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Research Article

Static and dynamic postural stability in subjects with and without chronic low back pain

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ABSTRACT

Background: The present study were undertaken to compare the static and dynamic postural stability among chronic low back pain and normal subjects. Most of the studies have been conducted on sports professionals. The present study focuses on recreationally active population, for which the activity levels are comparatively lesser.
Methods: Thirty subjects (15 Chronic Low back Pain and 15 Normal subjects) were recruited randomly who's demographic are not varied. The static and dynamic postural stability test namely postural sway meter and Star excursion balance test were analyzed. Data were analyzed using test of homogeneity and Independent sample t test.
Results: Descriptive statistics reflected homogeneity of the study population. Independent sample t-test was used to compare values for static and dynamic stability between chronic low back pain and Normal subjects. It showed a statistically significant (P<0.05) difference in posterior and left lateral direction with t-value of -2.720 and -1.601 respectively for static stability. On the other hand, dynamic postural stability (SEBT) showed significant difference in all direction except on right leg; anteromedial, anterolateral and right and left posterior direction.
Conclusions: Chronic low back pain group showed reduction in static and dynamic postural stability as compared to normals'.

Keywords: Postural sway meter, Star excursion balance test, Chronic low back pain

INTRODUCTION

Postural control, can be defined as "the ability to maintain the body's center of gravity within the limits of stability as determined by the base of support".[1] It can be described as either dynamic or static. Static postural control is attempting to maintain a base of support while minimizing movement of body segments and the center of mass; while dynamic postural control involves the completion of a functional task with purposeful movements without compromising an established base of support.[2,3] Dynamic activities can also be described as those that cause the center of gravity to move in response to muscular activity.[4] Differences in motor behavior between Low Back Pain (LBP) patients and healthy control subjects have been demonstrated in a variety of tasks, e.g. during walking and in response to several perturbations.[5-9] Published evidence indicates that LBP patients may have impaired control over trunk posture and movement.[10,11] Dynamic controls is important in many functional tasks as it requires integration of appropriate levels of proprioception, range of motion, and strength.

According to Kibler et al.,[11] core stability and strength is an important component to maximize efficient balance and athletic function in upper and lower extremity movements. The same authors suggest that the core acts as a base for motion of the distal segments, or "proximal stability for distal mobility". Hence, in subjects with chronic low back pain there results paraspinal and other trunk muscle weakness and reduction in coordination of low back muscles. This reduction in muscular strength and coordination contributes to decreased postural stability, balance and neuromuscular control in subjects with CLBP.

Most of the literature review suggest of postural stability among sports professional. There is a paucity of studies for analysis of static and dynamic postural stability among normal recreational activity subjects. Hence, the need of the study is to assess static and dynamic stability in subjects with and without chronic low back pain.

METHODS

Subjects: Thirty subjects were recruited randomly from outpatient physiotherapy department of Smt. Kashibai Navale Medical College Hospital. There are two groups, group I subjects were of normal subjects without any neuromusculoskeletal dysfunction and group II were of patients with CLBP i.e. patients with low back pain >8 weeks. All the subjects were of age group 20-40 years of normal recreational active subjects without any radicular involvement, hemi paresis, hemiplegic, cerebellar disorder, vestibular diseases or those with lower extremity musculoskeletal dysfunctions.

Procedure

Subjects were recruited after obtaining ethical clearance from institutional ethical committee and written consent from each subject. Demographic data such as age, gender, BMI and through musculoskeletal clinical examination subjects were evaluated to rule out any associated neuromusculoskeletal dysfunctions. Static and dynamic postural stability were analyzed using postural sway meter and Star excursion balance test respectively.

Materials

Static stability was assessed by postural sway meter as follows:

- The sway meter records displacements of the body in the horizontal plane at waist level.
- The device consists of an inflexible 40-cm-long rod with a vertically mounted pen at its end.
- The rod will be mounted on a 20 cm wide metal plate which will be fitted over the participant's lower back (level of the posterior superior iliac spine) by a firm belt so that the rod extended posterior.
- Fitted firmly, the Sway meter offers 1 degree of freedom between the belt and pen as it is free to move in the pitch plane.
- The pen records participant's postural sway on a sheet of millimeter graph paper, fastened to the top of an adjustable-height table (Figure 1).

Measurement

- The sway path length will be manually determined as the number of millimeter squares traversed by the pen.
- The anteroposterior (AP) and mediolateral (ML) peak-to - peak sway displacements will also be calculated from the extremes of sway length in these two planes.

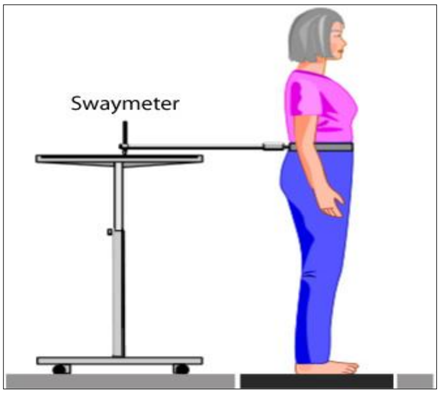

Figure 1: Measurement by the sway meter.

