The relationship between prolonged sitting position and adaptive alterations in lumbar spine and pelvic range of motion in cyclists with chronic low back pain

Sara Zamiri (1)
Mohammad Jafar Shaterzadeh Yazdi (2)
Mohammad Mehravar (3)
Ismail Ebrahimi Takamjani (4)
Amir Ahmadi (5)
Nader Maroufi (5)

(1) PhD Candidate, Physical Therapy Department, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran.
(2) Associate Professor, Musculoskeletal Rehabilitation Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
(3) Instructor, Musculoskeletal Rehabilitation Research Center, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
(4) Professor, Physical Therapy Department, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran.
(5) Associate Professor, Physical Therapy Department, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran.

Corresponding Author:
Ismail Ebrahimi Takamjani,
Physiotherapy Department, School of Rehabilitation Sciences,
Iran university of medical sciences, Mirdamad Blvd., Tehran, Iran
Tel: +98-21- 22229086 Fax: +98-21- 22220946
Email: Ebrahimi.pt@gmail.com

Abstract

Background: The majority of low back pain (LBP) problems in athletes are the result of stress induced by prolonged postures or repeated movements. Cycling is a sport that needs prolonged trunk flexion during the activity.

Objective: To compare sagittal lumbar spine and sagittal pelvic tilt range of motion (ROM) between athletes with CLBP (chronic low back pain) who regularly ride bicycles and healthy controls without regular bicycle riding.

Methods: Nineteen cyclists with CLBP and 20 asymptomatic non-cyclist athletes participated in the study, (mean age: 26.00±8.67 years). Sagittal lumbar spine and sagittal pelvic tilt range of motion (ROM) were measured during forward bending and backward return clinical tests using a three-dimensional motion capture system.

Results: During forward bending, cyclists with CLBP demonstrated a limited anterior pelvic tilt angle ($p = 0.03$), compared to non-cyclists athletes. No significant differences were found in lumbar flexion angle between the groups during the test. During Backward return, cyclists with CLBP exhibited a limited posterior pelvic tilt angle ($p = 0.02$) and lumbar extension range ($p = 0.05$), compared to non-cyclist athletes.

Conclusions: A regular sitting position on the bicycle for a prolonged period may result in adaptations in sagittal lumbar and pelvic ROM which may contribute to the development of LBP.

Key words: Low back pain; Cycling; Prolonged posture; Lumbar; Pelvic, Range of motion

Please cite this article as: Sara Zamiri. Mohammad Jafar Shaterzadeh Yazdi Mohammad Mehravar, Ismail Ebrahimi Takamjani. Amir Ahmadi, Nader Maroufi. The relationship between prolonged sitting position and adaptive alterations in lumbar spine and pelvic range of motion in cyclists with chronic low back pain World Family Medicine. 2017; 15(10):23-27. DOI 10.5742/MEWFM.2017.93132

Introduction

A large number of low back pain (LBP) problems in athletes are as a consequence of movement demands on the hip and the lumbopelvic regions during repetitive performed sport activities(1-4).

It has been proposed that regular participation in activities which require prolonged postures and repeated movements can increase tissue stress and microtrauma, and eventually develop movement impairment syndromes (kinesiopathological model)(5). Despite the higher prevalence of LBP from prolonged postures or repeated movements in athletes, there are relatively little research literature to investigate this type of LBP (6, 7).

One way to identify the effects of prolonged trunk flexion on spinal kinematics and the development of LBP is to examine lumbar and pelvic range of motion (ROM) in cyclists with LBP. Cyclists spend much time riding their bicycle in a prolonged trunk flexion position and this position may be associated with the development of LBP (8-10). Muyor et al. found that cyclists demonstrated significantly greater lumbar flexion during bending forward and on the bicycle when compared with non-athletes (11). In another study of cycling, Van Hoof et al. compared lower lumbar ROM in cyclists with LBP to asymptomatic controls. They suggest that cyclists with CLBP ride with a greater lower lumbar flexion which is associated with an increase in pain (10).

