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Evaluation of Differences Between two Groups of Low Back Pain Patients with and without Rotational Demand Activities Based on Hip and Lumbopelvic Movement Patterns

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SUMMARY

Background. Excessive and earlier lumbopelvic motions during trunk and limb movements tests have been reported in both low back pain (LBP) patients with and without trunk and hip rotational demand activities. The aim of the present study was to determine differences in hip and lumbopelvic rotation during the active hip internal rotation (AHIR) test between two groups of LBP patients with and without regular trunk and hip rotational demand activities.

Material and methods. A total of 35 LBP patients, including 15 males who regularly participated in rotational demand sports activities and 20 males not participating in sports and functional rotational demand activities, participated in study. The AHIR test was performed. The kinematic variables of hip and pelvic rotations were recorded by a Qualisys motion analysis system. Pelvic and hip rotations were calculated across time during the test. In addition, pelvic rotations in the first half of the test and pelvic-hip timing were calculated.

Results. People with rotational demand activities had a higher pelvic rotation both during the test and in the first 50% of movement. Earlier pelvic rotation was observed in people with rotational demand activities compared to people with non-rotational demand activities.

Conclusions. 1. The data of the current study suggests that lumbopelvic movement patterns in different groups of LBP patients in regard to their specific activities may vary. 2. LBP people with rotational demand sports activities have a greater tendency of pelvic rotation motion during the AHIR.

Key words: low back pain, hip internal rotation, lumbopelvic, limb movement

BACKGROUND

Low back pain (LBP) and lumbar spine dysfunctions are the most common causes of musculoskeletal impairment that are frequently referred to primary care clinics [1]. Also, LBP is one of the most prevalent musculoskeletal pain syndromes in people who regularly participate in rotational demand sports activities [2]. There is a mechanical and functional linkage between the lumbar spine and the hip joints [3]. In this connection, the relationship between hip internal rotational ROM and LBP was investigated previously [4-13]. The presence of deficits in hip internal rotation ROM was reliably demonstrated in patients with LBP in these studies. However, in none of these studies, differences in hip internal rotation ROM between LBP people practising or not practising rotational demand sports activities were not investigated.

In addition, in these studies the effect of the hip internal rotation movement on lumbopelvic motion was not considered. Several authors in their models have addressed increased lumbopelvic motion as an important factor in the provocation and persistence of the LBP symptoms [14-17]. It is believed that trunk and limb movements with application of the force on the lumbopelvic region can result in lumbopelvic motion provided that lumbopelvic motion takes place in greater ranges and/or earlier in time. In conclusion, spinal dysfunctions are the result of cumulative and repeated microtrauma [17,18].

It has been shown that excessive lumbopelvic motion during trunk and limb movements induces pain in many LBP patients [19,20]. Modifying the movement pattern by delaying and/or reducing lumbopelvic motion during a limb movement test was associated with a reduction or elimination of pain [20-23]. Also, there is much clinical and laboratory evidence that clearly shows increased and/or early lumbopelvic motion during trunk and limb movements in groups of LBP patients and in comparison to healthy controls [14,24-27]. Moreover, Scholtes et al. investigated the lumbopelvic movement pattern between patients with rotational demand activities and healthy groups during the active hip external rotation test. According to their findings, a greater magnitude of lumbopelvic rotation was observed in patients with rotational demand activities [18].

The hip internal rotation test is one of the limb movement tests that was associated with inducing pain in patients with and without rotational demand activities [19,20,23]. So, examination of lumbopelvic movement patterns during active hip internal rotation (AHIR) in addition to hip rotational ROM examination is essential in evaluating LBP people.

As uncontrolled lumbopelvic motion and hip rotational ROM restriction were established in both LBP patients with and without rotational demand activities [8,9,13,14,18,27,28], it is not clear what differences exist in the hip internal rotation ROM and lumbopelvic movement pattern between these two groups of patients during the AHIR test. On the other hand, little is known about the causes of lumbopelvic movement pattern impairment and the direction of movement that was impaired in each group. One question of our study was whether the lumbopelvic movement pattern in LBP groups varied with different specific activities. It was hypothesized that lumbopelvic movement configuration is task dependent and patients with rotational demand activities would demonstrate greater and earlier lumbopelvic rotation during the AHIR compared to LBP people without rotational demand activities. Accordingly, in the current study, the hip internal rotation ROM and the lumbopelvic movement pattern were compared in two groups of patients with and without rotational demand activities during the AHIR.

