

SENSORY INTERACTION BALANCE AND LIMITS OF STABILITY IN NECK PAIN: COMPARISON OF TRAUMATIC AND NON-TRAUMATIC PATIENTS

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ABSTRACT

Purpose: A variety of sensory-motor changes are reported in both the traumatic and non-traumatic neck pain. However, it is still unclear whether there is a significant difference between individuals with traumatic neck pain and those with non-traumatic in terms of postural control. The aim of this cross-sectional study was to investigate whether there was a difference between individuals with traumatic pain and non-traumatic neck pain in terms of postural control and disability.

Material and Methods: Ninety-two patients with chronic neck pain were grouped according to the onset of pain. Clinical test of sensory interaction balance (CTSIB) and limits of stability (LOS) test were used for postural control assessment. The Numeric Rating Scale and Neck Pain Disability Index (NPDI) were used to measure pain intensity and disability, respectively. Mann-Whitney U test was used to compare groups.

Results: There were no significant differences between groups in terms of LOS, CTSIB and NPDI scores ($p>0.05$).

Conclusion: The results of this study suggest that postural control and disability do not differ between patients with traumatic and non-traumatic neck pain. Therefore, from a clinical perspective, postural control and disability should be evaluated without considering trauma history in patients with neck pain.

Keywords: postural control, limits of stability, sensory interaction balance, traumatic neck pain

INTRODUCTION

Neck pain is a common condition that affects most people at some point in their lives (1). The cause of neck pain can be traumatic or non-traumatic. A traumatic neck pain is associated with previous neck injury and symptoms that may occur due to central sensitization mechanisms, whereas non-traumatic neck pain is defined as having no identifiable cause and pathology. Both traumatic and non-traumatic neck pain result in functional limitations in addition to pain (2-5).

Neck pain may lead to motor impairments, disability and decreased quality of life. In addition, sensory alterations, decreased motor function and morphological changes may occur (6,7). Cervical receptors have close connections to vestibular, visual and proprioceptive systems and also play an essential role in reflexes to provide information for postural control. Therefore, disruption of the afferent information due to the traumatic or non-traumatic neck pain can increase postural sway and individuals

can suffer from postural control problems in their daily routines (8,9).

It has been anticipated that patients with either non-traumatic or traumatic neck pain have poorer postural balance than healthy controls (10-12). A variety of sensory-motor changes were reported in both the traumatic and non-traumatic neck pain. It is claimed that postural control is further impaired in individuals with traumatic pain due to damage to neck structures, inhibition in deep muscles, decreased neuromuscular control, loss of endurance or atrophy in the muscle (10,13). Accordingly, it is expected to be better postural control in non-traumatic situations (3,5,6). However, it is still unclear whether there is a significant difference between individuals with traumatic neck pain and those with non-traumatic in terms of postural control.

Chronic neck pain is also known to be associated with disability. Studies showed that pain extent is positively correlated with increased disability in individuals with whiplash-associated disorders (14,15). However, there is still very limited data on whether disability level differs between patients with traumatic and non-traumatic neck pain (16).

Considering the various biological impairments observed, a thorough understanding of how trauma history affects postural control and disability in patients with chronic neck pain is crucial to conduct rehabilitation programs and clinical practice perfectly. Therefore, the aim of this study was to investigate whether there were differences between individuals with traumatic pain and non-traumatic pain in terms of postural control and disability. The hypothesis was that postural control and disability of people with traumatic neck pain are significantly poorer and higher than that of people with non-traumatic neck pain, respectively.

MATERIAL AND METHODS

Design

This cross-sectional study was carried out between January 2019 and January 2020. This study conformed to The Declaration of Helsinki, fulfilling all ethical requirements and was approved by Dokuz Eylül University ethics committee (Decision No: 2019/03-11, 13.02.2019). Written informed consent was obtained from all participants.

