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Assessment of Motor Control in Chronic Mechanical Low Back Pain Patients with Flexible Flat Foot

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ABSTRACT
Background: Flexible flatfoot may affect motor control in chronic mechanical low back pain (CMLBP) patients.
Objective: This study aimed to assess the motor control in CMLBP with flexible flatfoot.
Subject and Methods: This observational study with a cross-sectional and comparative design that was conducted on 52 CMLBP patients assigned into 2 equal groups: Group A (study group) involved 26 CMLBP patients with flexible flatfoot and group B (control group) involved age-matched 26 CMLBP patients with normal foot posture. They aged from 20 to 35 years, and their body mass index ranged from 20 to 25 Kg/m^2. The motor control was measured using static and dynamic core muscle endurance tests.
Results: When comparing CMLBP patients with flexible flatfoot to those with normal foot posture, the results revealed a significant difference in static endurance of the flexor, extensor, and lateral muscles and dynamic core muscles endurance among both groups (P=0.001).
Conclusion: When CMLBP patients with flexible flatfoot and those with normal foot posture were assessed for motor control, there were notable differences between the two groups.
Keywords: Chronic mechanical low back pain, Flexible flatfoot, Motor control.

INTRODUCTION

One of the most prevalent musculoskeletal problems affecting humans, low back pain (LBP) has extensive economic and societal consequences [1]. Now, LBP is the number one source of disability around the world [2], and affects the young population, approximately affect about 80% of adults. It can be debilitating and limit or prevent physical activity[3, 4].

Chronic Mechanical Low back Pain (CMLBP) is a worldwide health problem that is defined as LBP with no pathological evidence and with a history of more than 3 months [5]. Dysfunction in the core muscles (trunk, pelvis, hips) can cause motor chain disturbances, which can lead to lower extremity injury and LBP [6]. Flat foot or foot over pronation is defined as decline or absence of the medial longitudinal arch. Flexible Pes planus (mobile flat feet) is present in about 15-25% of adults [7, 8].

When walking, the arch of the foot distributes the individual's weight evenly throughout the whole foot. Additionally, it cushions the foot from impact [9]. Dysfunction of the arch complex could disturb the whole lower limb kinetic chain system and even the spine. As disorders in a part of a kinetic chain impairs other parts of the chain [10, 11].

Therefore, diminished arch results in increased ground reaction force, can put individuals at risk for complications like LBP [12].

Although the strong theoretical basis links foot function to lower extremity and trunk biomechanical dysfunction, there has been a lack for studies on how foot deformities affect trunk and muscular function [13, 14].

When comparing individuals with and without flat feet, **Zahran *et al.*** [15] found that those with flat feet had significantly lower isokinetic concentric strength in the hip flexors, extensors, medial rotators, as well as lateral rotators. When comparing the groups' concentric strength in the trunk's extensors as well as flexors, no statistically significant differences were found. Although, endurance testing is the most reliable measure of trunk assessment [16], to the best of the authors knowledge, there have been no studies evaluating muscle endurance in patients with flatfoot.

PATIENTS AND METHODS

Study design: This was observational study with a cross-sectional and comparative design.

Participants: Fifty-two male & female CMLBP patients were included in this study. They aged from 20 to 35 years, and their BMI ranged from 20 to 25 Kg/m^2. Patients were randomized into 2 equivalent groups (A and B): Group A (study group) was diagnosed with CMLBP with flexible flatfoot. Group B (control group) was diagnosed with CMLBP with normal foot posture. The patients were chosen from the Outpatient Clinic, Faculty of Physical Therapy, Cairo University. The sample size was calculated by G-power and prior to collecting data each patient completed a consent form that he was well-informed.

Inclusion criteria: Male and female patients diagnosed with CMLBP met the criteria of the ACR appropriateness, who had a history of LBP without a known cause, and it was persistent for more than 3 months. Age from 20 to 35 years old, while their BMI ranged from 20 to 25.

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Exclusion criteria: Patients with rigid flatfoot, patients who were found to have a deformity or deviation of the spine as a result of past trauma, inherited or congenital conditions, prior surgery on the back or lower extremities, being pregnant, having a BMI greater than 25.5, or having neurological problems or vascular disease that might interfere with their capacity to undergo the planned evaluation.

Procedure: Flatfoot was assessed by navicular drop test, and then tip toe test to assess the flexibility of the flatfoot. Patients without flatfoot were not assessed by tip toe test. Then all patients in both groups were assessed by core muscles endurance tests (static and dynamic). The static endurance tests were the trunk flexor test, trunk extensor test, in addition to bilateral side bridge tests (the endurance time of each isometric test was recorded), while for dynamic endurance sit-up test was performed. The examiner allowed a minimum of 5 minutes' rest between each test as a result of the fatiguing nature of the tests.

