Balance Assessment for Low Back Pain Patients

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ABSTRACT

The purpose of this study was to determine whether balance responses of low back pain patients differed from healthy control subjects under various upright standing conditions which challenged the balance system. Twenty female patients with low back pain, as study group, their age ranged from twenty to fifty years with mean stander deviation was 36.2 9.4 years, compared with twenty healthy female patients as control group their mean age was 39.5 8.0 years. Computerized balance master system was used to measure; eye open target sway (EOTS), eye closed target sway (ECTS), central target target sway (CTTS), then rhythmic weight shift in both left/right direction (RWS L/R) and forward/backward direction (RWS F/B). The results showed a significant difference between the study group and the control group in all measures. The level of significance for each group was as follow; EOTS (P=0.012), ECTS (P=0.001), CTTS (P=0.001), RWS L/R (P=0.015) for the first and second seconds and (P=0.002) for the third second while RWS F/B was (P=0.013) for the first second while it was (P=0.001) for the second and third seconds. The findings of this study suggest that the low back pain has an influence on balance in this particular patient group in this situation. Specially if balance was measured using an objective balance master system. Therefor, further studies involving deferent patient groups with deferent etiology and deferent clinical pictures are needed to confirm this effect. On the other hand it might be advisable to recommend balance evaluation as a part of the routine examination for the low back pain patients.

Key words: *balance, assessment, low back pain, impairment.*

INTRODUCTION

Many patients with low back pain are referred to physical therapy, the treatment usually begins with a thorough evaluation consisting of observation and/or measurement of range of motion, strength, overall function, posture and body mechanics[1,2,3,4,9,10,11,12,19,23]. The typical physical therapy treatments for low back pain include strength training, stretching, education, work hardening and application of modalities[1-5,10-12,19,23,25]. It appears that balance ability of patients with low back pain is not routinely evaluated; therefore, potential impairments in balance are not specifically treated.

Good balance is essential for performing normal activities of daily living, it is important for physical therapists to evaluate balance in patients with potential impairments. Patients with low back pain may have impairments of the afferent and/or efferent physiologic mechanisms which control balance. To maintain balance during normal activities, a constant interaction is required between central and peripheral components of the nervous system which control the center of gravity over the base of support[13,24]. Peripheral components of balance include **1-** the somatosensory system, ie: the receptors in joints, muscles, and ligaments, which provide input regarding tension, stretch, pain, and joint position, **2-** the visual system, which gives input regarding the changing environment, and **3-** the vestibular system, which gives input regarding the position of the head in relation to gravity, angular velocity, and linear acceleration[13,20,23,24]. The central nervous system integrates the peripheral inputs and selects the most appropriate muscular responses to control body position and posture[14,15]. If any of these components are injured, balance dysfunction may occur. Normally, during quiet standing the center of gravity constantly oscillates over the base of support in response to internal and external stimuli[22,26,27]. This oscillation is called postural sway. Many disorders can adversely affect the ability to compensate for changing stimuli, causing an increase in postural sway and an increase in energy expenditure to maintain the upright position[6,16,17,18]. Injury to the lumbar region can cause balance dysfunction as a result of two primary interruptions of the physiologic mechanisms which control balance: 1) sensory inputs, such as proprioception, may be altered, causing deficiencies in the somatosensory system and. 2) motor responses may be distorted due to impairments in muscle strength, motor coordination, or somatosensory degradation. These interruptions of the balance control system may lead to abnormal postural patterns, impaired reaction times, and instability or unsteadiness[6,14,17,24].

The purpose of this study was to compare balance and weight distribution in normal subjects with subjects complaining from low back pain.