MATERIAL AND METHODS

Subjects

A total of 35 subjects with non-specific chronic LBP [29], including 15 patients who regularly participated in rotational demand sports activities (tennis, squash, racketball...) and 20 patients without rotational demand activities, participated in study. All of the patients had been examined by a physician to rule out specific causes of LBP. The inclusion criteria for the group of patients with rotational demand activities were as follows: non-specific chronic LBP [29], attending at least 2 sessions of trunk and hip rotational demand sports activities a week [3,18,30], pain during and/or after their specific sports activities. The inclusion criteria for the group of patients without rotational demand activities were as follows: non-specific chronic LBP, symptoms associated with non-rotational demand activities. All of the patients in the study were between 20-50 years old. Subjects were excluded from the study if they had an acute flare-up of LBP [31], lumbar spine pathology such as infection, tumor, rheumatological disease, DJD and..., disc bulging, leg length discrepancy, lower extremity injury and dysfunction, neurological and psychological conditions and radiculopathy. The aim of the study was explained to all of the patients. Then, an informed consent form that had been approved by Shahrekord University of Medical Sciences was signed by the subjects. This study was approved by the Human Studies Committee of Shahrekord University.

Tab. 1. Characteristics and demographic differences between the groups

	Patients without rotational activities (n=20) Mean (±SD*)	Patients with rotational activities (n=15) Mean (±SD)	Mean difference (95%CI)	Degrees of freedom (df), P-value
Age (years)	30.15(6.5)	31.5 (7.7)	1.3 (-3.5 – 6.3)	df=33 , p=0.57
Height (m)	1.76 (0.07)	1.77 (0.04)	0.009 (-0.03 – 0.05)	df=33 , p=0.64
Weight (kg)	77.3 (11.9)	80.5 (11.4)	3.2 (-4.9 – 11.3)	df=33 , p=0.42
MBI (kg/m^2)	24.77 (3.26)	25.57 (3.7)	0.79 (-1.6 – 3.2)	df=33 , p=0.50
Duration of LBP (month)	22.8 (17)	20 (18.2)	-2.8 (-15 – 9.3)	df=33 , p=0.63
Average pain	5 (1.2)	4.5 (1.2)	-0.47 (-1.3 – 0.38)	df=33 , p=0.27
Most pain	5.1 (1.65)	5 (1.8)	-0.03 (-1.2 – 1.16)	df=33 , p=0.95
Current pain	2.7 (2.48)	2.2 (2.04)	-0.55 (-2.1 – 1)	df=33 , p=0.49
Oswestry score	21.8 (8.33)	15.2 (9.7)	-6.6 (-12.8 - -0.37)	df=33 , p=0.03
Fear-avoidance during physical activity	19.55 (4.18)	14.2 (5.6)	-5.3 (-8.7 - -1.9)	df=33 , p=0.00
Fear-avoidance during work	26.55 (9.77)	16.6 (8.54)	-9.9 (-16.3 - -3.5)	df=33 , p=0/00
Habitual physical activity	5.75 (1.18)	9.23 (1.3)	3.4 (2.6 – 4.3)	df=33 , p=0/00

*standard deviation of the mean.

Clinical measurements

Participants were asked to complete the following questionnaires to provide a clinical profile: 1) A questionnaire that was related to the subject and LBP history, 2) visual analogue scale (VAS) questionnaire to measure pain intensity [32], 3) Persian version of Oswestry disability questionnaire [33], 4) Baecke habitual physical activities questionnaire for measurement of habitual physical activities during the last 1 year [34]. Fear-avoidance belief questionnaire that shows the level of fear-avoidance behavior of the subject during physical and work-related activities [35] (Table 1).

Movement test and kinematic measurements

The AHIR test, a standard test in the movement system impairment model, was used in the current study [17]. In our study, patients were in prone position, their heads were positioned in rotation to one side that the subjects were comfortable with, upper extremities at their sides and in flexion and abduction position, lower extremities in neutral position and in mid-range of abduction/adduction and internal/external rotation. During the test of internal rotation of one limb, the knee was positioned by examiner in 90°of flexion and the hip in mid-range of abduction/adduction and internal/external rotation. The patients were asked to internally rotate their hips as far as possible and return to the start position in less than 10 seconds. Subjects performed three repetitions of the AHIR test for each side (Fig. 1,2).