In most previous research studies regarding the relationship between prolonged cycling and lumbopelvic kinematics in cyclists, spinal kinematics were analyzed in prolonged, flexed-spine position during cycling (10, 12-14). However, the examination of individuals using standardized clinical tests helps to identify the movement impairments and the factors that contribute to the presence of a dysfunction (5). Assessment of the lumbar spine and pelvic contributions to forward bending and backward return are basic clinical examination tests in people with LBP (5, 15-17). Therefore, the current study was conducted because sports-related LBP problems associated with prolonged postures and repeated movements have not been extensively analyzed in previous research studies. This study focused on cycling to examine lumbar and pelvic mobility in cyclists who sit on a bicycle for prolonged periods. To our knowledge, no previous study has measured the lumbar spine and pelvic ROM during forward bending and backward return clinical tests in cyclists with LBP. The purpose of this study was to compare athletes with CLBP (chronic low back pain) who regularly ride a bicycle with healthy controls without regular bicycle riding, regarding lumbar spine and pelvic ROM during standardized forward bending and backward return clinical tests. We hypothesized that repetitive flexion demands which are imposed on pelvic and lumbar regions contribute to impairments in the magnitude of lumbar and pelvic motion and eventually lead to LBP.

Methods

Participants

Nineteen cyclists with CLBP and 20 asymptomatic non-cyclist athletes (soccer: 11, badminton: 5, and running: 4), between the ages of 18 and 60 (mean age: 26.00±8.67 years), were included in this cross-sectional study. The cyclists with CLBP reported that they rode in a trunk flexion position for at least one-year (minimum of two times per week) (3, 5) and had suffered from LBP in the past 12 months (18). All cyclists with LBP attributed their symptoms to riding a bicycle. Healthy subjects did not have LBP experiences in the past 12 months. People were excluded from this study if they had a history of spinal surgery, any spinal deformity, serious spinal diseases (e.g. cancer, infection), systemic diseases and current pregnancy. The groups were matched for participant personal characteristics (Table 1). Patients were referred from physicians and healthy subjects were called through an advertisement and friends of the participants. All participants read and signed an informed consent form approved by the Human Studies Committee of Iran University of Medical Sciences before participating in the study.

Laboratory Measures

Prior to any laboratory test, participants completed the following questionnaires: (1) demographic and sport activity questionnaires, (2) questionnaire about LBP history, and (3) the numeric pain rating scale questionnaire (19). Afterwards, kinematic data were recorded during the tests of forward bending and backward return in standing position. The subject performed forward bending and backward return tests as far as possible at an individual preference speed. A 6-camera motion capture system (Qualisys AB. Sweden) was used to track the 3-dimensional marker positions. The sampling frequency of kinematic data capturing was 100 HZ. The dynamic resolution of the capturing volume was greater than 1 mm. Reflective skin markers were placed 7cm to the side of the spinous process of the 3rd lumbar vertebra, corners of the 1st sacral vertebra, highest point of the iliac crest, greater trochanter, posterior aspect of the middle of the femur, medial and lateral knee joint line, lateral malleolus, bilaterally, and two markers on spinous process of the 1st and 5th lumbar vertebra. Calibration was performed before the data acquisition. All laboratory measures were conducted in the Movement Science Laboratory in Physical Therapy Department at Iran University of Medical Sciences.

