Ortopedia Traumatologia Rehabilitacja
© MEDSPORTPRESS, 2015; 5(6); Vol. 17, 455-462
DOI:10.5604/15093492.1186813

Correlation between Hip Rotation Range-of-Motion Impairment and Low Back Pain. A Literature Review

Meissam Sadeghisani[1(A,E)], Farideh Dehghan Manshadi[1(A)], Khosro Khademi Kalantari[1(D)], Abbas Rahimi[1(F)], Neda Namnik[2(F)], Mohammad Taghi Karimi[3(D)], Ali E. Oskouei[4(E)]

[1] Department of Physiotherapy, Rehabilitation Faculty of Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2] Rehabilitation Faculty of Ahvaz Jundishapour University of Medical Sciences, Ahvaz, Iran
[3] Rehabilitation Faculty of Isfahan University of Medical Sciences, Isfahan, Iran
[4] Physical Medicine and Rehabilitation Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

SUMMARY

Background. Hip rotation range-of-motion (ROM) impairment has been proposed as a contributing mechanical factor in the development of low back pain (LBP) symptoms. There is a hypothesis which suggests that a limited range of hip rotation results in compensatory lumbar spine rotation. Hence, LBP may develop as the result. This article reviews studies assessing hip rotation ROM impairment in the LBP population.

Material and methods. The MEDLINE and EMBASE databases were searched without time restriction. Two authors independently selected related articles using the same search strategy and key words.

Results. Among 124 articles 12 met the review inclusion criteria. The results of the studies are assessed in three sections, investigating the relationship between low back pain and 1) hip internal rotation ROM, 2) hip external rotation ROM and 3) hip total rotation ROM. Asymmetrical (right versus left, lead versus non-lead) and limited hip internal rotation ROM were common findings in patients with LBP. Reduced and asymmetrical total hip rotation were also observed in patients with LBP. However, none of the studies explicitly reported limited hip external rotation ROM.

Conclusion. The precise assessment of hip rotation ROM, especially hip internal rotation ROM, must be included in the examination of patients with LBP symptoms.

Key words: low back pain, range of motion, hip, rotation

BACKGROUND

Low back pain (LBP) is one of the most problematic conditions in the populations of both developed and developing countries [1, 2]. LBP is the primary cause of functional limitation in people under 45 years old [3]. The prevalence of low back pain in various populations and study groups varies between 14.4% and 85% [2-4]. Thus, LBP places a heavy direct and indirect burden on the individuals, their families, societies and the governments.

LBP with its biopsychosocial nature has been known as a multidimensional problem [5-7]. Identifying the potential contributing factors is essential in solving the problem of LBP [7]. Among various etiological factors, mechanical factors play an important role in the induction and persistency of LBP symptoms [4]. Symptoms in mechanical LBP normally begin or intensify with physical activities and are relieved by rest [4]. Through identifying the mechanical contributing factors that are associated with a risk of LBP and possibly correcting them, we may be able to help the people suffering from LBP.

The hip joints are the intersegmental elements between the lumbopelvic and knee joints [8]. Thus, the lumbopelvic-hip-knee complex forms a kinematic chain whose activity is co-ordinated during functional and recreational physical activities [9-17]. Therefore, the role of the lumbopelvic-hip movement impairments, such as hip ROM restriction, has been an interesting subject of many studies [18-22].

Due to the connection between the hip joints and the lumbopelvic region described above, hip rotation ROM impairments have been suggested as an important dysfunction in LBP [15,23]. Limited hip rotation is well documented in different categories of LBP patients [16,24-27]. It has been proposed that a reduced hip rotation ROM may be compensated for by excessive lumbopelvic rotation. A greater magnitude of lumbopelvic rotation may be associated with micro trauma and, eventually, LBP [16]. There is some evidence that shows that increasing hip rotation ROM is associated with improving functional performance and relieving pain in patients who suffer from LBP [28-30].