A Qualisys motion analysis system with 7 cameras was used to capture the movements of the lumbopelvic area and the hip joints. The retro reflective markers were attached on the left and right PSISs, left and right lateral malleolus and lateral aspect of knee joint line of both sides. From the vectors that left and right PSISs markers make between the initial and terminal point of movement, angular displacement and angular velocity of pelvic rotation was calculated. Using the vectors from a marker on the late-

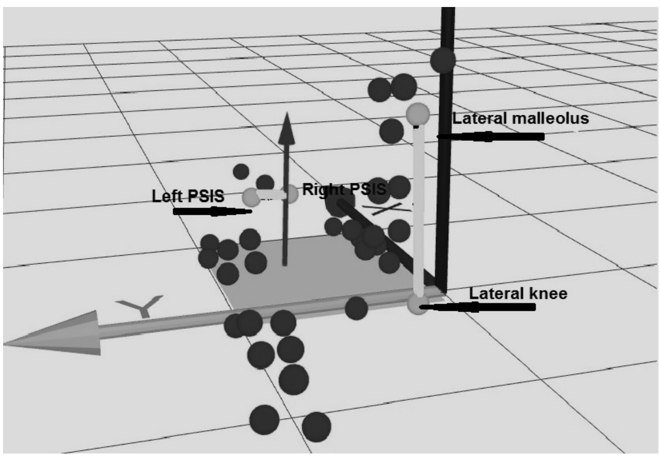

Fig. 1. Initial point of the AHIR test

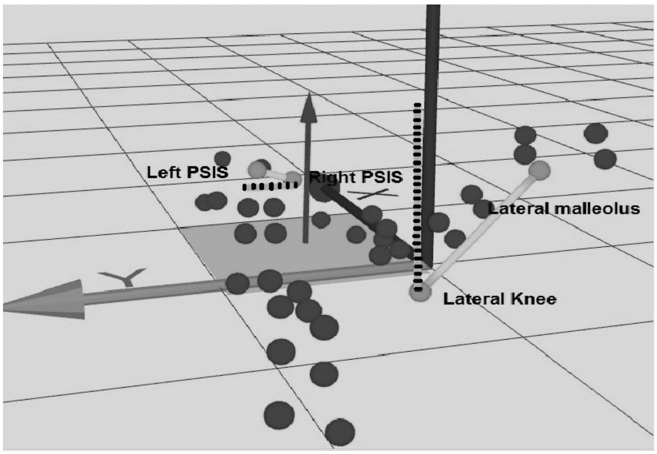

Fig. 2. Terminal point of the AHIR test

ral knee joint line to a marker on the lateral malleolus of the testing side in the initial and terminal point of motion, angular displacement and angular velocity of lower extremities internal rotation were measured. The initial and terminal points of movement were determined based on previous studies [3,30]. Raw data also were filtered with regard to the specific speed of the movement test for each side and subject [3,30]. After data preparation, data were entered in the MATLAB software for calculation of the variables such as lower limb internal rotation ROM, hip internal rotation ROM, pelvic rotation ROM, timing of pelvic--hip rotation and pelvic rotation ROM during the first 50% of movement.

Data analysis

The SPSS statistical package version 21 was used for all statistical analyses. The K-S test was used for assessing the normality of the dependent variables. An independent t-test was performed for dependent variables of the subject characteristics and kinematic variables for comparison of two groups with and without rotational demand activities.

RESULTS

Subject characteristics and clinical measurements

Based on Table 1 and comparison of the subject characteristics, there were no differences between groups with regard of age, height, weight, duration of LBP and BMI (p>0/05). Also, there was no difference between groups in pain intensity (p>0/05). The mean values for LBP-related disability and fear-avoidance of movement during functional and work activities in the group without rotational related activities were statistically less than in the group with rotational related activities ($p<0.05$). At the same time, the group of patients with rotational sports activities had a greater level of habitual physical activities and this variable was significantly different between two groups ($p=0.00$).

