Postural Balance, Visual Verticality Perception, and Its Association in Individuals with and without Neck Pain

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Objective: *To compare postural balance and visual verticality perception between neck pain and asymptomatic subjects; to determine its association within groups.*
Material and Method: *Fourteen neck pain and 14 asymptomatic subjects participated in the study. Subjects stood on a force platform to measure the displacement of the center of pressure in the medial-lateral and anterior-posterior directions, total path length, and sway velocity. Subjects performed 10 patterns of the rod and frame test in the sitting position to measure absolute errors of visual verticality perception. Postural balance variables between neck pain and asymptomatic participants were determined by Independent t-test. Two-way analysis of variance determined the effect of absolute errors of visual verticality perception, groups and its interaction. The association between postural balance variables and absolute errors of visual verticality perception was determined by Pearson's correlation.*
Results: *Neck pain patients showed greater total path length and sway velocity than asymptomatic subjects. Similar absolute errors of visual verticality perception between groups were shown. No correlation between postural balance variables and absolute errors of visual verticality perception within groups was demonstrated.*
Conclusion: *Postural balance, not visual verticality perception was disturbed in individuals with neck pain. Postural balance was not associated with visual verticality perception in individuals with and without neck pain.*

Keywords: *Neck, Pain, Postural balance, Vertical perception, Vision*

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Abnormal neck inputs produce postural imbalance and may affect visual perception. Individuals with neck pain show postural instability by increased sway area[1-3], center of pressure displacement amplitude in the medial-lateral and anterior-posterior directions and path length[4]. Deviation in judging the true visual vertical perception was found in individuals with neck pain[5-7]. However, similar visual verticality perception between patients with neck pain and asymptomatic individuals has been reported[8]. Some chronic neck pain and headache patients show dizziness, unsteadiness and/or visual disturbances[9].

It can be seen that vision may be disturbed in individuals with neck pain and the irritation may involve postural balance. This may disturb spatial orientation in individuals with neck pain. Additionally, a previous study proposed to consider the relationship between postural balance and visual perception[5] since several means are available to detect spatial orientation and whether the different methods would correlate. To investigate the correlation between postural balance and vision in individuals with neck pain, the present study aimed to compare postural stability and visual verticality perception between neck pain and asymptomatic individuals and to determine its association within groups.

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Material and Method

Participants

Twenty-eight participants (neck pain = 14, asymptomatic = 14) enrolled in the present study. Fourteen non-traumatic neck pain patients without referred pain (male = 3, female = 11) were recruited from an outpatient physiotherapy clinic (mean $\pm$ SD = 44.4$\pm$5.96 years, range 36-54 years), and 14 age- and sex-matched asymptomatic subjects without history

of neck pain for at least six months before participation were recruited from a nearby community (43.6±6.09 years, range 35-55 years). Both were excluded if they had impairments in neurological, musculoskeletal, visual, and vestibular systems.

Procedure

Before participation, all subjects were informed about the present study and signed a written, informed consent form. The present study was approved by a university ethics review committee (MU-IRB 2010/327.3011).

Subjects with neck pain rated pain level using a visual analog scale[10] (mean ± SD = 4.79±1.25, range 2-10) and reported neck pain duration (mean ± SD = 9.36±8.54 months, range 3-24 months) and symptoms accompanied with neck pain (no headache = 6, only headache = 6, headache and dizziness = 2). A four-year experienced physiotherapist examined structures of neck pain (muscle = 4, muscle and joint = 10) and the locations (side of neck pain: right = 5, left = 3, both = 6; pain region: upper cervical = 5, lower cervical = 8, both upper and lower cervical = 1).

In a quiet room, subjects stood comfortably with feet a part at their shoulder width, arms alongside the body, looking straight ahead on a force platform (AMTI model OR6-7), sampled at 50Hz and filtered at 8Hz, for 20s to measure the average center of pressure displacement amplitude in the medial-lateral (COP-ML) and anterior-posterior (COP-AP) directions (cm), total sway length (cm) and average sway velocity (cm/s).