The indices of hip internal, external and total rotation ROM may be related to LBP. Numerous investigators have explored the role of hip rotation ROM impairment in LBP. In this review, we turn our attention to studies that examined active/passive hip internal, external and total rotation ROM in people with LBP. Therefore, the present article reviews studies that assessed hip rotation ROM impairment in LBP patients.

MATERIAL AND METHODS

The search strategy in our review was based on an electronic database search of titles and abstracts. The source databases were MEDLINE and EMBASE without time restriction. The key words used were: hip, low back pain, rotation and range of motion. The search was limited to studies published in English. Case reports were not included. Studies which examined hip rotation ROM during functional activities or in patients with a history of lower extremity injury were excluded. In addition, studies which included pathological causes of LBP were not included in the review. In the initial stage of database search, a total of 124 articles were identified. Then, their abstracts and titles were reviewed, and full texts of the studies that were related to our review were accessed. Of 124 articles relating to low back pain and hip rotation ROM, a total of 12 studies met our inclusion criteria. To confirm the accuracy of the search strategy, a second investigator re-reviewed the articles using the same query terms as listed above. The stages of the article selection process are presented in Figure **1**.

The results of the studies are presented in three sections, investigating the relationship between low back pain and 1) hip internal rotation ROM, 2) hip external rotation ROM and 3) hip total rotation ROM (Table 1).

Relationship between hip internal rotation ROM and low back pain

Ellison and his coworkers observed that in a population of 50 people with LBP, the number of patients who had a lesser hip internal rotation ROM than hip external rotation ROM was higher compared with a group of 100 people without LBP [31]. In this study, the passive internal and external hip rotation ROM of patients with LBP who were referred for physical therapy was measured with an inclinometer. Although the direction of lumbar spine impairment and specific activities of the patients were not described, lesser hip internal rotation and more asymmetrical hip rotation were common findings in the groups with LBP.

A deficit in hip internal rotation ROM was also observed in two studies of Vad et al. [26, 27]. One study compared the pattern of hip internal rotation between asymptomatic and LBP symptomatic professional tennis players. The LBP individuals had a history of LBP with a disability of more than two weeks [27]. Another study by Vad et al. enrolled 42 professional golfers (14 with LBP and 28 without LBP) [26]. In both studies, passive hip internal rotations of were measured on both sides of the body and

