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RESEARCH

EFFECTS OF CHRONIC LOW BACK PAIN ON POSTURAL STABILITY IN THE ELDERLY

ABSTRACT

Introduction: The aim of the present study was to investigate the effects of chronic low back pain on postural stability in an elderly population.

Materials and Method: The study enrolled 30 patients >65 years with chronic low back pain and 30 age-matched healthy controls. To assess postural stability, the centre of foot pressure sway was examined using a foot pressure platform. The chair stand, 10-m walk and timed up and go tests were conducted in both groups.

Results: There was no difference between the two groups with respect to the mean age and gender. The centre of pressure sway was increased in the anteroposterior and mediolateral directions in the group with low back pain. A marked reduction in postural stability was observed during measurements with the eyes closed. This reduction was more prominent in the anteroposterior direction (p<0.001). The elderly group with low back pain showed worse dynamic balance as assessed by the timed up and go test (p<0.001). The elderly patients with low back pain also showed considerably diminished performance during the chair stand and 10-m walk tests (p<0.001).

Conclusion: Chronic low back pain leads to impaired postural stability, loss of dynamic balance and reduced functional mobility in the elderly. Consequently, rehabilitation for postural instability should not be overlooked while planning treatment for low back pain in older patients.

Key Words: Low Back Pain; Postural Balance; Aged.

ARAŞTIRMA

YAŞLILARDA KRONİK BEL AĞRISININ POSTURAL STABİLİTE ÜZERİNE ETKİLERİ

ÖZ

Giriş: Bu çalışmanın amacı yaşlı populasyonda kronik bel ağrısının postural stabilite üzerine etkilerini incelemektir.

Gereç ve Yöntem: Çalışmaya 65 yaş üstünde kronik bel ağrılı 30 hasta ile aynı yaş grubunda 30 sağlıklı kontrol alındı. Postural stabilitenin değerlendirilmesi amacı ile basınç platformu kullanılarak katılımcıların ayak basınç merkezi salınımları değerlendirildi. Her iki gruba sandalyede kalkma testi, süreli kalk yürü testi ve 10 metre yürüme testleri uygulandı.

Bulgular: Gruplar arasında yaş ortalaması ve cinsiyet dağılımı açısından fark saptanmadı. Bel ağrılı grupta ayak basınç merkezi salınımları anteroposterior ve mediolateral doğrultularda artmış bulundu. Gözler kapalı yapılan ölçümlerde postural stabilitenin belirgin şekilde azaldığı görüldü. Bu azalmanın anteroposterior doğrultuda daha belirgin olduğu gözlendi (p<0,001). Süreli kalk yürü testi ile değerlendirilen dinamik dengenin bel ağrılı grupta daha kötü olduğu saptandı (p<0,001). Sandalyede kalkma ve 10 metre yürüme testlerinde bel ağrılı yaşlıların belirgin şekilde düşük performans sergiledikleri görüldü (p<0,001).

Sonuç: Yaşlılarda kronik bel ağrısı postural stabilitede bozulma, dinamik denge kaybı ve azalmış fonksiyonel mobilite ile sonuçlanmaktadır. Yaşlı hastalarda bel ağrısı tedavisi planlanırken postural instabilite rehabilitasyonu ihmal edilmemelidir.

Anahtar Sözcükler: Bel Ağrısı; Postural Stabilite; Yaşlılık.

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INTRODUCTION

Chronic low back pain (LBP) is a condition that results in substantial limitations in activity. Balance, which is fundamental for performing activities of daily living, is affected in patients with LBP (1). LBP is associated with some changes in postural control (2-4). The majority of studies on postural control in patients with LBP have shown increased postural sway in these individuals (1). A prolonged reaction time of the trunk muscles to sudden postural changes has been reported in the presence of LBP (5).

Aging is associated with impaired postural control and an increased risk of falls (6). Sensory and motor performance declines with aging. Elderly individuals with poor proprioception have been found to have greater postural sway. The factor that most commonly affects postural control is reduced proprioception of the joint position (7).

In recent years, foot pressure platforms that examine the centre of foot pressure sway have been utilized to quantify postural stability. While lower amplitude sway indicates good postural stability, higher amplitude sway indicates reduced postural stability. Although the impact of aging and chronic LBP is well recognized, the effects of LBP on postural control have not been fully elucidated in the elderly.

The aim of the current study was to investigate the impact of chronic LBP on postural stability in an elderly population and the changes in dynamic balance and mobility in these individuals.