METHODS

Subjects

Twenty females patients wearing high heal shoes, and give birth once in her life as study group between the ages of 20 and 50 years participated in the study, had one side (unilateral) low back pain of at least 3 months duration with no exacerbation over the previous 4 weeks. The subjects were receiving the same physical therapy treatment program (local heating, ultrasonic and therapeutic exercises) at the time of testing. Twenty healthy females as control group matching in their age the study group, were pain free at the time of the study, with no history of low back pain. Subjects were recruited from the King Saud University Community and Surrounding Area in Riyadh, Saudia Arabia during the period from January, 2000 to May, 2000. Exclusion criteria for study participation in both groups included uncorrected vision or other visual disorders, diagnosed vestibular or neurologic disorder uncontrolled metabolic disorder, history of dizziness or unexplained falls within the past 6 months, medications with known effects on balance, or any lower extremity pathology (total joint replacement, decreased sensation, or unresolved musculoskeletal injury).

Instrumentation

A balance master dual force plate (Neurocom International, inc., Clackamas, OR, USA) was used for data collection. The force plate consists of two foot plates connected by a pin joint. Each foot plate rests on two force transducers with sensitive axes oriented vertically[21,26]. The force plate was leveled in the X and Z planes using a bubble level prior to data collection and was calibrated with standard weights on a regular basis before any measurement every day. The force plate was connected to a balance master system computer (IBM) via A/D converter. Data were sampled at a rate of 20 Hz. An accompanying software program (balance master, version 3.4) calculated the mean position of the center of pressure relative to the platform coordinates. From the center of pressure data, the software then calculated an estimate of the center of gravity based on the subjects height. The center of gravity calculation assumed a kinematically rigid lower extremity link model with primary motion occurring at the ankle joints. Sway data were then plotted relative to the mathematically estimated center of gravity mean position. The center of pressure is equal and opposite to the average of all downward acting forces on the force plate. Center of pressure represents the neuromuscular response at the ankle to imbalances in the body center of gravity[26,27]. The path center of gravity excursion was traced on a printout for each subject trial. The tracing on this printout is directly proportional to the actual mathematical estimates of center of gravity and equivalent when multiplied by a factor of 5.50[21]. On the tracing, the Z axis represented the anterior / posterior excursion and the X axis represented the medial / lateral excursion of the center of gravity. From both axes, the maximal anterior / posterior and medial / lateral calculated center of gravity sway excursions were measured in millimeters. This technique has previously been demonstrated to have good intertester reliability (r .95)[16].

PROCEDURES

Subjects were signed a written consent and completed a medical history questionnaire. Written approval for subject participation was obtained prior to testing subjects with low back pain. Subjects then underwent upper and lower quarter screening evaluations, as described by Cyriax, to rule out any latent neurological or musculoskeletal deficits[8]. The height was measured by using a standard height measurements to standardize foot placement on the force plate. Vision was evaluated by a professional optometrist using a standard eye chart to ensure all subject had 20/20 vision, with or without correction. Subject were positioned barefooted on the force plate using the manufacturers recommended procedures. During data collection, the subject stood as still as possible with arms at their sides for 20 seconds with eyes open and for 20 seconds with eyes closed. Subjects were then instructed to stand with their weight equally distributed between both lower extremities for 30 seconds. A visual scale on the computer screen indicated percentage of weight distribution on each lower extremity. Subjects before measurement were made completed three trial runs to familiarize them with the tasks. Measurements were taken at the beginning of the study and on completion of the 16 weeks of physiotherapy program. For target sway measurements patients were instructed to stand still while looking straight ahead, initially with their eyes open and then with eyes closed. Postural sway was recorded for 20 sec. Then they were asked to focus on the cursor on the monitor screen [which corresponded to the subjects center of gravity (COG)] and to maintain the position of the cursor within a centrally placed target box. The target box represented the subject's theoretical limit of stability (LOS). Rhythmic weight shift measurements were made under three test conditions, all of which, required the subjects to shift their COG in various direction and the speed of the movements a cursor on the monitor screen by shifting their weight as required from lift/right and in the forward/backward to 50% of the LOS with pacing frequency of 1,2 and 3 sec. The subject shifted their body to match the position of eight targets arranged in an ellipse, the perimeter of which corresponded to 75% of the LOS. The target were presented in a random fashion and each one remained on the screen for 3 sec. Before it moved back to the central starting point. The time taken to track the target from one position to the next (transition time) and the accuracy of matching the target (sway path) were recorded. The percentage of changes in the LOS was also calculated.