Participants

Participants were patients who consulted the Neurosurgery Clinic of a University Hospital with the

complaint of chronic neck pain. Individuals were divided into two groups according to neurosurgeon's diagnosis as traumatic or non-traumatic neck pain. Inclusion criteria for traumatic neck pain group were: (i) age between 18 and 65 years, (ii) neck pain lasting more than 12 weeks, (iii) a history of neck injury such as classifiable as Whiplash associated disorders (WAD); while non-traumatic neck pain group were: (i) age between 18 and 65 years, (ii) pain lasting more than 12 weeks, (iii) neck pain with no identifiable cause or pathology. Patients were excluded if they have: (i) brachial neuropathy, (ii) psychiatric illness, (iii) neurologic, metabolic, and cardiovascular disorders, (iv) inflammatory conditions, (v) fibromyalgia, (vi) pregnancy, (vii) a history of shoulder girdle or lower extremity surgery that could possibly influence postural control, (viii) the vestibular or uncorrected vision problems, (ix) being in progressive physical or medical treatment for both groups. All eligible participants were asked to stop to take of analgesics 6 hours before the assessments. In addition, participants were asked not to do heavy physical activity and to avoid from using up alcohol on the test days.

Procedure

Sociodemographic characteristics of participants were recorded and they were asked to complete self-reported measures including the Numeric Pain Rating Scale (NPRS) and the Neck Pain Disability Index (NPDI). An assessor who was blinded to grouping carried out all the remaining measurements.

Postural control was assessed using Biodex Balance System SD (12.1" Display 115 VAC, NY, USA). The Limits of Stability (LOS) test and the Clinical Test of Sensory Interaction and Balance (CTSIB) were performed to measure postural control. In the LOS test, individuals were asked to reach eight different points on the fixed firm surface without changing their foot positions on the platform and to return to the starting position each time as fast as possible. The higher overall scores indicate better postural control. In the CTSIB, the individuals were instructed to stabilize themselves in straight position in four different conditions: (i) firm (hard) surface when eyes opened, (ii) firm surface when eyes closed, (iii) foam (soft) surface when eyes opened, (iv) foam surface when eyes closed. Individuals were warned not to change foot positions during each test. Higher index values indicate worse sensory interaction balance. Before the tests, individuals were informed that they

were free to discontinue the task at any point if they feel discomfort. The device was found to be valid and reliable in measuring postural control (17).

Self-reported pain both in rest and in activity were assessed using the NPRS. Individuals were asked to choose the number between 0 and 10 that express their pain intensity. Zero means “no pain” while ten means “the worst pain” (18).

The validated Turkish version of the NPDI was used to measure pain-related disability. This index includes 10 questions about disability and each question is scored between 0 and 5. Therefore, the level of disability is calculated a total of 50 points. Higher scores reflect higher level of disability (19).

Statistical Analysis

Shapiro-Wilk Test, histograms and probability plots were used to examine the normality of the data. The variables were expressed as median and interquartile range (25%–75%) since most of them were not normally distributed. The Chi-square Test was used to compare gender proportions between the groups. The Mann-Whitney U Test was used to compare age, BMI, pain intensity, postural control variables and disability between the groups. Statistical analyses were performed using the SPSS software (version 23.0 for Windows; IBM Corp, Armonk, NY) at the 0.05 significance level.

RESULTS

In total, 98 patients with chronic neck pain were evaluated and were grouped according to the onset of pain as Traumatic group ($n = 26$) and Non-traumatic group ($n = 72$). Two participants in traumatic group who did not meet the inclusion criteria were excluded. The data of 4 patients, 2 from each group, were also not analyzed because patients could not complete postural control test. Final analyzes were performed on data from 92 patients (22 of them were in Traumatic group while 70 of them in Non-traumatic group). Gender proportions were similar between the groups ($\chi^2 = 0.186$, $p = 0.667$). There were no significant differences in the demographic characteristics (age and BMI), NPRS-rest and -activity scores between the groups ($p > 0.05$) (Table 1).

Between group comparisons (Mann-Whitney U Test) of the measured variables showed that there were no significant differences between the traumatic and the non-traumatic group in terms of LOS-overall score,

CTSIB scores (EO-firm, EC-firm, EO-foam, EC-foam) and NPDI scores ($p > 0.05$) (Table 2).

DISCUSSION

The results of the present study showed that there were no significant differences in postural control and disability between patients with traumatic and the non-traumatic neck pain. Our hypothesis that postural control of people with traumatic neck pain is significantly poorer than that of people with non-traumatic neck pain has not been validated in this study.