Data Processing

The lumbar segment local coordinates were reconstructed using the marker on the spinous process of the 1st lumbar vertebra, the marker on the spinous process of the 5th lumbar vertebra and the two markers on the 7cm to the side of the spinous process of the 3rd lumbar vertebra. The knee medial and lateral markers, and the greater trochanter and femur markers were used to define femur local coordinate system. The pelvic area was defined by the markers on the iliac crests and corners of the 1st sacral vertebra. The tibia was defined using the lateral malleolus and the medial and lateral knee joint line markers. Firstly, three-dimensional positions of the markers were gap filled and filtered. A robust spline smoothing algorithm (20) was used for filling the gaps. Next, the output was filtered using a second order bidirectional low pass Butterworth filter with the cutoff frequency of 10 Hz. Three-dimensional kinematics were extracted using the Euler-Cardan approach programmed in MATLAB software (The MathWorks, Inc., Natick, Massachusetts, USA). The X-Y-Z Cardan sequence was used to find the transformation matrix from global to a local coordinate system (to find limb angles), and from local to another local coordinate system (to find joint angles). We used an iterative process to determine the start and termination of each movement. For each test, the main and dependent movements were plotted against time. The start and end points were identified using threshold criteria of angular velocity and displacement. The times at which angular velocity goes above and comes back below 10 percent of the peak velocity were considered as the movement's start and end, respectively. The peak velocity was considered as the maximum velocity of the first bell-shaped velocity movement in the direction of the movement under consideration. The iterative process was used to control the start time for searching for the movement start and end and also used to visually confirm the accurate detection. At an accurate start point, the angle-time plot should have a consistent slope change. This iterative process was also carried out using a custom-made MATLAB program. Sagittal lumbar spine and sagittal pelvic tilt ROM at the termination of forward bending and backward return tests were calculated as kinematic variables of interest.

Statistics

The statistical software SPSS 16.0.0 (SPSS Inc. Chicago, IL, USA) was used for all data analyses. Categorical data are reported as number (percentage). Continuous variables are presented as mean±SD. The Shapiro-Wilk's test was used to examine the normality assumption of quantitative variables. For testing hypothesis about difference of means between the 2 groups, continuous variables were compared using either the t-test (normal distribution) or the Mann-Whitney test (non-normal distribution). Independent samples t-test was applied to examine the differences in pelvic and lumbar ROM between the two groups (cyclists and non-cyclists). A P value ≤ 0.05 was considered as statistically significant.

Results

There were no differences between cyclists with CLBP and asymptomatic non-cyclists in age, Height, Weight and BMI (Table 1).

Table 1. Participant Characteristics

Characteristics	Cyclists with LBP (n=19)	Control group (n=20)	P-value
Age (y)	26.48±8.13 (range 18-53)	25.55±9.22 (range 18-60)	0.51
Height (cm)	176.83±7.61	175.47±7.48	0.58
Weight (kg)	75.11±11.84	69.68±10.96	0.15
BMI (kg/m²)	23.99±3.32	22.54±2.58	0.14
VAS (0-10)	5.94±1.89	NA	NA

Data are expressed as mean±SD.
Note: Low back pain: LBP; BMI: Body Mass Index; VAS: visual analog scale.

Forward bending

Compared to athletes without LBP, cyclists with LBP demonstrated a restriction in anterior pelvic tilt angle (p = 0.03) in forward bending test. There were no statistically significant differences between groups in magnitude of lumbar flexion (p = 0.06) during forward bending test (Table 2).

Table 2: Means and standard errors of variables and p-values for cyclists with LBP and Control group

	Cyclists with LBP (n=19)	Control group (n=20)	P-value
Forward bending test			
Maximal anterior pelvic tilt angle (degree)	45.70 (1.88)	50.99 (1.48)	**0.03**
Maximal lumbar flexion angle (degree)	81.40 (2.85)	87.68 (1.60)	0.06
Backward return test			
Maximal posterior pelvic tilt angle (degree)	45.66 (2.02)	51.86 (1.68)	**0.02**
Maximal lumbar extension angle (degree)	81.86 (3.03)	88.86 (1.86)	**0.05**

Data are expressed as mean (SE) .
Note: Low back pain: LBP.

Backward return

Compared to athletes without LBP, cyclists with LBP demonstrated a restriction in posterior pelvic tilt angle ($p = 0.02$) and lumbar extension range ($p = 0.05$) in backward return test (Table 2).

Discussion

The purpose of the current study was to examine lumbar spine and pelvic ROM between athletes with CLBP who regularly ride a bicycle and healthy controls without regular bicycle riding during forward bending and backward return clinical tests. People with CLBP who regularly ride a bicycle demonstrated a restriction in end-range anterior pelvic tilt angle during forward bending and also in end-range lumbar flexion and posterior pelvic tilt angles during backward return. There were no significant differences between the two groups with respect to end-range lumbar flexion angle during forward bending.

