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Hip Rotation Range of Motion in People With and Without Low Back Pain Who Participate in Rotation-Related Sports

Linda R. Van Dillen, PhD, PT,
Associate Professor, Program in Physical Therapy and Orthopedic Surgery, Washington University Medical School, St. Louis, MO 63110

Nancy J. Bloom, PT, MSOT, DPT,
Assistant Professor, Program in Physical Therapy and Orthopedic Surgery, Washington University Medical School, Campus Box 8502, St. Louis, MO 63110

Sara P. Gombatto, MSPT, and
Doctoral Candidate, Movement Science, Program in Physical Therapy, Washington University Medical School, Campus Box 8502, St. Louis, MO 63110

Thomas M. Susco, M.Ed., D.P.T., A.T.C.
Assistant Chief Physical Therapist and Assistant Chief Athletic Trainer, Purdue University Student Health Center, Purdue University, West Lafayette, IN.

Abstract

Objective—To examine whether passive hip rotation motion was different between people with and without low back pain (LBP) who regularly participate in sports that require repeated rotation of the trunk and hips. We hypothesized that people with LBP would have less total hip rotation motion and more asymmetry of motion between sides than people without LBP.

Design—Two group, case-control.

Setting—University-based musculoskeletal analysis laboratory.

Participants—Forty-eight subjects (35 males, 13 females; mean age: 26.56±7.44 years) who reported regular participation in a rotation-related sport participated. Two groups were compared; people with LBP (N=24) and people without LBP (N=24; NoLBP).

Main outcome measures—Data were collected on participant-related, LBP-related, sport-related and activity-related variables. Measures of passive hip rotation range of motion were obtained. The differences between the LBP and NoLBP groups were examined.

Results—People with and without a history of LBP were the same with regard to all participant-related, sport-related and activity-related variables. The LBP group had significantly less total rotation (P=.035) and more asymmetry of total rotation, right hip versus left hip, (P=.022) than the NoLBP group. Left total hip rotation was more limited than right total hip rotation in the LBP group

Corresponding author: Linda Van Dillen, Ph.D., P.T.; Program in Physical Therapy, Washington University School of Medicine, Campus Box 8502, St. Louis, MO 63110; 314-531-0729 (home); 314-286-1427 (work); 314-286-1410 (fax).
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(P=.004). There were no significant differences in left and right total hip rotation for the NoLBP group (P=.323).

Conclusions—Among people who participate in rotation-related sports, those with LBP had less overall passive hip rotation motion and more asymmetry of rotation between sides than people without LBP. These findings suggest that the specific directional demands imposed on the hip and trunk during regularly performed activities may be an important consideration in deciding which impairments may be most relevant to test and to consider in prevention and intervention strategies.

Keywords

Low back pain; hip mobility; hip rotation; sports; athletic activity

INTRODUCTION

Given the anatomical proximity of the hip joint and lumbopelvic region, a number of investigators have focused on the relationship between hip joint mobility and low back pain (LBP) (Chesworth, Padfield, Helewa, & Stitt, 1994; Cibulka, 1999; Cibulka, Sinacore, Cromer, & Delitto, 1998; Coplan, 2002; Ellison, Rose, & Sahrmann, 1990; Grimshaw & Burden, 2000; Mellin, 1988; Mellin, 1990; Vad, Gebeh, Dines, Altchek, & Norris, 2003; Vad, Bhat, Basrai, Gebeh, Aspergren, & Andrews, 2004; Wong & Lee, 2004; Fairbank, Pynsent, Van Poortvliet, & Phillips, 1984). The interest in hip motion and LBP is based on the hypothesis that limited hip motion will contribute to increased forces, with some of the increased forces potentially resulting from compensatory motion of the lumbopelvic region (Fairbank et al., 1984; Thurston, 1985; Mellin, 1988; Mellin, 1990; Ellison et al., 1990; Vad et al., 2004). The proposed result is an increase in low magnitude loading, accumulation of tissue stress in the lumbopelvic region, and eventually LBP symptoms (Sahrmann, 2002). In particular, many studies have focused on the relationship between hip rotation motion and LBP.

In prior studies of hip rotation and LBP, the measurement of interest has been either active or passive end range hip rotation. The patients studied have been those with and without LBP who participate in a variety of activities. The findings from reports of active hip rotation motion and LBP have been mixed. Fairbank et al. (1984) reported that adolescents with LBP tended to have less left hip rotation than adolescents without LBP (3° difference). There were, however, no group differences in right hip rotation. In a study of young adults, Mellin (1990) found that women with LBP had less active hip lateral rotation than women without LBP, but there were no differences in active hip medial rotation between women with and without LBP. Mellin (1990) also reported no differences between men with and without LBP for active hip medial or lateral rotation. Chesworth et al. (1994), on the other hand, reported significantly less active medial, lateral and total hip rotation in people with LBP compared to people without LBP. Findings from studies of passive hip rotation motion and LBP have also been equivocal. Ellison et al. (1990) reported no differences in passive range of hip rotation motion between people with and people without LBP. Different patterns of end-range hip rotation motion, however, were identified in people with and without LBP. Cibulka et al. (1998) identified a specific pattern of passive hip rotation motion in people with LBP in which hip lateral rotation was significantly greater than medial rotation on the side associated with the LBP symptoms. The identified pattern, though, was specific only to a subset of people with LBP who presented with signs associated with sacroiliac joint dysfunction (Cibulka et al., 1998; Cibulka, 1999). Thus, the findings across these studies suggest that there may be a relationship between hip rotation mobility and LBP, but the specific nature of the relationship remains unclear.