Postural control emerges by examining incoming proprioceptive information and producing appropriate feedback on this information (20). Impaired postural control is manifested by an enlarged swing area and altered swing speed, meaning that the response of postural control to incoming stimuli is delayed. Both peripheral and central alterations might thus affect this process (21).

A trauma might directly stimulate peripheral adaptations, such as decreased function of muscle and joint receptors, directly or indirectly due to an inflammatory reply. Trauma-induced muscular alterations may negatively affect muscle spindles and subscribe to the increased repositioning error and lack of postural control (22).

Although there were many studies on postural control in patients with neck pain, only few have investigated the relation of the possible cause of pain with postural control. While some researchers compared postural control between non-specific neck pain patients and healthy individuals (9,11), others compared postural control of individuals with traumatic neck pain with that of healthy ones (13,22). In few studies, this relationship was investigated in a specific gender or occupation group (10,12).

Vuillerme and Pinsault examined the effect of neck pain on standing balance on a force platform in young healthy adults. The results of their study showed that there was increased postural balance in condition with the pain when compared to no pain. Researchers expressed the destabilizing effect of neck pain, and verify the importance of exact neck neuromuscular function on the maintenance of an upright posture (23). Amaral et al. compared postural control in university students with chronic idiopathic subclinical neck pain with an age-matched group of asymptomatic ones. Their results showed that there was no difference between the groups in terms of postural control. However, they found that university

Table 1. Demographic characteristics and pain intensity of the groups.

	Traumatic (n=22)	Non-traumatic (n=70)	MWU	p value
Age, years	47.0 (35.3 – 53.3)	44.5 (35.8 – 54.0)	755000	0.891 ^a
BMI, kg/m ²	25.7 (22.5 – 29.3)	26.0 (24.0 – 30.5)	684500	0.434 ^a
Pain intensity				
NPRS - Rest	4.5 (1.8 – 7.0)	4.0 (3.0 – 6.0)	699500	0.516 ^a
NPRS - Activity	8.0 (4.8 – 8.0)	8.0 (6.0 – 10.0)	678500	0.393 ^a
Gender, %			χ^2	
Female	14 (%63.6)	48 (%68.6)	0.186	0.667 ^b
Male	8 (%36.4)	22 (%31.4)		

a Mann-Whitney U (MWU) Test, b Chi-square (χ^2) Test

BMI Body mass index, NPRS Numeric pain rating scale

Values are presented as median (interquartile ranges) for age, body mass index, and pain intensity.

Table 2. Comparison of the measured variables between groups.

	Traumatic (n=22)	Non-traumatic (n=70)	MWU	p value
LOS				
LOS-Overall	51.50 (42.50 – 61.00)	51.00 (42.75 – 57.25)	701500	0.530
LOS-time	0.38 (0.34 – 0.42)	0.43 (0.36 – 0.49)	565500	0.061
CTSIB				
EO-Firm	0.43 (0.35 – 0.59)	0.39 (0.28 – 0.54)	666500	0.343
EC-Firm	0.60 (0.47 – 0.87)	0.68 (0.51 – 0.86)	677000	0.394
EO-Foam	0.85 (0.67 – 1.22)	0.79 (0.62 – 0.95)	615500	0.157
EC-Foam	1.63 (1.27 – 1.96)	1.73 (1.40 – 2.01)	682000	0.420
Disability				
NPDI	37.00 (25.50 – 60.00)	36.00 (25.50 – 44.50)	698500	0.512

Mann-Whitney U (MWU) Test

Values are presented as median (interquartile ranges)

CTSIB Clinical test of sensory interaction of balance, EC Eyes closed, EO Eyes open, LOS Limits of stability,

NPDI Neck pain disability index

students who have lower intensity neck pain and lower disability presented lower postural control (11). Jørgensen et al. investigated postural balance in cleaners with and without neck pain in variety conditions. The main finding of their study was that cleaners with neck pain had impaired postural balance compared to cleaners without neck pain (12). Unlike these studies, our study was conducted in patients with traumatic and non-traumatic chronic neck pain and we used LoS and CTSIB tests to assess postural control.