Ethical approval: Cairo Faculty of Physical Therapy Medical Ethics Committee approved this study. After obtaining the necessary information, all participants provided signed consents. The Helsinki Declaration was observed throughout the study's conduction.

Statistical analysis

The data were analyzed using computation algorithms and the SPSS computer program, version 22.0. The data were tested for normality utilizing the Kolmogorov-Smirnov test. Quantitative measures were employed to characterize qualitative data. Parametric data was shown using continuous variables (min-max), with the mean ± standard deviation (SD). Continuous parametric data were tested for comparison using Pearson correlation, for each of these statistical tests, a p-value ≤ 0.05 was used to determine statistical significance.

RESULTS

The study enrolled 52 CMLBP patients who were assigned into 2 equal groups: Group A (study group) involved 26 CMLBP patients with flexible flatfoot and group B (control group) involved age-matched 26 CMLBP patients with normal foot posture. All patients in both groups underwent motor control assessment in terms of static and dynamic core muscle endurance tests. Fifty-two male & female CMLBP patients were included in this study. They aged from 20-35 years, and their BMI ranged from 20-25 Kg/m^2 (Table 1).

Table (1): Subjects and physical characteristics of both groups

Measurd variable	Group A	Group B	t-value	p-value	Sig
Age (years)	Mean ±SD 26.6±4.4	Mean ±SD 28.1±4	-1.28	0.206	NS
BMI (kg/m^2)	25.2±5.2	25.8±5.3	-0.39	0.694	NS
Sex N (%) Males Females	 12 (46%) 14 (54%)	 14 (54%) 12 (46%)	χ^2 =0.308	0.782	NS
Physical					
Navicular height from sitting (mm)	Mean ± SD 44±1.9	Mean ± SD 43±1.9	1.85	0.069	NS
Navicular height from sstanding (mm)	35.3±2	39.5±1.9	-7.9	0.001	S
Navicular drop (mm)	8.7±0.7	3.5±0.5	32	0.001	S

SD: Standard deviation, χ^2: Chi squared, value p value: Probability value, NS: Non-significant, S: significant.

Comparison of core muscle static endurance between both groups:

a) Flexors endurance: As shown in table (2), the mean values ± SD of flexors endurance of group A was 31.5 ± 1.1 while of group B was and 43.5 ± 1.1 sec. The mean difference between groups was -12. A statistically significant difference was found in the mean values of flexors endurance between both groups (P=0.001).

b) Extensors endurance: As revealed in table (2), the mean values ± SD of extensors endurance of group A was 34.5 ± 1.1, while it was 46.5 ± 1.1sec. in group B. The mean difference between groups was -12. A statistically significant difference was observed in the mean values of extensors endurance among both groups (P=0.001).

c) Left musculature endurance: As revealed in table (2), the mean values ± SD of left musculature endurance of group A was 28 ± 0.7, while it was 38.7 ± 0.9 sec in group B. The mean difference between groups was -10.6. A statistically significant difference was observed in the mean values of left musculature endurance among both groups (P=0.001).

d) Right musculature endurance: As revealed in table (2), the mean values ± SD of right musculature endurance of group A was 31 ± 0.7, while it was 41.7 ± 0.8 sec in group B. The mean difference between groups was -10.8. A statistically significant difference was observed in the mean values of right musculature endurance among both groups (P=0.001).

Table (2): Comparison of mean values of core muscle static endurance between groups

Endurance (sec)	Group A Mean ±SD	Group B Mean ±SD	Mean difference	f-value	P value	Sig
Flexors	31.5 ± 1.1	43.5 ± 1.1	-12	1496	0.001	S
Extensors	34.5 ± 1.1	46.5 ± 1.1	-12	1441	0.001	S
Left side bridge test	28 ± 0.7	38.7 ± 0.9	-10.6	2270	0.001	S S
Right side bridge test	31 ± 0.7	41.7 ± 0.8	-10.8	2506	0.001	S

SD: Standard deviation, p value: Probability value, S: significant.

Comparison of core muscle dynamic endurance between both groups:

As shown in table (3), the mean values ± SD of dynamic endurance of group A was 19.5 ± 1.1, while it was 25.7 ± 1.5 sec in group B. The mean difference between groups was -6.2. A statistically significant difference was observed in the mean values of dynamic endurance among both groups (P=0.001).