Dynamic stability was assessed as follows by using SEBT kit:

- The SEBT is a dynamic postural control test that requires balance on 1 leg with maximum reach of the opposite limb.
- The goal of the SEBT is to maintain single leg stance on one leg while reaching as far as possible with the contra lateral leg.[17]
- The person performing this test must maintain a base of support on one leg, while using the other leg to reach as far as possible in 8 different directions.
- This person (standing on her right leg for example) must reach in 8 different positions, once in every of the following directions: anterior, anteromedial, medial, posteromedial, posterior, posterolateral, lateral and anterolateral.[18]

Measurement: The reach distance in each direction will be measured in centimeters.

Figure 2: Dynamic stability was assessed by using SEBT kit.

Data analysis

Data obtained were analyzed by Statistical Package for Social Science (SPSS) version 20.0; Independent sample t test was used to compare the means. Homogeneity of sample was established and a priori alpha level of 0.01 was set to determine statistical significance.

RESULTS

Descriptive statistics of age, gender, BMI, postural sway and dynamic excursion direction are enlisted in Table 1. Samples are homogeneous which were considered for Independent t test (Table 2).

Table 1: Descriptive statistics of all the parameters.

Variables	Group 1 (Norm) Male-7, Female-8	Group 2 (CLBP) Male-9, Female-6
	Mean ± SD	Mean ± SD
Age	27.6 ± 4.92	30.33 ± 5.13
BMI	25.46 ± 5.70	26.23 ± 2.68
Postural sway		
Anterior (cm)	0.58 ± 0.37	0.81 ± 0.34
Posterior (cm)	0.74 ± 0.34	1.03 ± 0.54
Rt. Lateral (cm)	0.66 ± 0.34	0.72 ± 0.42
Lt. Lateral (cm)	0.60 ± 0.43	0.94 ± 0.67
Star excursion balance test		
Rt. Anterior	63.43 ± 2.23	63.37 ± 4.02
Rt. Anteriomedial	58.07 ± 1.34	55.10 ± 3.34
Rt. Anteriolateral	58.93 ± 3.45	60.47 ± 5.38
Rt. Posterior	67.53 ± 3.23	61.63 ± 4.23
Rt. Posteromedial	61.13 ± 2.28	57.93 ± 1.99
Rt. Posterolateral	62.13 ± 3.56	61.03 ± 4.89
Rt. Medial	54.77 ± 4.02	53.00 ± 9.23
Rt. Lateral	61.77 ± 3.34	58.47 ± 3.67
Lt. Anterior	60.97 ± 5.38	60.33 ± 4.01
Lt. Anteriomedial	55.63 ± 4.23	56.17 ± 2.78
Lt. Anteriolateral	59.20 ± 1.99	58.70 ± 3.56
Lt. Posterior	66.00 ± 4.89	61.43 ± 4.02
Lt. Posteromedial	58.53 ± 9.23	57.27 ± 3.34
Lt. Posterolateral	57.40 ± 3.67	55.53 ± 5.38
Lt. Medial	54.60 ± 4.01	54.10 ± 1.12
Lt. Lateral	61.77 ± 2.78	56.73 ± 5.23

Table 2: Independent sample t-test value for age, BMI and postural sway.

Variables	t-value	P value
Age	0.74	0.09
BMI	0.97	0.12
Direction		
Anterior	-1.782	0.08
Posterior	-2.72	0.05*
Rt. Lateral	-0.42	0.60
Lt. Lateral	-1.601	0.05*

*P<0.05 **P<0.01

The postural sway showed significant difference between normal and CLBP in posterior and left lateral direction as shown in Table 2 of P value <0.05. The CLBP group showed reduction in dynamic excursion distances (SEBT) in all direction as compared to control group, except on right anteromedial, anterolateral and right and left posterior direction as shown in Table 3.

Table 3: Independent sample t-test values for SEBT.

Direction	t-value	P value
Rt. Anterior	-3.45	0.001**
Rt. Anteriomedial	1.24	0.12
Rt. Medial	-1.34	0.05*
Rt. Posteriomedial	-6.22	0.05*
Rt. Posterior	0.98	0.07
Rt. Posteriolateral	-1.22	0.05*
Rt. Lateral	-1.187	0.05*
Rt. Anteriolateral	0.78	0.09
Lt. Anterior	-8.42	0.001**
Lt. Anteriomedial	-1.76	0.04*
Lt. Medial	-1.27	0.001**
Lt. Posteriomedial	-2.05	0.05*
Lt. Posterior	0.83	0.08
Lt. Posterolateral	-2.05	0.05*
Lt. Lateral	-1.12	0.05*
Lt. Anteriolateral	-1.08	0.04*

*P<0.05 **P<0.01

DISCUSSION

In the present study, the postural sway was present in all the directions in subjects with chronic low back pain with statistical significance in posterior and left lateral direction. The sway was least in right lateral direction may be because of influence of right side dominance. But, no supportive data has been reviewed. The maximum anterior sway was 1.8 cm in low back pain subjects and 1.5 cm in healthy subjects. This shows that there is not much difference in the anterior sway but was least and it supports the fact that vision helps in controlling sway.