MATERIALS AND METHOD

The study enrolled 30 patients >65 years with at least a 6-month history of chronic LBP and 30 age- and sex-matched healthy controls without LBP. Patients with spinal deformities, such as scoliosis and spondylolisthesis, neurological deficits, a history of spinal surgery, peripheral or central nervous system disease, vertigo, severe cardiac, respiratory and rheumatic conditions or malignancies were excluded. Approval was obtained from the local ethics committee of our hospital before the initiation of the study. All of the participants signed a written informed consent before entering the study. The characteristic features that were recorded for all participants included age, sex, body weight, height and a history of falls within the previous year.

Assessment of Postural Stability

Centre of pressure (CoP) sway measurements were performed to assess the postural stability of each patient. A Win-Track (Medicapteurs, France) pressure platform was used for measuring CoP sway. Win-Track is a 150x50 cm device that measures vertical ground reaction force with 12,288 sensors located on a highly sensitive surface. During the measurements, the feet were placed 22 cm apart for patients with a height of 76–140 cm, 26 cm apart for patients with a height of 141–165 cm and 30 cm apart for patients with a height of 166–203 cm (4). Measurements were taken while the patients were in a standing position with the arms placed right next to the body. Postural stability data were obtained using 30-s CoP sway recordings taken on the pressure platform. All measurements were conducted twice, once with the eyes closed and once with the eyes open. Data for total trajectory (T-Trajectory) and total area (T-Area) parameters were obtained. T-Trajectory is the length of trajectory drawn by CoP sway in all directions and T-Area indicates total sway area; both parameters were calculated using the Win-Track software. In addition, the amounts of CoP displacement in the anteroposterior (AP-Trajectory) and mediolateral (ML-Trajectory) directions were evaluated. Furthermore, mean CoP sway velocity was analysed in the anteroposterior (AP-Velocity) and mediolateral (ML-Velocity) directions.

Chair Stand Test

The chair stand test (CST) was performed on both groups in order to assess functional mobility. In the CST, the subject is asked to sit in an upright position at the centre of a chair with a seat height of 43 cm, with the hands placed on the contralateral shoulders. The subject is instructed to sit on the chair and stand up from the chair repeatedly within a 30-s period following a 'Start' command. The test score is determined on the basis of the number of chair stands in 30 s.

Ten-metre Walk Test

The 10-m walk test was used to evaluate the brief walking performance of the participants. In this test, the time taken to walk a 10-m distance briskly is recorded. For each subject, the average of three measurements was used in the analysis.

Timed Up and Go Test (TUG)

The TUG test is used to assess dynamic balance. It measures the time a participant takes to stand up from a chair, walk a 3-m distance and return and sit on the chair again. The TUG test has been demonstrated to be valid and reliable for the evaluation of functional mobility in older individuals (8).

Statistical Analyses

Statistical analyses of the study findings were conducted using SPSS (Statistical Package for Social Sciences) for Windows version 19.0. For analysis of the study data, descriptive statistical methods (mean, median, standard deviation and minimum-maximum) were used. The Student-t test was used for between-group comparisons of normally distributed quantitative data, and the Mann–Whitney U test was used for between-group comparisons of non-normally distributed quantitative data. The results were interpreted at a 95% confidence interval (CI) with a significance level set at $p<0.05$.

RESULTS

The mean age of the LBP patients who were enrolled in the study was 69.5±4.9 years, which was not significantly different from the mean age of the control group (70.5±5.5 years). The patient and control groups did not differ in gender distribution or mean body mass index (Table 1). Compared to the control group, the LBP patients had a statistically significant higher number of falls within the previous year. The LBP group had significantly lower CST scores and took significantly longer to finish the 10-m walk test and the TUG test in comparison to the control group (Table 1).

The results of postural analysis on the pressure platform with the eyes open are presented in Table 2. For all the study parameters, the CoP sways were markedly greater in the LBP group than in the control group.

The results of the postural analysis with the eyes closed showed significantly greater CoP sways in the LBP group than in the control group (Table 3).

Table 4 shows the magnitude of changes in postural balance during the postural stability tests with the eyes closed as compared to that with the eyes open in both groups. The shifts in postural stability were greater in the LBP group than in the control group when the eyes were closed, with highly significant differences for T-Trajectory, T-Area, AP-Velocity and AP-Trajectory parameters.