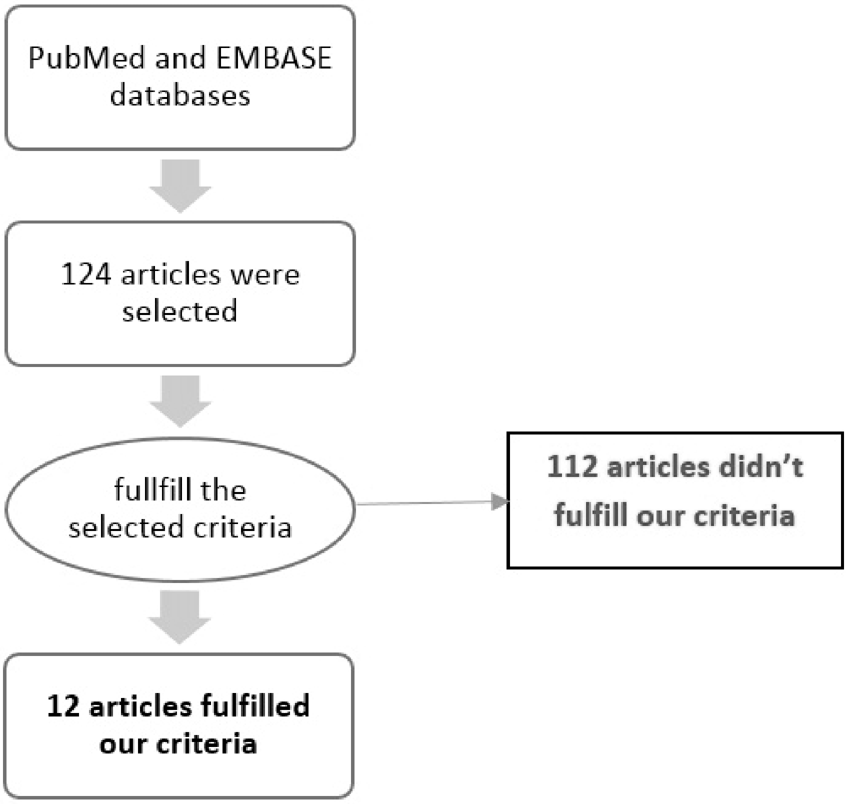

Fig. 1. The stages which were selected in this review study

similar results were observed. Moreover, limited lead hip internal rotation and greater asymmetry of hip internal rotation (right versus left) were reported in the athletes with LBP [26, 27].

Alemida et al. investigated differences in active and passive hip internal, external and total rotation ROM among 21 low back pain patients and 21 healthy subjects [32]. All participants of this study were judo athletes. Hip rotation ROM was measured by photogrammetry. In relation to hip internal rotation ROM, the LBP group demonstrated limited active hip internal rotation on the dominant side and reduced passive hip internal rotation of both sides. Restriction in hip internal rotation and asymmetrical hip rotation between the dominant and non-dominant side were presented as mechanical factors in LBP development in judo athletes [32].

Mellin et al. measured, by using an inclinometer, the hip internal and external rotation ROM of a population of workers (301 males and 175 females) who had a history of at least 2 years of LBP symptoms [33]. Based on the results of this study 1) males have a lesser range of hip internal rotation in comparison to females, 2) in the males group, there was a reverse relationship between hip internal rotation ROM and LBP, and 3) males have a greater magnitude of hip external rotation ROM in comparison to females. The authors believe that limited hip internal rotation ROM in males may function as a risk factor that predisposes them to LBP.

In a 1998 study by Cibulka et al., passive hip internal and external rotation ROM of 100 people with low back pain (24 subjects without sacroiliac involvement and 76 subjects with sacroiliac involvement) was measured by a goniometer [24]. Patients of both genders participated in the study. The duration of symptoms was less than 3 weeks and the patients were undergoing treatment. No specific activities of the patients were mentioned. Statistical analysis of data revealed that 1) overall hip internal rotation ROM was significantly smaller than hip external rotation ROM and 2) the group with symptomatic sacroiliac joint involvement had significantly less hip internal rotation unilaterally whereas the LBP group without sacroiliac dysfunction had bilaterally smaller hip internal rotation ROM. Based on the results, a unilateral and bilateral deficit in hip internal rotation ROM was presented as a factor that may contribute to the development of lumbar spine and sacroiliac dysfunctions and, ultimately, to pain.