After that, subjects sat in front of a 19-inch computer monitor in a darkened room. On the computer monitor was a 13-cm long white line (the rod) and an 18-cm long x 15-cm wide white rectangular border (the frame) on a plain black background, created using LabVIEW version 6.1 (National Instruments, S/N M21X59197). The rod was rotated independently of the frame and could move in step of 0.1° in a circle either clockwise (C) or counter-clockwise (CC), using a computer mouse. The frame was at 30° and 10° either C or CC, and vertical position (0°)[11] with the rod 28° tilted to either the left or right[12] and ten patterns were randomly applied and unseen before testing. Subjects manipulated the rod until they were satisfied that the rod was vertical. The absolute error in degree from the true vertical was recorded.

Data analysis

SPSS 18.0 software package (SPSS, S/N 5089368) was used for statistical analyses. The calculation of sample size was based on comparison between two groups on postural stability variables. The sample size was seven for each group.

All data were tested for normality using the Kolmogorov-Smirnov test and showed normal distribution (p>0.05). Thus, independent t-test was conducted to compare the COP-ML, COP-AP, total sway length, and average sway velocity between neck pain and asymptomatic subjects. Two-way ANOVA with post-hoc Bonferroni was used to determine the main effect of the rod and frame test (RFT) pattern and group and its interaction. Pearson's correlation was used to determine the association between postural stability and absolute error in visual vertical perception within groups. A probability of <0.05 was considered statistically significant.

Results

Postural stability

A significant increase in the total sway length (p = 0.001) and average sway velocity (p = 0.001) was observed between neck pain and asymptomatic groups (Table 1).

Absolute error in visual verticality perception

Significant differences in RFT pattern main effect ($F_{9, 260}$ = 2.272, p = 0.047) was shown, however, no pair differences were found. No difference in the group main effect ($F_{1, 260}$ = 1.771, p = 0.195) and its interaction effect ($F_{9, 260}$ = 1.578, p = 0.166) was found (Table 1).

Association between postural stability and absolute error in visual verticality perception

No correlation was demonstrated between postural stability and absolute error in visual verticality perception within neck pain and asymptomatic group.

Disscussion

Neck pain increases error in the cervical position sense[1,2,13]. The present result on postural stability is unambiguous and consistent with previous studies[3,4,7]. The result on visual verticality perception is similar to a previous study[8], but different from several earlier studies[5-7]. It may be from frame angles and initial rod positions in the RFT. The present study and previous research[5-8] operated various frame and rod directions. The angle of the frame and rod in the present study totally differs from that in the present study of Bagust et al[8]; however, a similar finding was observed. In contrast, the present result is dissimilar to previous findings[5-7] using different angles of the frame and rod.

Table 1. Postural stability and absolute error in visual vertical perception between neck pain and asymptomatic subjects

	Neck pain (n = 14)	Asymptomatic (n = 14)
Postural stability (mean ± SD)		
COP-ML displacement (cm)	0.21±0.14	0.14±0.09
COP-AP displacement (cm)	0.34±0.08	0.28±0.10
Total sway length (cm)	33.6±6.61*	26.1±4.18
Average sway velocity (cm/s)	1.68±0.33*	1.30±0.21
Absolute error in visual vertical perception (mean ± SD)		
 30CC, L	1.12±0.75°	0.92±0.79°
 10CC, L	0.84±0.90°	0.86±0.75°
 0, L	0.52±0.62°	0.72±0.48°
 10C, L	1.52±1.31°	0.78±1.06°
 30C, L	1.22±0.99°	0.98±0.80°
 30CC, R	1.11±0.61°	0.57±0.63°
 10CC, R	1.04±0.57°	0.98±1.00°
 0, R	0.82±0.94°	0.38±0.48°
 10C, R	1.50±1.28°	0.86±0.83°
 30C, R	0.76±0.64°	0.98±0.59°

* $p<0.05$ significant difference from asymptomatic subjects
COP = centre of pressure; ML = medial-lateral; AP = anterior-posterior; C = clockwise; CC = counter-clockwise; L = left; R = right

Moreover, age and pain features may be an explanation. Neck pain participants in the present study were unlike those in previous studies[5-8]. The certain RFT and meaningfully minimal deviation change of error from the true vertical of the RFT for neck pain individuals are suggested for future study. This may benefit clinical applications. In the present study, none of the neck pain participants complained of visual disturbances but showed a greater deviation of visual vertical perception in some RFT when compared with asymptomatic subjects. Therefore, postural imbalance is clearly presented and visual verticality perception may be disturbed but not shown in individuals with neck pain.