Data analysis

The data were analyzed on IBM personal computer using statistical software (SPSS- PC, version 6) using non-parametric statistics with the level of significance set at 0.05 for all tests.

RESULTS

The mean subject age was ranged from twenty to fifty years, for the study group was 36.2 9.4 (X SD) while for the control group was 39.5 8.5. The mean subject height in centimeters for the study group was 170.2 8.1 while for the control group was 173.7 6.5. The mean subject weight in kilograms for the study group was 83.5 10.6 while for the control group was 80.9 8.7.

The mean and standard deviation of target sway measurements for both study and control groups under the difference three conditions; eye open target sway (EOTS), eye closed target sway (ECTS) and central target target sway (CTTS) was showed in table (1) and figure (1).

Table (1): Mean and standard deviation of target sway measurements for both study and control groups under the difference three conditions.

Test conditions (body target sway)	Study group (X ± SD)	Control group (X ± SD)	P valve
Eye open target sway (EOTS)	0.89 ± 1.2	0.48 ± 0.14	0.012
Eye closed target sway (ECTS)	1.80 ± 1.07	0.85 ±0.47	0.001
Central target sway (CTTS)	1.40 ± 0.92	0.94 ± 0.65	0.001

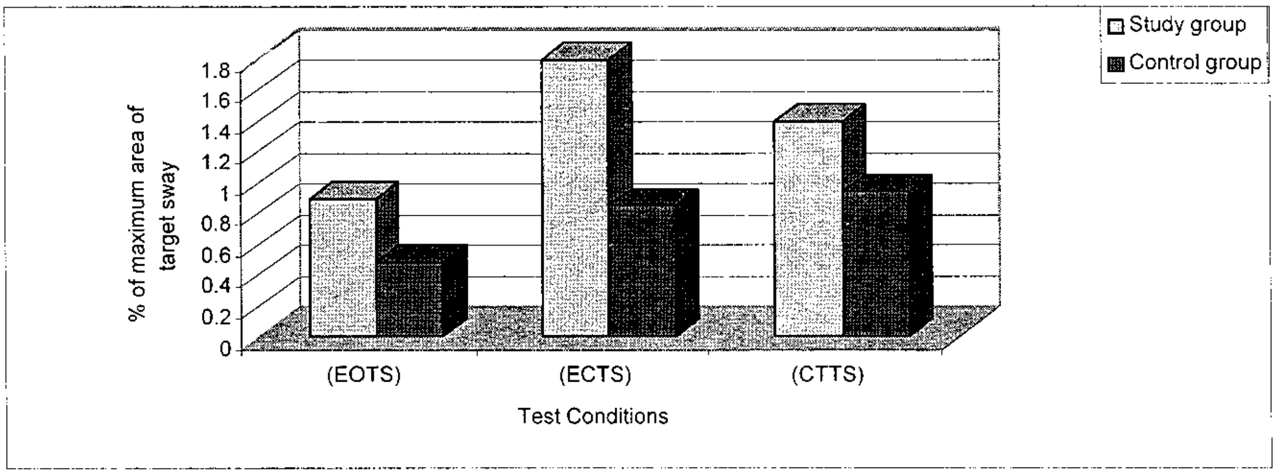

Fig. (1): Mean and standard deviation of target sway measurements for both study and control groups under the difference three conditions.

The mean and standard deviation of rhythmic weight shift in both left/right direction and forward/backward direction was showed in table (2).

Table (2): The mean and standard deviation of rhythmic weight shift in both left/right direction and forward/backward direction.