Tab. 1. Cross sectional studies: LBP and hip rotation range of motion

References	age (year)	Participants	Sample size	Specific activity	Duration of LBP	Instrumentation	test	result
Ellison, 1990 [31]	20-61	Male and female	100 healthy, 50 LBP	student	1-20 weeks	inclinometer	Passive internal and external	Greater proportion of people who have greater external rotation than internal rotation in the LBP group.
Cibulka, 1998 [24]	13-69	Male and female	24 patients with only LBP, 76 patients with LBP and sacroiliac joint dysfunction	…..	Less than 3 weeks	goniometer	Passive Internal and external	Participants had less internal rotation than external rotation bilaterally, unilaterally greater hip internal rotation restriction was observed in patients with sacroiliac joint dysfunction.
Mellin, 1998 [33]	Mean age in males 44.2 years and in females 46	Male and female	301 males and 175 females with LBP	worker	More than 2 years	inclinometer	Active Internal and external	Males in comparison to females had a greater external rotation and lesser internal rotation.
Vad, 2003 [27]	17-37	male	60 healthy, 40 LBP	Professional tennis player	Limiting performance for more than 2 weeks	Goniometer	Passive Internal rotation and FABERE test	LBP group had a lesser internal rotation and a greater FABERE distance in the lead hip.
Vad, 2004 [26]	21-40	male	14 symptomatic, 28 asymptomatic	Professional golfer	At last 2 weeks in the last year	Goniometer, meter	Passive Internal rotation and FABERE test	LBP group had a lesser internal rotation and a greater FABERE distance in the lead hip.
Gombatto, 2005 [12]	18-45	Male and female	46 LBP	Rotational demand sports activities	Chronic or recurrent	Motion analysis system	Active hip external rotation	Active hip external rotation ROM was not different between the males and females.
Van Dillen, 2007 [13]	Mean age 28.1	Male and female	13 subjects in rotation, 26 subjects in rotation with	Rotational demand sports activities	Chronic or recurrent	Motion analysis system	Active hip external rotation	Active hip external rotation ROM was not different between the two
Van Dillen, 2008 [16]	19-47	Male and female	24 healthy, 24 LBP	Rotational demand sports activities	Chronic or recurrent	inclinometer	Passive internal, external and total hip rotation	LBP group had limited total hip rotation bilaterally than healthy group and lesser total rotation of left side in comparison to right side (more asymmetry right versus right).

Lumbopelvic and hip rotation motion differences between males and females were investigated in a study by Hoffman et al, [34]. In total, 59 people with chronic LBP, including 30 men and 29 women, participated in this study. The patients performed an active hip internal rotation test in the prone position. Kinematic data were recorded by a motion analysis system. Lumbopelvic rotation ROM and hip internal rotation ROM were measured. Statistical analysis revealed that men had significantly less hip internal rotation in comparison to women. The authors of this study believe that men might be at greater risk of LBP than women due to smaller hip internal rotation ROM.

This review of the literature relating to hip internal rotation ROM reveals a strong link between limited hip internal rotation ROM and LBP. This kind of hip impairment may be unilateral or bilateral. Reduced hip internal rotation ROM was observed during active and passive hip rotational tests. Men in comparison to women had lesser hip internal rotation ROM. Accordingly, men may be at greater risk of developing LBP associated with hip internal rotation ROM. A deficit in hip internal rotation ROM was observed in LBP people both engaged and not engaged in rotational demand activities. Accordingly, assessment of hip internal rotation ROM must be applied carefully in both these groups of LBP people.

Relationship between hip external rotation ROM and low back pain

Scholtes and her associates assessed the difference in hip external rotation ROM between healthy and LBP people [35]. This study enrolled 91 subjects (50 people with LBP who were involved in rotation-related activities and 41 people without LBP symptoms who were not involved in rotation-related activities). The patients had a history of chronic and recurrent LBP symptoms. They performed an active hip external rotation test in the prone position. Kinematic data in relation to hip external rotation and pelvic rotation were captured by employing a motion analysis system. After data processing and statistical analysis, no difference in hip external rotation ROM was observed between people with and without LBP. However,

Tab. 2. Cross sectional studies: LBP and hip rotation range of motion

References	Age (year)	participant	Sample size	Specific activity	duration of LBP	instrumentation	test	result
Murray, 2009 [36]	18-70	Male and female	36 healthy, 28 LBP	Amateur golfer	More than 12 months	inclinometer	Active and passive external, internal	Limited lead hip internal rotation during active and passive hip rotation tests were observed in the LBP group.
Scholtes, 2009 [35]	Mean age: 27.9 in the healthy group and 28.2 in patient group	Male and female	50 LBP, 41 healthy	LBP subjects with rotational demand sports activities	Chronic or recurrent	Motion analysis system	Active hip external rotation	Active hip external rotation ROM was not different between the LBP and healthy groups.
Hoffman, 2011 [40]	18-60	Male and female	59 LBP	….	Chronic or recurrent	Motion analysis system	Active hip internal rotation	Males had lesser hip internal rotation ROM in comparison to females.
Alemida, 2012 [32]	15-23	male	21 healthy, 21 LBP	Judo	More than 1 year	Computer photogrammetry	Active and passive internal, external and total hip rotation	During active tests, limited lead hip internal and total rotation and lesser bilateral total rotation were noted in the LBP group. In addition, during passive tests, limited internal rotation in the both sides, limited total rotation of the non-dominant limb and total rotation were obtained in the LBP group.

compared to healthy people, LBP people had a greater magnitude and earlier lumbopelvic rotation during the test.