Kinematic variables

Based on Table 2, in the group of patients with rotational activities, the mean values for averages of bilateral lower limb and hip joint internal rotation ROM were 44.9±10 and 22.3±10.1, respectively, and for the group with non-rotational demand activities, the-

Table 2. Differences in kinematic variables of pelvic and hip rotation between the groups

	Patients without rotational activities (n=20) Mean (±SD)	Patients with rotational activities (n=15) Mean (±SD)	Mean difference (95%CI)	Degrees of freedom (df), P-value
Total rotation	36.5 (±15)	44.9 (±10)	8.38 (-0.78 – 18.5)	df=33, p=0/072
Hip rotation angle	20.6 (±11.6)	22.3 (±10.1)	1.65 (-6 – 9.3)	df=33, p=0/066
Pelvic rotation angle	15.8 (±6.7)	22.5 (±6.6)	6.7 (2 – 11.4)	df=33, p=0/006
Timing of pelvic rotation	2.24 (±2.8)	0.62 (±0.89)	-1.6 (-3.0 - -0.2)	df=33, p=0/026
Pelvic rotation in first half of motion	7.2 (±4.2)	9.8 (±3.1)	2.5 (0.07 – 5.12)	df=33, p=0/044

all values expressed in degrees

se indices were 36.5±15 and 20.6±11.6, respectively. There were no statistically significant differences between the groups with regard to lower extremity and hip joint internal rotation ROMs (P>0.05).

The group of the patients with rotational demand activities demonstrated a greater extent of pelvic angular rotation both in full range (22.5±6.6) and during the first 50% of the test (9.8±3.1). Differences in pelvic angular rotation between two groups were statistically significant (P>0.05).

In addition, patients with rotational demand activities moved their pelvis significantly earlier during the AHIR test (P=0.026).

DISCUSSION

Subject characteristic and clinical measurements

The amount of LBP related disability and fear--avoidance behaviors in LBP group that did not have regular rotational activities in our study was significantly higher. Although we did not find any differences in pain intensity between the two groups participating in the study, there is well established potential evidence that the amount of pain intensity, lumbar spine impairment, fear-avoidance and cognitive factors are related to LBP-related disability [36-39]. Indeed, fear-avoidance and cognitive factors are more disabling in comparison to pain intensity [36-38].

One explanation of the finding that disability and fear-avoidance during activities in LBP sufferers who regularly practising sports rotational demand activities were less than the other group may be related to the fact that they frequently participated in recreational sport activities. Participation in recreational activities may decline the fear of injury and the patients may engage in their functional activities with more confidence.

Movement pattern and kinematic variables

Due to an intimate anatomical and functional link between the hip joints and the lumbopelvic region, the effect of hip rotation ROM impairment on LBP was a subject of interest in many previous studies [4-13]. It is believed that limitation in hip rotational ROM may initiate compensatory lumbopelvic rotational movement [4,10-13]. The faulty lumbopelvic motion, in the form of excessive rotation, repeated during functional, habitual and recreational activities, consequently leads to soft tissue injury and LBP symptoms [28].

Limited hip internal rotation ROM has been reported in various groups of LBP patients both engaged and not engaged in hip rotational demand activities [4-13]. For example, LBP people who practise tennis [13], golf [10] and judo [4] have limited hip internal rotation ROM in comparison to healthy people. This kind of impairment was also observed in patients with unilateral sacroiliac involvement [6] and LBP people without trunk and hip rotational activities [6,8,9]. In addition, the comparison of hip internal rotation ROM between males and females was investigated by Haffman et al. [40]. However, differences in hip internal rotation ROM pattern between LBP people with and without rotational activities have not been investigated in any previous study. The result of the present study suggest that there were no differences in hip internal rotation ROM between LBP people who regularly participated in rotational demand sports activities and patients without rotational demand activities. Nevertheless, as performing rotational demand sports activities requires a considerable or near-full ROM, any limitations and deficits in the hip internal rotational ROM in patients who regularly engage in rotational demand sports activities must be considered as an important contributing factor and must be examined carefully [28]. One of the reasons why we did not find any differences in hip internal rotation ROM between the two groups that participated in our study may be restriction in hip internal ROM that was established in both groups of patients (with and without rotational activities).