One potential reason for the equivocal findings could be because prior research did not take into consideration a person's need for full hip rotation motion during regularly performed activities. It is possible that a limitation in hip mobility may contribute to a person's LBP problem only if the person repeatedly performs activities that require full range of a particular direction of hip and trunk motion. Thus, one way to better understand the nature of the hip rotation-LBP relationship would be to examine hip rotation mobility and LBP in people who place regular end-range rotational demands on the hip and the trunk, particularly in a weight-bearing situation. Recently, Vad and colleagues reported on two cohorts of men who put repeated, end range rotational demands on the hip and trunk; professional tennis players (Vad et al., 2003) and professional golfers (Vad et al., 2004). In both studies, players with LBP displayed asymmetry of hip medial rotation between the lead and non-lead hip that was not present in players without LBP. Asymmetries of motion were also found with the FABERE test. In the FABERE test the hip is passively flexed to place the foot on the opposite knee and then maximally abducted, laterally rotated and extended. Although not a specific measure of hip lateral rotation, the authors suggested that the FABERE test findings indicated a potential difference in the amount of hip lateral rotation between sides in the LBP group that was not present in the group without LBP.

The studies by Vad et al. (2003, 2004) studies are important because they are the first to examine the relationship between LBP and hip rotation by focusing on a specific cohort of people who regularly place repeated rotational demands on the hip and trunk. The findings from these studies, however, are somewhat limited for four reasons in particular. First, few characteristics of the sample were reported and none were statistically compared between those with and without LBP. Differences in sample characteristics could have been the reason why players did or did not have a LBP problem rather than differences in hip rotation motion. For example, differences in history of sport participation or current participation levels (frequency, duration, intensity) are two variables that could pose an alternative explanation for any obtained effects. Second, the generalizability of the findings is somewhat limited because samples in both studies included only men and all participated in a professional sport. Third, the FABERE test is a measure of the combined amount of available passive hip abduction, lateral rotation and extension motion rather than a specific measure of hip lateral rotation. The extent to which differences in hip lateral rotation rather than differences in hip abduction or extension contributed to the side to side differences obtained with the FABERE test is unknown. Finally, Vad et al. compared hip mobility *within* each group (LBP or NoLBP) but did not compare hip mobility *between* groups. Thus, the investigators do not directly examine whether or not the LBP group had less overall hip rotation motion compared to the NoLBP group.

In view of such limitations the purpose of the current study was to examine whether passive hip rotation motion was different between people with and without LBP who regularly participated in a rotation-related recreational sport. A rotation-related sport is defined as one that requires repeated rotation of the trunk and hips to perform most aspects of the activity. We hypothesized that people with LBP would have less total hip rotation motion and more asymmetry of motion between sides than people without LBP. The current study is important because it may provide some insight into information that could be used to direct treatment, as well as provide some insight into potential prognostic variables for development of LBP that could be examined in future studies.

METHODS

Participants

A convenience sample of 48 participants (35 male and 13 female) between the ages of 19 and 47 (mean age: 26.56±7.44 years) took part in the study. The whole sample reported regular participation in a sport that placed repetitive rotational demands on the hip and the lumbopelvic region. Regular participation was defined as an average of two times per week. Participants were recruited from students taking part in varsity, club-level, and intramural sports teams, as well as patrons of athletic centers or racquet sports clubs in a large metropolitan city. Table 1 shows participant-related and sports-related characteristics of the sample, including the lists the sports participants were involved. Two groups of subjects were studied, people without a history of LBP (NoLBP) and people with a history of LBP. The NoLBP group (M=18, F=6) consisted of people without a history of LBP that limited performance of daily activities for greater than 3 days or for which they sought medical or allied health intervention. The LBP group (M=17, F=7) included subjects who reported a history of chronic or recurrent LBP for a minimum of 1 year. Chronic LBP was defined as symptoms present on greater than half the days in a 12-month period, occurring in a single or in multiple episodes (Von Korff, 1994). Recurrent LBP was defined as symptoms present on less than half of the days in a 12-month period, occurring in multiple episodes over the year (Von Korff, 1994). All those in the LBP group also associated participation in their sport with an increase in their LBP, either during or after play. The groups were equal with regard to age, gender, body mass index, and Baecke activity score (Baecke, Burema, & Frijters, 1982) (Table 2).