A study of Gombatto et al. from 2006 investigated sex differences in lumbopelvic and hip rotation motion during an active hip external rotation test [12]. All of the participants (27 men and 19 women) regularly participated in rotational demand sports activities. The patients had a history of chronic and recurrent LBP symptoms. The subjects were asked to externally rotate their hips in the prone position. Kinematic data were recorded with a motion analysis system. After data processing, hip external rotation ROM was measured. The results of this study showed no difference in hip external rotation ROM between men and women. However, men demonstrated a greater percentage of their maximum lumbopelvic rotation in the first 60% of the test.

Differences in the hip and lumbopelvic movement patterns between two groups of LBP people were investigated in a study by Van Dillen et al. [13]. Participants of this study were 13 subjects with lumbar rotation syndrome and 26 subjects with rotation and extension syndrome who had chronic or recurrent LBP. An active hip external rotation test was performed and kinematic data were collected using a motion analysis system. Based on the kinematic comparison, there were no differences between the two groups in regard to hip external rotation ROM and lumbopelvic motion.

As mentioned earlier, there was no difference in hip external rotation ROM between healthy individuals and people with LBP, men and women and also different subgroups of LBP people. However, in these studies the pelvis was free to move and the average values of bilateral hip rotation were used in statistical analysis.

Two studies used the FABERE test to examine hip external rotation ROM. During the FABERE test, subjects lie in the supine position while the hip joint is held in flexion, abduction and external rotation. Then, the distance from the knee to the horizontal plane is measured [26]. Limited hip external rotation, abduction and flexion is manifested by an increase in the knee to horizontal distance [26]. An increase in the FABERE distance was established in LBP golfers and tennis players. In one study, the FABERE distance on the dominant side in golfers with LBP was significantly greater than in golfers without LBP [26]. In another similar study, tennis players with LBP demonstrated a greater FABERE distance in comparison to asymptomatic people. In both studies, players with LBP displayed asymmetry of the hip FABERE distance between the lead and non-lead hips [26, 27].

Because the FABERE distance depends on hip external rotation, flexion and abduction ROM, we cannot exactly state that an increase in the FABERE distance is a result of limited hip external rotation ROM.

Overall, as the results of these studies indicate, there is weak evidence supporting a relationship between LBP and deficits, limitations, in hip external rotation ROM. In other studies, there was no difference in hip external rotation ROM between people with and without LBP symptoms [12, 32, 35, 36].

Relationship between total hip rotation ROM and low back pain

Van Dillen et al. compared the passive hip rotation motion difference between people with and without LBP who participated in rotational demand sports activities [16]. A total of 48 subjects (24 people with LBP and 24 people without LBP) were requested to participate in the study. Measures of passive hip internal and external rotation ROM were obtained with an inclinometer. The results of this study demonstrated that the symptomatic group had less total hip rotation, reduced left total hip rotation and more asymmetry of total rotation (left versus right).

Limited total hip rotation ROM in LBP group was also demonstrated in a study by Alemida et al. [32] involving 42 judo athletes (21 athletes with LBP and 21 athletes without LBP). LBP patients had a history of LBP in the past year. Measures of hip internal and external rotation ROM were obtained using computed photography in passive and active movements. Based on a comparison between the symptomatic and asymptomatic groups, athletes with LBP had less active and passive total rotation on the non-dominant side and limited passive total hip rotation. Accordingly, a deficit in total hip rotation and asymmetry between the limbs was reported as a contributing factor of LBP in the athletes who practised judo.