Table (3): Comparison of mean values of core muscle dynamic strength between groups

	Group A Mean ±SD	Group B Mean ±SD	Mean difference	f-value	P value	Sig
Dynamic Endurance (sec)	19.5 ± 1.1	25.7 ± 1.5	-6.2	285	0.001	S

SD: Standard deviation, p value: Probability value, S: significant.

DISCUSSION

A three-dimensional malformation characterized by hindfoot valgus, forefoot abduction, as well as supination is typically described as a flexible flatfoot [17]. In adult populations, Flexible flatfoot prevalence was 13.6% (for females-14.4% & for males-12.8%) [18].

From a biomechanical point of view, a system of body movements is a series of movement chains that work together to form movements. When there are problems in one part of the body's kinetic chain, they affect other kinetic chains as well. Therefore, biomechanical foot conditions, including excessive pronation of the foot (flat foot), affect the entire motor chain of the lower extremities and the spine, and in some cases cause severe back pain [14, 19].

LBP has a significant impact on individual's health as well as quality of life. It may have an impact on their everyday performance and even their activities to a certain degree [20]. It is associated with psychological, social, and biophysical factors that affect function, social participation, work satisfaction, and socioeconomic status [21]. In addition, the disease poses a high economic cost to patients and society [22].

This study was done to examine motor control in terms of static and dynamic core muscle endurance in CMLBP patients with flexible flat foot and CMLBP patients with normal foot posture. Fifty-two male & female CMLBP patients were included in this study. They aged from 20-35 years, while their BMI ranged from 20-25 Kg/m^2. Patients were randomized into 2 equivalent groups (A and B): Group A (study group) was diagnosed with CMLBP patients with flexible flatfoot and group B (control group) that was diagnosed with CMLBP patients with normal foot posture.

In our study, significant differences were found in static as well as dynamic core muscle endurance including flexors, extensors, and lateral musculatures in both sides between both groups. The present results agree with **Abhilash *et al.*** [23] who discovered that those prone to LBP may have compromised core muscle endurance due to their flexible flat feet.

The calcaneum everts, the talus adducts, as well as the plantar flexes due to biomechanical changes in a flat foot [24]. The talus's inferomedial translation causes the tibia to rotate internally more than usual, which in turn causes the femur to rotate internally more than usual. Owing to the sacroiliac joint's taut fibrous attachment, a series of events occurs that causes the pelvis to tilt forward. The result is lumbar hyperlordosis, which forces the trunk muscle to contract in order to keep the spinal stability. This means that those with flexible flatfoot put more strain on their trunk muscles than those without the condition [24]. Therefore, the extensors of the back have to work harder, leading to stress as well as early fatigue, due to the proximal joints undergo compensatory motions that put more strain on the lumbopelvic area and because maintaining an upright posture requires them to do so [24, 25].

Proper control and erect posture are directly related to the anatomical position as well as functioning of the abdominal muscles. When the iliopsoas muscles are excessively taut in those who have flexible flat feet, it leads to a rise in lumbar lordosis, which in turn separates the pubic bones from the coastal arch. The result is a weakening along with stretching of the abdominal muscles. The abnormal inhibitory activity of the abdominal muscles, seen in individuals with flexible flatfoot, causes the muscles to fatigue more quickly than usual [24, 26].

The largest muscle in the abdomen region is the external oblique. The frontal pelvic rotation is controlled by it. When spinal stability is lacking, the external oblique muscle contracts more forcefully to make up the difference. Because flat feet cause an imbalance, this postural muscle has to work harder to correct the problem. These muscles will have to work longer to keep the neutral alignment, which might cause them to fatigue quickly [24].

The core muscles, comprising the trunk, pelvis, and hip, are recognized as pivotal components within the kinetic chain. Dysfunction within these muscles has the potential to disturb the kinetic chain of motion, a phenomenon that has been correlated with both lower extremity disorders and instances of lower back pain (LBP) [6].

This study has a tiny age range of patients. A further study with more patients and a wider age range is needed to generalize the findings to the adult population. Further studies may uncover disparities kinematics and muscle activation pattern between genders.

CONCLUSION

This study adds value to the available literature by assessing motor control in terms of static and dynamic core muscle endurance in CMLBP patients with flexible flatfoot as the past research focused on the kinematic effects of flatfoot on proximal segments and only inadequate studies had examined the impacts of flatfoot on the muscular performance and function in the lumbopelvic region. Thus, this study compared motor control in terms of static and dynamic core muscle endurance between CMLBP patients with flexible flatfoot and those with normal foot posture. It was concluded that a significant difference was found in flexor, extensor, and lateral musculature endurance between CMLBP patients with flexible flatfoot and those with normal foot posture.

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