The posterior sway was more than anterior and this can be related to many thoughts. It can be as a result of base of support as the inter-malleolar distance was kept constant (15 cm) for both the groups, indicating that CLBP subjects found difficult to maintain stability within that BOS. Furthermore, it has been suggested by O'Brien et al.[1] in one study that lumbar lordosis is the most variable angle between subjects and it may be related to changes occurring more proximally such as muscle lengths, strengths and pelvic inclination. Also, abnormal hip strategy would be one of the contributing factors for affection in posterior sway.

While someone is standing quietly, his body makes continuous movements even with his feet fixed on the ground. Such movements are small and reflexive processes to maintain his postural equilibrium. Since a human being has a high center point of mass and a small support base, he has difficulty maintaining a vertical posture. However, the multi-joints structure of the body allows a man to keep his balance in a variety of body configurations, even while he is in motion. It is considered that one's ability to rapidly adjust the movement timing of a muscle in response to any unexpected postural perturbation is very important for maintaining posture and balance. Chronic Low back pain increased the postural sway in quiet stance due to reduction of the function and coordination of stabilisation of low back muscle.[13] This reduction reduces the postural stability and neuromuscular control aid in varied postural sway among CLBP group. Moreover there are changes in proprioception transmission, paraspinal muscle spindle dysfunction, and delay in muscle recruitment along with poor postural control. Varied results are reviewed in the literature, showing increased postural sway in low back pain patients in all direction, Massod Mazaheri et al. 2010 in his review stated that majority of the study didn't showed increased sway in low back patients.[14] All the previous studies are on nonspecific low back pain-ranging from acute to chronic low back pain athletic subjects. This is the first study of this kind to evaluate the postural sway in normal recreational active subjects.

The dynamic excursion distance showed statistical difference in all direction except right anteromedial, anterolateral, and right and left posterior displacement. Balance, equilibrium, and postural control are synonyms concepts which are controlled by integrated system of postural mechanism - static or dynamic. The maintenance and control of balance, is an essential requirement for physical and daily activities. Postural mechanism is a complex phenomenon that occurs as a result of many interacting factors such as visual, vestibular, and proprioceptive sensations. The amalgamation of afferent and efferent signals provides a feedback control circuit between brain and musculoskeletal system.[15] This is the reason why control subjects performed well in all direction where all the systems are integrated. The excursion distances have been found to be reduced in CLBP group (Table 2). CLBP patients' exhibit deficit in proprioception and tactile acuity.[16-18] Moreover in CLBP, balance dysfunctions are attributed by altered feedback input from lumbar spine. In addition to it; pain proprioception inhibits the recruitment of muscular pattern from lumbar to ankle joint, CLBP also exhibits faulty kinematics aiding in poor performance of SEBT. Silfes et al. (2009) have demonstrated experimentally that lack of feedback activation of core musculature in CLBP patients leading to motor control dysfunction of posture during movement.

The external cues such as visual and vestibular inputs are required to control the dynamic excursion activity - SEBT. The visual cues are more reliable than vestibular system, due to accommodation strategy of eye movements even in conflicting base of support inputs. During posterior reach, vestibular system are more integrated than non-available visual cues leading to reduced posterior direction in both extremities. This may be attributed to the peculiar nature of SEBT, than any other factors. On the right leg reach, anteromedial and antero lateral direction didn't show any significant difference which is contradicting to previous studies.[13,20] Faulty proprioception, kinetics and altered muscle length tension could have reduced the performance of SEBT. In addition to it all the participants' were of right dominancy, where uneven muscle pattern and recruitment takes place i.e. as the subject stands on the stance leg and uses the opposite limb to reach, the rectus abdominus muscles and oblique's would fire before the movement occurs to perform trunk motion, allowing the subject to maintain balance. Also, the multifundi and transverse abdominus muscles would help to maintain dynamic balance during lower extremity movement by providing support to the lumbar spine.[11]

In order to comment strongly on affection of dynamic stability, one of the possible predictors of performance that was not investigated in this study was strength. The SEBT requires neuromuscular control though proper joint positioning as well as strength in surrounding musculature to create and maintain the necessary positions throughout the test. Future researchers should investigate the relation of muscle strength and fatigue of various lower extremity muscle groups and performance on the SEBT. Other physical factors that were not examined in this study that may be associated with variations in performance include the following: strength, neuromuscular control, and ROM of the joints.

CONCLUSION

Chronic low back pain group showed reduction in static and dynamic postural stability as compared to normals'.

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