Recently, it has been suggested that increased lumbopelvic motion or inappropriate movement control is one of the most important contributing mechanical factors in the occurrence and persistence of pain in symptomatic patients [15-17,19,20]. Several authors in their models mentioned the role of excessive lumbopelvic motion during lower limb movements and LBP [14,15,17,19,20]. Lower limb movements, such as hip rotation, are associated with lumbopelvic motion via forces acting on the lumbar spine [18]. The hip rotation test was associated with symptomatic aggravation in LBP patients [3,18,19,23,30]. Modification of movement strategies by restricting movement of the pelvis during hip rotation was followed by elimination or decrease in pain in the symptomatic people [20,22,23]. Accordingly, the assessment of hip rotational movements in LBP patients must include not only the hip ROM but also the lumbopelvic movement pattern during the hip internal rotational test.

The lumbopelvic movement pattern during hip external rotation has been studied between LBP sufferers and healthy groups [18], males versus females [3] and two subgroups of LBP patients that were classified based on a movement system impairment model [30]. Furthermore, gender differences in the lumbopelvic motion pattern during hip internal rotation were assessed by Hoffman et al. [40]. Increased and early lumbopelvic rotation during the hip rotational test was well established in patients who regularly participated in rotational demand sport activities in comparison to the control group [18]. Although insufficient lumbopelvic movement control in the form of increased and/or early motion during trunk and limb movements was reported in LBP people with and without rotational demand activities [14,24-26], quantitative differences in lumbopelvic rotational movement between LBP people with and without rotational demand activities have not been investigated in any study yet.

In the present study, however, we focused on the lumbopelvic rotation motion and the timing of lumbopelvic motion during AHIR between these two groups of patients. In our study, pelvic rotation in the transverse plane and in the group with rotational demand activities was significantly greater than in the group without rotational demand activities. This finding may be important in some aspects. Firstly, Sahrmann in the movement system impairment model proposed that repeated lumbar spine movements in a specific direction and during specific functional, habitual or recreational activities will cause more and/or early lumbopelvic motion with limb movement in those directions that act on lumbar spine and have less resistance against motion [17,41]. So based on this model, different groups of LBP sufferers may have different lumbopelvic movement patterns during trunk and limb movements due to their different specific tasks [17]. Consequently, the configuration of the lumbopelvic movement pattern in LBP people may be task dependent. Secondly, increased and/or early lumbopelvic rotation in LBP patients with rotational demand activities may be an important potent mechanical contributing factor in LBP development of this group, which must be examined with great precision and in an appropriate manner during treatment planning.

In addition, people with rotational activities that participated in the current study displayed earlier pelvic rotation during hip movement test in the transverse plane. Based on our result, we can expect that in this group of patients, pelvic rotation will begin earlier than hip rotation during functional and recreational activities [18].

Another purpose of our study was to examine and compare the lumbopelvic movement pattern between the two groups of patients during the first half of the limb movement test. This was investigated because many daily functional activities require early to mid-ranges of limb movements [3,18] and most LBP symptoms will begin or be aggravated during or following these activities [3]. It is hypothesised that exaggerated lumbopelvic motion in the early to mid-range of limb movements is one of the causes of symptoms in LBP sufferers [3,18,30]. Gombatto et al. reported that men in comparison with women exhibited greater pelvic rotation in the first 60% of the hip lateral rotation test [3]. Data from our study suggest that patients with rotational activities move their pelvis more during the first half of the hip internal rotation test. This movement pattern may be frequently repeated during the day in LBP patients with rotational demand activities, which could contribute to cumulative tissue stress and subsequently LBP. This approach to lumbopelvic movement examination will increase our insight into the mechanisms underlying the development of LBP symptoms after and during functional and habitual physical daily activities.

Several potential limitations can be considered in our study. One important limitation in our study was that we examined the lumbopelvic and hip movement pattern during a non-functional situation test. It is not clear what differences exist in the lumbopelvic and hip movement pattern during functional activities such as gait or other activities. Furthermore it is not obvious whether the greater magnitude and earlier lumbopelvic rotation in the patients with rotational demand activities was a result of movement adaptation or tissue impairments related to their specific task. Another limitation that can be mentioned in current study is that we used the AHIR and it is not clear what differences may exist between the two groups during the passive hip internal rotation test.

CONCLUSION

1. Lumbopelvic movement pattern configuration is a task dependent variable.
2. Different LBP sufferers in regard to their specific activities have different lumbopelvic movement patterns in comparison to each other.
3. The results of this study also show that we must classify non-specific LBP sufferers into homogeneous sub-groups in future studies due to differences in their lumbopelvic movement patterns.

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