Test conditions (rhythmic weight shift)	Study group (X ± SD)	Control group (X ± SD)	P value
Left/right direction			
1 sec	32.2 ± 6.4	30.6 ± 5.6	0.015
2 sec	34.8 ± 8.3	31.5 ± 7.4	0.001
3 sec	40.5 ± 9.1	36.7 ± 8.1	0.002
Forward/backward direction			
1 sec	28.4 ± 5.1	26.3 ± 6.3	0.013
2 sec	31.7 ± 5.7	27.8 ± 4.9	0.001
3 sec	37.5 ± 7.9	32.5 ± 6.5	0.001

DISCUSSION

The result of this study showed a significant difference in balance reactions for those who suffer from low back pain compared to those healthy subjects with no history of low back pain. Specifically with eye closed the subjects with low back pain showed a marked target sway (1.80 ± 1.07) compared to the healthy subjects (0.85 ± 0.47).

There was a significant difference in rhythmic weight shift in both left/right direction and forward/backward direction between the study group and the control group ($P < 0.05$). The proprioceptors may provide inaccurate or mistimed input to central nervous system thus causing impaired postural control[5,18]. The mechanoreceptors of the synovial facet joints and surrounding soft tissue of the lumbar spine could be likewise affected in low back dysfunction. These inadequacies in the somatosensory system magnified the balance impairment when visual input was eliminated by the eyes closed condition of testing.

Byl and Sinnott[7] compared the balance responses of patients who were undergoing physical therapy for varied complaints of low back pain to healthy control subjects. They found there was a difference in mean body sway and in failure of one footed balance tasks. This finding is consistent with findings of the present study. Clinically noted that patients with unilateral low back pain tend to have a preference for weight bearing on one lower extremity compared with the contralateral lower extremity. This asymmetrical weight distribution may contribute to muscle imbalance, asymmetrical joint forces, or increased postural sway, thus continuing the cycle of low back pain and dysfunction.

It is possible that patients who have a higher level of pain and or a lower level of function would have more severely impaired balance, resulting in greater postural sway and a continuing cycle of muscular imbalance, chronic pain, and dysfunction.

The results of this study suggested that subjects with low back pain tended to keep their center of force posterior compared with healthy subjects. This posterior shift causes a relaxation of the subject's trunk muscles, an increase in lumber lordosis and greater compressive forces to the vertebrae and neural foramina. It is unknown whether this shift is a cause or a result of the impaired balance, but this postural compensation may cause greater mechanical stress and muscle imbalance, thus continuing the progression of the low back pain.

Further studies are needed to understand the balance reactions of the subjects with low back pain and to determine if these impairments adversely affect pain level, function, chronicity, or recovery speed. Studies examining the effectiveness of balance training programs are needed to determine if improvements in balance reaction can be achieved in patients with low back pain.

CONCLUSIONS

The findings of this study demonstrated that balance was significantly influenced by the low back pain. It appears that balance ability of patients with low back pain is not routinely evaluated; therefore, potential impairments in balance are not specifically treated. Low back pain was associated with neuromuscular impairment of the balance control system, such impairment may be amenable to physical therapy treatment to prevent chronic low back pain, reduce pain, speed recovery and improve function.

By identifying the balance impairments, it may be possible to interrupt this vicious cycle by appropriately treating the balance impairments, thus improving the likelihood of the patients return to normal activities without chronic pain.

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الملخص العربي

تقييم الاتزان في مرضى ألم أسفل الظهر

أجريت هذه الدراسة على 20 مريضة بالآم أسفل الظهر بالمقارنة بعشرين أخرين أصحاء . وقد استخدم جهاز قياس الاتزان بالكمبيوتر لقياس درجة اتزان الجسم في وضع الثبات أثناء ثلاث حالات عند فتح العينين وعند إغلاق العينين وعند منتصف الهدف . وكذلك تم قياس درجة اتزان الجسم عند تغيير وزن الجسم على القدمين في اتجاه اليسار واليمين وكذلك في اتجاه الأمام والخلف . وقد أظهرت نتائج هذه الدراسة اختلاف معنوي في القياسات بين مجموعة مرضى ألم اسفل الظهر ومجموعة الأصحاء . وأوصت هذه الدراسة بضرورة أن يكون قياس الاتزان وتمرينات الاتزان ضمن برنامج العلاج الطبيعي لآلام أسفل الظهر .