum score ST_{Σ} of the eight different position tests was calculated and used for group comparison.
2. *"Fourier" analysis* (FA): Fourier analyses of the postural recordings were performed. Abnormal postural performance due to peripheral causes is characterized by a high intensity of sway in the frequency range of 0.10–1.00 Hz [20,22]. Again we used the sum score FA_{Σ} for group comparison.

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