Lumbopelvic-Hip Rhythm in People with Lumbar Flexion-with-Rotation Syndrome during Hip Internal Rotation

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Abstract

Background: According to previous research, hip internal rotation (HIR) aggravates low back pain (LBP) symptoms, especially in patients with lumbar flexion with rotation (F + R) syndrome. Therefore, the present study aimed to examine the lumbopelvic-hip rhythm during the HIR test in patients with this syndrome.

Methods: In this cross-sectional study, 20 men without LBP and 20 matched men with LBP, subcategorized in the F+R subgroup, participated. The participants performed the HIR test. Kinematics data were recorded using a motion analysis system. After processing the kinematics, a comparison was made in the hip and pelvic kinematics between the groups.

Results: A statistical analysis based on an independent t test revealed a significant increased (P < 0.05) pelvic rotation during the tests with the dominant (P = 0.007) and nondominant limbs (P = 0.025) in those with LBP. The analysis also showed that during the test with the dominant lower limb, the pelvis and hip moved with a more synchronized pattern in patients with LBP (P = 0.001).

Conclusion: In the patients with lumbar F + R syndrome, there was a tendency for early pelvic rotation during the dominant HIR test. Moreover, LBP people also exhibited a greater pelvic rotation range of motion in the first half and whole pathways of the test. These impairments could be a risk factor for the development of LBP symptoms in these patients.

Keywords: Low Back Pain, Lumbopelvic, Hip, Kinematics, Rotation

Conflicts of Interest: None declared

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Introduction

Low back pain (LBP) and its associated impairments are known as the first causes of disability among musculoskeletal disorders worldwide (1, 2). Despite extensive research with attempts to design and propose a confirmed plan of treatment, none of them have been successful (3). Recently, some authors believe that subclassifying patients with LBP in homogeneous subgroups could considerably help in solving the problem (3-5). Differences in movement patterns of lumbopelvic of subgrouped people with LBP were also indicated in previous studies (4, 6-9). Therefore, some authors have proposed models for the subgrouping of patients with LBP.

What is “already known” in this topic:
Limb movements are associated with lumbopelvic motions. Generally, if these motions take place in an excessive range during limb movement, LBP occurs accordingly. One limb movement that is associated with LBP, especially in those subcategorized in the F + R subgroup, is hip rotation. Previous studies have shown that patients with F + R syndrome might benefit from decreasing lumbopelvic rotation with limb movements.

What this article adds:
The present study indicated an increased and early lumbopelvic motion in the transverse plane of motion in patients with the F + R syndrome. These findings reveal how LBP occurs during or after activities requiring limb movements in patients.
Lumbopelvic-Hip Rotation Motion in People with Low Back Pain

The Movement system impairment model (MSI) is a new, valid model of classification, which is used for subclassifying patients with LBP (10). In this model, an LBP patient lies in 1 of the 5 subgroups: (1) lumbar flexion; (2) lumbar extension; (3) lumbar rotation; (4) lumbar flexion with rotation (F + R); and (5) lumbar extension with rotation, based on which the direction of lumbar movement stimulates pain symptom (10). Efficiency of this model in treatment of people with LBP has been established in clinical studies (11, 12). Therefore, we aimed to use the MSI model for specifying the patients who attended this study.

Investigations have indicated that not only trunk movements, but also limb movements, can provoke LBP symptoms (12, 13). A number of researchers have suggested that the insufficient control of the lumbopelvic in a specific direction can result in early or/and excessive lumbopelvic motion when a limb moves (14-16). These forms of the lumbopelvic motion may contribute to LBP, when repeated frequently during habitual activities. Based on this concept, a precise examination of the lumbopelvic movement pattern during tests of lower limb movement is essential in subgroups of people with the LBP.

One subgroup of people with LBP, based on MSI, is a subgroup of patients with lumbar (F + R) syndrome: patients who have LBP symptoms related to flexion and rotation direction of lumbar spine movements (10). Based on the reports, the subgroup of patients with lumbar F + R syndrome has a significant distribution among patients with LBP (15, 17). Previous studies have also demonstrated that this subgroup of patients had pain during lower limb rotation movements such as hip rotation (18, 19), and when the hip internally rotated, the pelvic rotation was restricted, which alleviated or lessened the symptom (12, 18, 19). Therefore, clinical evidences suggest a relationship between hip internal rotation (HIR) motion, pelvic rotation motion, and LBP symptom in patients who are categorized in the F + R subgroup. LBP in these patients may result from excessive pelvic motion in the transverse plane as the hip rotates, which puts strain on the lumbar tissues beyond what is normally tolerated. A review of the laboratory studies shows that the lumbopelvic-hip rhythms of patients with lumbar F + R syndrome have been examined in a limited number of studies, and these examinations were also limited to sagittal plane (15, 17, 20). Therefore, no study has so far examined lumbopelvic movement patterns in LBP people with F + R syndrome in the transverse plane and during a lower limb rotation test such as the HIR test.