DISCUSSION

Brumagne et al. (2) suggested that major changes in postural control occur in patients with LBP. To achieve postural control, such patients use proprioceptive information that

Table 1— Characteristics of Study Groups

Characteristics	Low Back Pain Group (n=30)	Control Group (n=30)	p
Age, mean±sd, years	69.5±4.9	70.5±5.5	0.476
Gender (female), n (%)	21 (70%)	20 (66.6%)	0.781
BMI, mean±SD, kg/m^2	29.5±3.5	28.4±3.7	0.244
Number of falls	0 (0-2)[a]	0 (0-1)[a]	0.046*
CST, mean±sd	8.5±2.2	10.6±1.6	0.000**
10 meter walk test, mean±sd	10.5±1.8	8.9±1.8	0.000**
TUG, mean±sd, second	10.9±2.3	8.9±1.4	0.000**

Median (minimum-maximum), * p<0.05, ** p<0.001, BMI: body mass index, CST: chair stand test, SD: standard deviation, TUG:timed up and go test

Table 2— Comparison of Groups With Respect to CoP Sway Parameters Measured with Eyes Open

	LBP Group Median (min-max)	Control Group Median (min-max)	p
$CoP_{T\text{-}Trajectory}$	80.4 (34.6-172.6)	53.9 (33.3-110.1)	0,006**
$CoP_{T\text{-}Area}$	21.4 (2.1-141.2)	9.5 (1.3-52.6)	0,004**
$CoP_{ML\text{-}Velocity}$	1.5 (0.8-3.5)	1 (0.7-2.3)	0,002**
$CoP_{AP\text{-}Velocity}$	1.8 (0.7-4.6)	1.2 (0.7-3)	0,020*
$CoP_{ML\text{-}Trajectory}$	0.9 (0.2-2)	0.7 (0.2-1.3)	0,004**
$CoP_{AP\text{-}Trajectory}$	1 (0.3-5.4)	0.7 (0.2-1.5)	0,020*

* p<0.05, ** p<0.01, AP: anteroposterior, CoP: center of pressure, LBP: low back pain, max: maximum, min: minimum, ML: mediolateral, T:total

Table 3— Comparison of Groups with Respect to CoP Sway Parameters Measured with Eyes Closed

	LBP Group Median (min-max)	Control Group Median (min-max)	p
$CoP_{T\text{-}Trajectory}$	137.1 (63.5-370.4)	84.9 (38.5-126.5)	0,000**
$CoP_{T\text{-}Area}$	68.2 (11.4-298.1)	18 (2.5-73.8)	0,000**
$CoP_{ML\text{-}Velocity}$	2.3 (1-5.4)	1.4 (0.7-2.4)	0,000**
$CoP_{AP\text{-}Velocity}$	3 (1.6-10.1)	2 (0.8-3.5)	0,000**
$CoP_{ML\text{-}Trajectory}$	1.3 (0.6-3.6)	0.9 (0.4-2.3)	0,001*
$CoP_{AP\text{-}Trajectory}$	1.9 (0.7-9.1)	1.2 (0.4-2.6)	0,000**

* p<0.01, ** p<0.001, AP: anteroposterior, CoP: center of pressure, LBP: low back pain, max: maximum, min: minimum, ML: mediolateral, T:total

Table 4— Comparison of Groups with Respect to Changes in Postural Sway Tested with Eyes Closed and Open

	LBP Group Median (min-max)	Control Group Median (min-max)	p
CoPT-Trajectory	41.8 (2.3-260.1)	18.3 (0.3-66.5)	0,000***
CoPT-Area	30 (0.4-285.3)	7.4 (3.2-39.1)	0,000***
CoPML-Velocity	0.6 (0-3.7)	0.2 (0-0.9)	0,002**
CoPAP-Velocity	1.1 (0.2-7.1)	0.5 (0-2.1)	0,000***
CoPML-Trajectory	0.4 (0.1-2.6)	0.2 (0-1.4)	0,016*
CoPAP-Trajectory	1 (0-5.4)	0.4 (0-1.5)	0,000***

* p<0.05, ** p<0.01, *** p<0.001, AP: anteroposterior, CoP: center of pressure, LBP: low back pain, max: maximum, min: minimum, ML: mediolateral, T:total

is obtained from muscles surrounding the ankles rather than the trunk muscles. It has been reported that while this postural control strategy is adequate for simple activities, they fail to achieve postural stability during complex tasks.