RESULTS

As the results of the reviewed studies show, reduced hip internal rotation ROM and asymmetrical hip internal rotation ROM (left versus right or dominant versus non-dominant) are two common findings related to hip rotation ROM impairment that are consistently found in people with LBP. Moreover, a deficit in hip internal rotation ROM was also observed in some case studies [28-29]. In these case studies, the treatment plan recommendation to improve hip rotation ROM was followed by a positive result [28-29]. In one study, a golfer player who experienced chronic golf-related LBP had bilateral hip internal rotation ROM restriction. However, the pain was immediately and completely resolved by a treatment that focused on increasing hip internal rotation ROM [37]. In a similar case study, an increase in right hip internal rotation as a part of the plan of care led to a significant improvement in the functional ability of a 42-year-old man with a history of LBP [29]. Thus, it seems that there is a strong relationship between LBP and restriction in hip internal rotation ROM and asymmetrical hip internal rotation ROM (left versus right).

Two studies that measured total hip rotation ROM reported reduced total hip rotation, due to possible restriction in hip internal rotation ROM, and asymmetry of total hip rotation ROM (left versus right or dominant versus non dominant).

Only in 2 studies in which the hip external rotation measurement was obtained indirectly (through the FABERE test), a decrease in hip ROM was reported in LBP groups [26, 27]. No evidence shows a direct relationship between LBP and limitation in hip external rotation.

CLINICAL APPLICATION

The precise identification of factors contributing to LBP is an important step in the management of LBP sufferers [7,38-39]. In most cases, mechanical factors have a strong influence on LBP [4]. As the results of the reviewed studies have shown, impairment in hip rotation ROM such as limited and asymmetrical hip internal rotation and total hip rotation must be considered an important contributing mechanical factor that may be related to LBP symptoms in symptomatic patients. These findings are potentially important in people with LBP who regularly participate in rotational demand activities [16].

It is not surprising that management strategies focused on improving hip rotation ROM were followed by short- and long-term positive results in patients with LBP [29-30,37]. Accordingly, an examination of the hip rotation ROM must be included in the assessment of patients with LBP, especially among patients who engage in repeated hip and trunk rotation motion activities [16]. If, during the examination of a patient with LBP, a clinician or physical therapist encounters an impairment in hip rotation ROM (limitation or asymmetry), he/she must establish a logical relationship between the LBP and hip rotation impairments and then attempt to resolve the LBP symptoms by improving hip joint rotation ROM.

CONCLUSION

Based on these observations, we conclude that there is a close and strong link between LBP and limitation in hip rotation ROM, especially hip internal rotation ROM. This evidence is very clear in patients with LBP who regularly participate in sports activities which require repeated hip and lumbar rotation motion. Although asymmetrical hip rotation ROM and reduced total hip rotation ROM were observed in patients with LBP, there is no direct evidence pointing to the importance of hip external rotation ROM in the population of patients with LBP. Accordingly, hip rotation ROM assessment must be included in the examination of LBP sufferers.

It is worth mentioning that in all of the studies reviewed, hip rotation ROM measurement was carried out during non-functional tests. It appears that this gap may be resolved by further studies that will investigate the hip rotation ROM in LBP sufferers during functional activities such as a walking.