Therefore, the purpose of this study was to examine the lumbopelvic movement patterns of LBP with F + R syndrome patients and healthy controls during the HIR test in the transverse plane. In this study, we hypothesized that the LBP patients would demonstrate more and/or early lumbopelvic rotation during the test as compared with healthy people.

Methods

Participants

In total, 40 men volunteered to participate in this cross-sectional study: 20 men without LBP and 20 with LBP. The participants were divided into 2 groups (LBP and control) and were matched based on weight, height, and age. Those participants who met the inclusion criteria signed a consent form approved by Shahid Beheshti University of Medical Sciences (IR, SBU.RETECH, and REC.1395.365). Controls were included if they (1) were aged 20 to 50 years, (2) had no LBP symptoms in the past year, and (3) had no previous lumbar spine surgery. Patients with LBP were enrolled in the study if they (1) were included in the lumbar F + R syndrome based on the approach proposed by Sahrman for subgrouping patients (15, 21); (2) had LBP symptoms more than 3 months (chronic LBP) (22); (3) were labeled as patients with nonspecific LBP by physicians; (4) had LBP symptoms that intensified gradually with or after flexion- and rotation-related activities; and (5) were 20 to 50 years old. Participants characteristics are included in Table 1.

The following formula was utilized to determine the sample size for the study.

\[
N=\frac{\left(\frac{\alpha}{2}+\frac{\beta}{2}\right)\left(\frac{1}{\eta^2}+\frac{1}{\eta^2}\right)}{\frac{1}{\eta^2}+\frac{1}{\eta^2}}
\]

\[a=0.05, \quad z_\alpha=1.96, \quad 1-\beta=0.8, \quad \eta=1.28\]

\[\mu_1=41.7, \quad SD=11.3, \quad \mu_2=30.4, \quad SD=8.5, \quad N=18 \sim 20.
\]

Participants were excluded from the study if they had (1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Back Pain Group N=20 Mean (SD)</th>
<th>Control Group N=20 Mean (SD)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr.)</td>
<td>27.75 (7.59)</td>
<td>24.42 (2.87)</td>
<td>0.080</td>
</tr>
<tr>
<td>Height (M)</td>
<td>1.74 (0.05)</td>
<td>1.78 (0.06)</td>
<td>0.109</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>74.8 (5.6)</td>
<td>73.9 (8.9)</td>
<td>0.726</td>
</tr>
<tr>
<td>Body Mass Index (BMI)</td>
<td>24.5 (2.49)</td>
<td>23.25 (0.02)</td>
<td>0.094</td>
</tr>
<tr>
<td>Oswestry disability index</td>
<td>16.1 (8.29)</td>
<td>8.38 (1.69)</td>
<td>0.045</td>
</tr>
<tr>
<td>Duration of pain (month)</td>
<td>19.5 (16.8)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Significant p-values are presented in bold.

Table 1. Demographic and clinical characteristics of the participants
a previous history of lower limbs or spinal surgery; (2) degenerative joint disease in a lower limb or lumbar spine; (3) pathological conditions, such as tumor, infection, et cetera in the lumbar spine; (4) psychological illness, leg length discrepancy, radiculopathy, neuropathy; or (5) a history of serious head injury.

Clinical Measures
Participants initially completed a demographic questionnaire. Those with the LBP also completed 3 additional questionnaires: (a) the visual analog scale questionnaire (VAS) for determining the pain intensity of patients; (b) a Persian version of Oswestry Disability Index (ODI) questionnaire, a questionnaire of perceived LBP-related disability (23); and (c) a Persian version of Baekcke Habitual Physical Activity questionnaire (BHPAQ) (24).

Kinematic Measurement and Processing
We employed a 7-camera, 3-dimensional, motion measurement system (Qualisys Motion Capture Systems), located in Isfahan University of Medical Sciences, for recording the kinematics data. We aimed to record kinematics data of the hip and lumbo pelvic regions in the transverse plane (rotation motion). For this purpose, we attached retroreflective markers on the specified anatomical landmarks including (1) the left and right posterior superior iliac spine, (2) medial side of the left and right knee joints line, and (3) the left and right medial malleolus, demonstrated in Figures 1 and 2. The kinematics data collection was performed with a sampling rate of 100 Hz.