During the forward bending test, the restriction of anterior pelvic tilt which was observed in cyclists with CLBP might be due to the fact that the key alignment producing their symptoms is bending forward. Therefore, the cyclists with CLBP tended to restrict the motion of anterior pelvic tilt as a result of pain during the forward bending test. Another explanation for this finding is attributed to the possible shortness of hamstring muscles in cyclists with LBP. Previous research studies indicate that there is a relationship between lack of sufficient hamstring muscle length and the decrease in anterior pelvic tilt motion during maximal trunk flexion with extended knees (21-24). During backward return test, the restriction in the end-range lumbar extension and posterior pelvic tilt angles in cyclists with LBP might be as a result of prolonged trunk forward flexion posture on the bicycle. This posture is suggested to associate with an adaptive decrease in lumbar lordosis (9, 11, 25) and also an adaptive anterior pelvic inclination (9, 26), which in turn, leads to a decrease in end-range lumbar and pelvic motions during the test.

Other studies have evaluated the effects of repetitive motions and prolonged postures on lumbopelvic kinematics in athletes. Our results are in agreement with most previous studies in which it is suggested that regular participation in sport activities, which is associated with prolonged postures and repeated movements, may contribute to kinematic alterations of lumbar and pelvic regions and the development of LBP (3, 10, 27, 28). Muyor et al. (26) compared maximal lumbar flexion of cyclists and non-athlete individuals. Lumbar flexion angle was measured during maximal trunk flexion in seated position on the floor and while sitting on the bicycle. They found that cyclists demonstrated an increased anterior pelvic tilt compared to non-athlete individuals. However, no significant differences were found between cyclists and non-cyclists in lumbar flexion except in the case of lower handlebar heights. Results regarding lumbar flexion angle in the current study are in agreement with the Muyor et al(26) study, in which they reported that cyclists were not significantly different in lumbar flexion angle when compared to non-athletes. However, some results of our study are in disagreement with the Muyor et al(26) study which suggested an increased anterior pelvic tilt in cyclists compared to non-cyclists. This difference may be due to the fact that the current study included cyclists with LBP but the participants in the Muyor et al.(26) study were healthy individuals.

Van Dillen et al. (4) conducted a study to examine differences between people with LBP who participated in symmetric, with those who participated in asymmetric sport activities. The authors found that the movement impairments which were identified on clinical examination may be associated with the types of specific repetitive demands in which the athlete is involved. Our findings are in agreement with Van Dillen et al.(4) and those previous studies which support the kinesiopathological model in that prolonged postures and repeated movements contribute to kinematic alterations associated with the development of LBP.

The present study can be criticized in that it is not clear whether the differences in the magnitude of pelvic and lumbar motions were related to the LBP condition, the flexion demand or both. In addition, it is unknown whether cyclists developed LBP as a result of the decreased pelvic and lumbar motions, or the decreased pelvic and lumbar motions are a result of the LBP problem. These limitations are due to the study design, a cross-sectional study in which the data gathering was preformed over a short period of time. Another potential limitation of our study is that it is unknown whether the results of the present study are generalizable to females. Future studies are required to understand whether the same is true for females. The reason why our participants were limited to men was the gender differences in movement patterns and ROM (29-31).

We recommend further studies with other clinical movement tests to obtain more information on the relationship between repetitive rotation demands and movement impairments.

Conclusion

The results of this study suggested that a decrease in the magnitude of end-range pelvic and lumbar motion during backward return test might be associated with prolonged, flexed-spine position during cycling in cyclists with LBP. These results further supported the kinesiopathological model. The limited anterior pelvic tilt ROM which was observed in cyclists with LBP might be related to the moving toward painful direction in forward bending test. An awareness of contributing factors in the kinematic alterations and the development of LBP might be important to direct clinical examination and injury prevention in cyclists who regularly participate in cycling tasks.

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