There are also studies investigated postural control in patients with WAD, a trauma-originated event. In the study of Juul-Kristensen et al., postural control in

patients with WAD were compared with healthy controls. Researchers assessed postural control of participants on a force plate in different ways. They concluded that subjects with WAD had poorer postural control than the control subjects. Their results also indicated that there was disturbed sensory feedback patterns in WAD when limited light and/or the diminished physical area. Their results may suggest that Whiplash trauma might negatively affect cervical proprioception, thereby reducing control of posture (10).

Field et al. investigated postural control in subjects with WAD, subjects with idiopathic neck pain (INP) and the healthy individuals. Participants performed

standing balance tests in 3 different position (13). The age range of subjects was restricted to 18–45 years in this study and the Center of Pressure (CoP) changes in the mediolateral and anteroposterior directions were measured. The authors showed that postural control deficiency exist in both subjects with WAD and INP compared to controls, however, differentiations in postural control strategies might obtain between the neck pain groups. Overall, traumatic patients showed greater postural control inconveniences. Unlike this study, the age range of the participants in our study was between 18 and 65 years, and participants performed LoS test on an 8-point platform as well as sensory interaction balance test in firm and foam surfaces when eyes-open and closed. Our results showed that postural control values were similar in individuals with traumatic and non-traumatic neck pain. This result may be due to the characteristics of our sample which consisted of patients with chronic neck pain. The negative effects of trauma on tissues may be healed over time even though pain, which was expected to be more associated with the nervous system -in other words “centralized”- by the time, still persists (24).

Similar to the study of Field et al., Michaelson et al. compared postural performance of patients with work-related chronic neck pain (WRCNP) with that of patients with chronic WAD (25). They measured the ability to maintain postural control in variety standing conditions. They found that patients with chronic WAD showed larger sway areas. Based on the differences found, the authors also concluded deficits in proprioception and somatosensory control may be the main factors describing the clinical condition in different chronic neck pain conditions rather than the chronic pain itself. Somatosensory impairments were greater in those with traumatic neck pain, with possibly a reduced ability to fulfill to the postural control system. In addition, sample size of their study consisted of only nine participants in each group and, therefore, their results might be misleading (25).

Although studies suggest that postural control of patients with traumatic neck pain might have been more impaired when compared to non-traumatic patients, postural control of the two groups were similar in our study. The fact that all patients were in the chronic stage of neck pain in our study may have caused lack of difference in postural control between the groups. Effects of trauma on peripheral tissues that contribute to postural control such as proprioceptors or proprioceptive afferents may have

been neutralized at least 12 weeks after the trauma, thus deficits in postural control may have been eliminated.

Patients with chronic neck pain may experience disability due to physiological and psychological changes. Elliot et al. compared disability levels in patients with traumatic neck pain and idiopathic neck pain. Results of their study showed that the idiopathic group had a significantly lower neck pain-related disability than the WAD group. Researchers stated that decreased muscle function, kinesiophobia and pain level might have an effect on the emergence of this result (16). However, our results revealed that there was no significant difference between the traumatic and the non-traumatic group in terms of disability. This result may be due to the similarities of the demographic characteristics and the pain intensity levels of the groups.

The major strengths of the current study could be the assessment of postural control in a detailed manner using LOS and CTSIB tests via computerized technology and the blinding of the assessor. Therefore, the results obtained from our study can be accurate and instructive by performing the objective measurements with standardized equipment. Furthermore, all the subjects were tested by the same assessor, thereby minimizing inter-examiner bias.

This study has also some limitations. First, the relatively low number of traumatic patients can be considered as a limitation. Second, the inclusion of a healthy control group could have been useful in interpreting our results. The last, we only recruited patients with chronic neck pain to the study. Future studies should investigate the relation of trauma history with postural control and disability in patients with either acute, subacute or chronic neck pain.

CONCLUSION

In conclusion, postural control and disability do not differ between patients with traumatic and non-traumatic neck pain. Therefore, from a clinical perspective, there does not seem to be a need for evaluating trauma history of a patient with neck pain when postural control or disability to be assessed. Moreover, it may not be necessary to consider the traumatic or non-traumatic onset of pain when designing rehabilitation programs to improve postural control and disability in patients with neck pain.

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