The Test
Participants were asked to perform the HIR test in the prone position (25). Three trials with the dominant limbs and 3 trials with the nondominant lower limbs were performed. Procedures involved in the performance of the test were based on the study of Sadeghisani et al (26). For this purpose, we asked the patients to assume prone position and hold a knee in the 90° of flexion. Then, the patients were instructed to internally rotate their lower limb as much as they can and return the limb to the initial position. We requested the patients to perform the test at a speed of their choosing while a randomly chosen limb was used to initiate the test. Figure 1 illustrates the procedures of performing the test in the prone position.

After data collection, a Butterworth filter filtered all the raw data. Cutoff frequency of the filter was 2.5 Hz. Then, kinematics variables, regarding the hip-pelvic regain, were calculated in the transverse plane. The kinematics variables included an amount of hip and pelvic rotation range of motion during the test, the range of pelvic rotation from the starting point to the mid-point of the test, and the range of hip rotation from the start point of the test to the point in which pelvic rotation initiated. The start and end points of the limb and pelvic rotation motions were determined based on the method used in previous studies (7, 25). Reliability of the variables measured was tested in a sample of 10 participants without a history of LBP during the test with the dominant limb. The intraclass correlation coefficient (ICC, 3, 1) was used to index reliability. The values for each test was found to be reliable and are reported in Table 2.

Statistical Analysis
All statistical analyses were completed using SPSS Version 20. Initially, normality of the data distribution was assessed using the Kolmogrov-Smiranov test. Next, independent samples t tests were used to compare dependent variables between the groups, that is, with and without LBP.

Results
In the study, 20 healthy men (mean age, 24.42 ± 2.87 years) and 20 LBP men (mean age, 27.75 ± 7.59 years) par-

Table 2. ICC (3, 1) values of variables obtained in the study

<table>
<thead>
<tr>
<th>Variables</th>
<th>Lower Limb Rotation Range</th>
<th>Pelvic Rotation Range</th>
<th>The Completed Range of Hip Rotation Before the Starting Point of Pelvic Motion</th>
<th>Range of Pelvic Rotation During the First Half of the Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICC</td>
<td>0.99</td>
<td>0.97</td>
<td>0.77</td>
<td>0.93</td>
</tr>
</tbody>
</table>

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Discussion

Among biopsychosocial risk factors related to LBP, the biomechanical factor is the most prominent factor in most of the cases (27). Many biomechanical characteristics, which may be related to LBP, have been the focus of previous studies. Therefore, many biomechanical features have been proposed as the causes of LBP. Recently, numerous authors and researchers have focused on the lumbopelvic and hip movement impairments (14, 15, 20, 26). They believe that increased lumbopelvic motion, during trunk and/or lower limb motion, in a specific direction, is associated with an excessive load on the lumbopelvic region (14, 15, 26). Based on this concept, with the repetition of the loads, LBP would be possible to be observed. Therefore, examining patterns of lumbopelvic-hip movement can help clinicians to explore the causes of LBP and making decisions for considering the problem (28).

Based on evidence, patients with F + R are a frequent group of patients among people who suffer from LBP symptoms, and the symptoms were associated with lower limb motions that caused rotation in the lumbopelvic region. A lower limb motion caused lumbopelvic rotation motion and pain in these people was HIR. However, no

Figure 2. Result of the Kinematics Measurements and Differences between the 2 Groups during the Tests with the Nondominant (1) and Dominant (2) Limb A, range of lower limb rotation; B, range of hip rotation; C, range of pelvic rotation; D, amount of pelvic rotation in first half of pathway; E, hip/pelvic synchronization; SD, Standard deviation; m, mean.

*Significant value (P < 0.05).

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The present study was not without limitation. The following limitations need to be considered by researchers in future studies. The first limitation deals with the notion that only 1 subgroup of patients was compared with the healthy group. We recommend that other subgroups of patients be compared with healthy controls. The second limitation relates to the fact that differences between the groups were examined based on the HIR test. In the future studies, attention should be paid to the examination of the lumbopelvic movements, which must be performed during other limb motions. The third limitation was that the test employed in the study was a nonfunctional test. We recommend that assessments be performed based on functional activities in future studies. Last, the present study was limited to the transverse plane. Examination of lumbopelvic motion in the other planes is required to be included in addition to the transverse plane.

Conclusion
The authors would like to thank Dr Mohammad Taghi Karimi, Farideh Dehghan Manshadi, and Dr Abbas Rahimi for all their conceptual supports. This study was part of a doctoral thesis design by research (IR, SBMU.RETECH, and REC.1395.365).

Acknowledgment
The authors declare that they have no competing interests.

References