Maintaining a fixed position on stable surfaces has no effect on postural stability in young adults with LBP; however, stability was impaired when testing was performed on a foam surface with the eyes closed and the arms in an abducted position (9,10). According to Caffaro et al. (4), increased CoP oscillation is more likely in patients with chronic LBP in comparison to the controls. Unstable surfaces and loss of vision increase postural instability. Braga et al. (11) reported that the CoP sway area was wider in LBP patients than in healthy individuals but with no difference in average sway velocity. Our results showed increases in all of the studied parameters, including the length and area of CoP sway trajectory and the average sway velocity, in older patients with LBP as compared to their healthy counterparts.

Volpe et al. (3) determined that postural control in individuals with LBP is impaired only on mobile surfaces. That study was conducted on younger patients and reported that anteroposterior stability was particularly affected in individuals with LBP. Tanaka et al. (6) found that although anteroposterior stability was impaired even when the eyes were open, mediolateral stability was only impaired when the eyes were closed in healthy older people. Our results indicated that both the anteroposterior and mediolateral stabilities were impaired in the presence of LBP in the elderly.

It is apparent that most of the studies on the relationship between LBP and postural stability have been conducted in younger subjects, and that the findings of these studies show that postural balance is usually impaired on unstable surfaces and/or with the eyes closed in LBP patients. Our results showed that balance is impaired even with eyes open, at a fixed position, and on a stable surface in older people with LBP. Consistent with our findings, a study with older patients as part of the study population demonstrated that CoP sway was increased in LBP patients when tested at a fixed standing position. The same study showed that the time to restore postural stability following perturbation of proprioceptive feedback by applying vibration to the ankle muscles was longer in the elderly people. These findings were interpreted as 'aging and low back pain diminish the sensitivity of paraspinal muscle spindles or alter the capability of the central nervous system to process this afferent information' (2).

Our findings showed that impairment of postural stability was more prominent when visual input was removed in older patients with LBP as compared to age-matched healthy controls. This result is consistent with all of the available literature (3,4,9,12). Older people were reported to use visual sensory information in an attempt to compensate for reduced proprioception in order to achieve postural control. In the elderly, postural control has been shown to be considerably impaired, particularly when the eyes are closed (6,13). While our results showed increased postural sway in both directions when the subjects were tested with the eyes closed, the finding of greater impairment in anteroposterior stability is remarkable.

In a study examining the dominant side in LBP patients, stability was significantly worse while standing on one foot and this was attributed to reduced lumbopelvic control (14). Sitting-standing performance is negatively affected due to suboptimal lumbar proprioception in patients with chronic LBP (15). Similarly, in the present study, the LBP patients were found to have a lower performance in the CST.

Kiers et al. (16) found that CoP sway was irregular and at a higher frequency in LBP patients and this was attributed to greater co-contraction of muscles and insufficient cognitive control in such patients. Furthermore, they reported diminished proprioception due to increased postural sway on a foam surface in LBP patients. Postural sway is reduced by the trunk muscles, which control the gravitational forces applied on the spine because of rotational motion on the axis of the ankle joint (1). According to Leionen et al. (17), impaired lumbar proprioception and motor control account for the reduced postural control in patients with LBP.

Using kinematic analyses, unbalanced functioning of the trunk muscles contributes to postural instability in patients with recurrent LBP (12). Higher resting activity has been demonstrated in the trunk and ankle muscles by electromyography in LBP patients and has been associated with increased muscle stiffness. In that study, acute muscular activity was diminished (18). Subsequently, a delay in CoP displacement according to a new body position has been shown on dynamic postural assessments in LBP patients (19).

Reorganization of trunk muscle representation at the motor cortex has been reported in individuals with recurrent LBP, and it has been suggested that this reorganization is associated with deficits in postural control (20). The effects of chronic LBP on postural stability are quite complicated. Factors that include pain, neurological problems, impaired muscular performance, fear of pain and adoption of alternative mobility strategies have all been implicated (1,21,22,23).

At present, little is known about postural stability problems in older individuals with LBP. The fact that more than half of the healthy elderly population is at a moderate to high risk for falls underscores the importance of postural stability (24). Our study showed that, in contrast to younger people, LBP affects postural stability even on stable surfaces in older individuals, that increased postural sway is common in all directions and that anteroposterior stability, in particular, is substantially impaired when visual input is removed. One limitation of our study is that we assessed postural stability only on a stable surface. Further studies are warranted to investigate the effect of various rehabilitation methods on postural stability.

Optimal postural control is essential in order to be able to perform activities of daily living. Given the adverse impact of aging and LBP on postural stability, it should be kept in mind that older patients with LBP are more likely to experience balance problems and that the risk of falls is aggravated by irregular surfaces and the dark. It is obvious that rehabilitation for postural instability should be a part of LBP treatment in older patients.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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