REFERENCES

1. Sadeghisani M, Shaterzadeh MJ, Rafiei AR, Salehi R, Negahban H. Pain, Disability, Fear-avoidance and Habitual Physical Activity in Subjects with Low Back Pain with and without Trunk and Hips Rotational Demand Sport Activities. Journal of Research in Rehabilitation Sciences 2014; 9(7): 1213-21.
2. Mousavi SJ, Akbari ME, Mehdian H, et al. Low back pain in Iran: a growing need to adapt and implement evidence-based practice in developing countries. Spine (Phila Pa 1976) 2011; 36(10): 638-46.
3. Andersson GB. Epidemiological features of chronic low-back pain. Lancet 1999; 354(9178): 581-5.
4. Diamond S, Borenstein D. Chronic low back pain in a working-age adult. Best Pract Res Clin Rheumatol 2006; 20(4): 707-20.
5. Dunn KM,Croft RP. Epidemiology and natural history of low back pain. Eura Medicophys 2004; 40(1): 9-13.
6. Hoy D, Brooks P, Blyth F, Buchbinder R. The Epidemiology of low back pain. Best Pract Res Clin Rheumatol 2010; 24(6): 769-81.
7. O'Sullivan P. Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. Man Ther 2005; 10(4): 242-55.
8. Sadeghisani M, Namnik N, Karimi MT, et al. Evaluation of Differences Between two Groups of Low Back Pain Patients with and without Rotational Demand Activities Based on Hip and Lumbopelvic Movement Patterns. Ortop Traumatol Rehabil 2015; 1: 51-7.
9. Souza RB, Powers CM. Predictors of hip internal rotation during running an Evaluation of hip strength and femoral structure in women with and without patellofemoral pain. The American journal of sports medicine 2009; 37(3): 579-87.
10. Schache AG, Bennell KL, Blanch PD, Wrigley TV. The coordinated movement of the lumbo–pelvic–hip complex during running: a literature review. Gait & posture 1999; 10(1): 30-47.