In the present study, postural stability was not associated with visual verticality perception in individuals either with or without neck pain. It may infer lesser role of vision in postural control in individuals aged 35-55 years. The age of our participants was in the age range that reported minimum visual function (40-49 years)[14], maximum vestibular performance (40-49 years)[14], and significant decrease in somatosensation (40-59 years)[15]. However, the relationship between balance and visual verticality perception within neck pain and asymptomatic individuals still requires investigation.

A large number of neck pain individuals with homogeneous clinical features are suggested for a future study. The present results may not be applied to acute and traumatic neck pain individuals and to individuals who are below or beyond middle age.

Conclusion

Individuals with neck pain have postural disturbance but no deviation in visual vertical perception. No association between postural stability

and error in visual vertical perception was presented in either neck pain or asymptomatic individuals.

What is already known on this topic?

In individuals with neck pain postural disturbance have been recorded, whereas visual vertical, perception deviation may be presented. Clinically, some individuals with neck pain complain of visual disturbance.

What this study adds?

The present study showed postural disturbance in individuals with neck pain. There was no visual vertical perception or its association with postural disturbance in individuals having neck pain and asymptomatic individuals.

Potential conflicts of interest

None.

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การทรงตัว การรับเห็นแนวตรง และความสัมพันธ์ของทั้งสองในผู้มีและไม่มีอาการปวดคอ

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วัตถุประสงค์: เปรียบเทียบการทรงตัวและการรับเห็นแนวตรงระหว่างผู้ปวดคอและไม่มีอาการ และหาความสัมพันธ์ระหว่างการทรงตัวและการรับเห็นแนวตรงภายในกลุ่ม

วัสดุและวิธีการ: ผู้ป่วยปวดคอ 14 ราย และไม่มีอาการ 14 รายเข้าร่วมการศึกษา การยืนบนแผ่นวัดแรงวัดระยะ จุดศูนย์กลางแรงกดทิศใน-นอกและหน้า-หลัง ระยะทางทั้งหมด และความเร็วการเซ การทำ 10 รูปแบบการทดสอบ แท่งและกรอบในท่านั่งวัดความผิดพลาดสัมบูรณ์การรับเห็นแนวตรง การทดสอบผลต่างค่าเฉลี่ยอย่างเป็นอิสระ เปรียบเทียบตัวแปรการทรงตัวระหว่างผู้ปวดคอและไม่มีอาการ การวิเคราะห์ความแปรปรวนแบบสองทางหาอิทธิพลความผิดพลาดสัมบูรณ์การรับเห็นแนวตรง กลุ่ม และอิทธิพลร่วม คำนวณค่าสหสัมพันธ์เพียร์สันหาความสัมพันธ์ ระหว่างการทรงตัวและความผิดพลาดสัมบูรณ์การรับเห็นแนวตรงภายในกลุ่ม

ผลการศึกษา: ผู้ป่วยปวดคอแสดงระยะทางทั้งหมด และความเร็วการเซมากกว่าผู้ไม่มีอาการ ความผิดพลาดสัมบูรณ์ การรับเห็นแนวตรงเหมือนกันระหว่างกลุ่ม ไม่มีความสัมพันธ์ระหว่างการทรงตัวและความผิดพลาดสัมบูรณ์ การรับเห็นแนวตรงในสองกลุ่ม

สรุป: การทรงตัวไม่ใช่การรับเห็นแนวตรง ถูกรบกวนในผู้ปวดคอ การทรงตัวไม่สัมพันธ์กับการรับเห็นแนวตรงในผู้มีและไม่มีอาการปวดคอ