11. Schache AG1, Blanch PD, Rath DA, Wrigley TV, Starr R, Bennell KL. A comparison of overground and treadmill running for measuring the three-dimensional kinematics of the lumbo–pelvic–hip complex. Clinical Biomechanics 2001; 16(8): 667-80.
12. Gombatto SP, Collins DR, Sahrmann SA, Engsberg JR. Gender differences in pattern of hip and lumbopelvic rotation in people with low back pain. Clin Biomech (Bristol, Avon) 2006; 21(3): 263-71.
13. Van Dillen LR, Gombatto SP, Collins DR, Engsberg JR, Sahrmann SA. Symmetry of timing of hip and lumbopelvic rotation motion in 2 different subgroups of people with low back pain. Arch Phys Med Rehabil 2007; 88(3): 351-60.
14. McGregor AH, Hukins DW. Lower limb involvement in spinal function and low back pain. J Back Musculoskelet Rehabil 2009; 22(4): 219-22.
15. Chuter VH, Janse de Jonge XA. Proximal and distal contributions to lower extremity injury: a review of the literature. Gait Posture 2012; 36(1): 7-15.
16. Van Dillen LR, Bloom NJ, Gombatto SP, Susco TM. Hip rotation range of motion in people with and without low back pain who participate in rotation-related sports. Phys Ther Sport 2008; 9(2): 72-81.
17. Liebenson C. Hip dysfunction and back pain. Journal of Bodywork and Movement Therapies 2007; 11(2): 111-5.
18. Shum GL, Crosbie L, Lee RY. Symptomatic and asymptomatic movement coordination of the lumbar spine and hip during an everyday activity. Spine (Phila Pa 1976) 2005; 30(23): 697-702.
19. Shum GL, Crosbie L, Lee RY. Movement coordination of the lumbar spine and hip during a picking up activity in low back pain subjects. Eur Spine J 2007; 16(6): 749-58.
20. Kim MH , Yi CH, Kwon OY, et al. Comparison of lumbopelvic rhythm and flexion-relaxation response between 2 different low back pain subtypes. Spine (Phila Pa 1976) 2013; 38(15): 1260-7.
21. Kim SH, Kwon OY, Yi CH, Cynn HS, Ha SM, Park KN. Lumbopelvic motion during seated hip flexion in subjects with low-back pain accompanying limited hip flexion. Eur Spine J 2014; 1: 142-8.
22. Sung PS. A compensation of angular displacements of the hip joints and lumbosacral spine between subjects with and without idiopathic low back pain during squatting. J Electromyogr Kinesiol 2013; 23(3): 741-5.
23. Reiman MP, Weisbach PC, Glynn PE. The hips influence on low back pain: a distal link to a proximal problem. J Sport Rehabil 2009; 18(1): 24-32.
24. Cibulka MT, Sinacore DR, Cromer GS, Delitto A. Unilateral hip rotation range of motion asymmetry in patients with sacroiliac joint regional pain. Spine (Phila Pa 1976) 1998; 23(9): 1009-15.
25. Cibulka MT, Strube MJ, Meier D, et al. Symmetrical and asymmetrical hip rotation and its relationship to hip rotator muscle strength. Clin Biomech (Bristol, Avon) 2009; 25(1): 56-62.
26. Vad VB, Bhat AL, Basrai D, Gebeh A, Aspergren DD, Andrews JR. Low back pain in professional golfers: the role of associated hip and low back range-of-motion deficits. Am J Sports Med 2004; 32(2): 494-7.
27. Vad VB, Gebeh A, Dines D, Altchek D, Norris B. Hip and shoulder internal rotation range of motion deficits in professional tennis players. J Sci Med Sport 2003; 6(1): 71-5.
28. Grimshaw PN, Burden AM. Case report: reduction of low back pain in a professional golfer. Med Sci Sports Exerc 2000; 32(10): 1667-73.
29. Reinhardt G. The Role of Decreased Hip IR as a Cause of Low Back Pain in a Golfer: a Case Report. HSS J 2013; 9(3): 278-83.
30. Van Dillen LR, Sahrmann SA, Wagner JM. Classification, intervention, and outcomes for a person with lumbar rotation with flexion syndrome. Phys Ther 2005; 85(4): 336-51.
31. Ellison JB, Rose SL, Sahrmann SA. Patterns of hip rotation range of motion: a comparison between healthy subjects and patients with low back pain. Phys Ther 1990; 70(9): 537-41.
32. Almeida GP, de Souza VL, Sano SS, Saccol MF, Cohen M. Comparison of hip rotation range of motion in judo athletes with and without history of low back pain. Man Ther 2012; 17(3): 231-5.
33. Mellin G. Correlations of hip mobility with degree of back pain and lumbar spinal mobility in chronic low-back pain patients. Spine (Phila Pa 1976) 1988; 13(6): 668-70.
34. Hoffman SL, Johnson MB, Zou D, Van Dillen LR. Gender Differences in Modifying Lumbopelvic Motion during Hip Medial Rotation in People with Low Back Pain. Rehabil Res Pract 2012; 635312.
35. Scholtes SA, Gombatto SP, Van Dillen LR. Differences in lumbopelvic motion between people with and people without low back pain during two lower limb movement tests. Clin Biomech (Bristol, Avon) 2009; 24(1): 7-12.
36. Murray E, Birley E, Twycross-Lewis R, Morrissey D. The relationship between hip rotation range of movement and low back pain prevalence in amateur golfers. Phys Ther Sport 2009; 10(4): 131-5.
37. Lejkowski PM, Poulsen E. Elimination of intermittent chronic low back pain in a recreational golfer following improvement of hip range of motion impairments. J Bodyw Mov Ther 2013; 17(4): 448-52.
38. Sahrmann SA. Diagnosis and Treatment on Movement Impairment Syndromes 2002. St Louis: MO:Mosby.
39. Sahrmann SA. Movement system Impairment Syndromes 2011. St. Louis: MO:Mosby.
40. Hoffman SL, Johnson MB, Zou D, Van Dillen LR. Sex differences in lumbopelvic movement patterns during hip medial rotation in people with chronic low back pain. Arch Phys Med Rehabil 2011; 92(7): 1053-9.

Liczba słów/Word count: 4365 **Tabele/Tables:** 2 **Ryciny/Figures:** 1 **Piśmiennictwo/References:** 40

Adres do korespondencji / Address for correspondence
Farideh Dehghan Manshadi,
e-mail: sadeghi.m@sbmu.ac.ir
tel: +989137716567

Otrzymano / Received 10.05.2015 r.
Zaakceptowano / Accepted 30.07.2015 r.