Using a forced choice format (yes/no), participants were given a standard set of questions during screening to determine eligibility. People were excluded from the study if they reported that they had been diagnosed at any time by a physician with any of the following: serious spinal complications (e.g. tumor or infection), previous spinal surgery, marked kyphosis or scoliosis, spondylolisthesis, spinal stenosis, spinal instability, spinal fracture, ankylosing spondylitis, disc herniation, lower extremity impairment such as previous lower extremity surgery or leg length discrepancy, severe neurological involvement, rheumatoid arthritis, neurological disease which required hospitalization, history of unresolved cancer, osteoporosis, or current pregnancy. All participants read and signed an informed consent statement approved by the Washington University Medical School Human Studies Committee before taking part in the study.

Procedures

All testing was conducted in the Movement Science Laboratory affiliated with the Program in Physical Therapy at a university-based medical school. There were two primary components to the testing: (1) completion of self-report measures and (2) measures of passive hip rotation motion.

Self-Report Measures—Participants first completed each of the following measures: (1) Demographic, sports-related and LBP history questionnaire, (2) Numerical Rating Scale (NRS) of symptoms (Downie, Leatham, Rhind, Wright, Branco, & Anderson, 1978), (3) Oswestry Disability Index (ODI) (Fairbank, Couper, Davies, & O'Brien, 1980), and (4) Baecke Habitual Activity questionnaire (Baecke et al., 1982). The demographics, LBP history, NRS and ODI are measures recommended as necessary for a comprehensive description of samples of people with LBP (Bombardier, 2000; Deyo, Andersson, Bombardier, Cherkin, Keller, & Lee et al., 1994). Information about sport-specific and activity-related variables were included to test for equivalence of important variables that might contribute to differences in LBP history between the two groups of interest other than passive hip rotation ROM measures.

Passive Hip Rotation Measures—Two examiners were involved in testing each participant. Examiner 1 performed the set-up and the passive hip rotation movements. Examiner 2 read and recorded the hip rotation measures. The participant was positioned in prone on a treatment plinth with the hip in neutral abduction and adduction, the knee flexed to 90° and his pelvis stabilized with a belt (Figure 1). The participant’s arms were positioned at his sides and his head was turned to the side which was most comfortable. The non-tested lower extremity was placed in slight abduction similar to methods used by Ellison et al. (1990). To familiarize the participants with the procedures and to assure then that the lower extremity movements were pain-free, the lower extremity to be tested was passively moved once into medial rotation and once into lateral rotation. The start position for testing passive hip rotation then was achieved by positioning thes tibial plateau of the tested leg parallel to the support surface. Measures of passive hip rotation were taken with a fluid filled inclinometer (Biokinetics Inc., Annapolis, MD, USA). After zeroing the inclinometer to a fixed vertical reference, the inclinometer was positioned on the distal third of the fibula and the starting position was measured (Figure 2). The lower limb was then moved passively through both hip lateral and medial rotation a total of three times. End range of motion was determined by Examiner 1. End range of motion was defined as the point in which the lower shank could no longer be moved without pelvic rotation. Passive range of motion was calculated as the difference between the final and initial position of the lower leg averaged across the three trials. Examiner 2 positioned and read the inclinometer values. The order of testing for both side (right, left) and direction of rotation (medial, lateral) was randomized. Randomization was achieved through a card draw from cards coded for all possible combinations of rotation type and side.

The intra-tester reliability of passive hip rotation measures was tested with 10 people without LBP. Similar to the current study two examiners participated; one examiner to passively move the hip and determine end range of motion and the second examiner to read and record the inclinometer values. The patient positioning and passive movement procedures for reliability testing were the same as those described for the current study except only two trials of each hip rotation motion were obtained with each extremity. Examiner one remained blinded to all measures obtained by examiner two across the duration of the reliability study. The ICC (3,1) (Shrout & Fleiss, 1979) values for hip rotation measures obtained were found to be acceptable ranging from .92 to .99. The ICC values, 95% confidence intervals for the ICCs and standard error of the measure for the hip rotation measures from the subjects in the reliability testing are provided in Table 3.

Statistical Analysis

Descriptive statistics and tests of differences (independent t-test or chi-square goodness of fit analysis) between the LBP and NoLBP groups were conducted on participant-related, sports-related and activity-related variables. To test for differences in hip rotation ROM between the two groups (LBP and NoLBP) a mixed model analysis of variance was conducted on the passive hip rotation measures. The between subjects factor was Group; there were two levels, LBP and NoLBP. One within subjects factor was Rotation Type; there were two levels, medial rotation and lateral rotation. A second within subjects factor was Side; there were two levels, right and left. Significance for all main effects and interactions from the analysis of variance was set at $P \leq .05$. Simple effects analyses with a Bonferroni correction were conducted for any significant interactions.

RESULTS

There were no statistically significant differences between the two groups for participant-related, sports-related, or activity-related variables (Table 1 and Table 2). Although participants were not matched on handedness, all but one was right handed. Low back pain-related characteristics for the LBP group are summarized in Table 4.

Table 5 provides the rotation ROM measures for the LBP and the NoLBP groups. The variables reported include total rotation, total left rotation, total right rotation, right and left lateral rotation, and right and left medial rotation. Total rotation was the sum of left and right lateral and medial rotation divided by two. Total right rotation was the sum of right medial and lateral rotation. Total left rotation was the sum of left medial and lateral rotation. There were 2 significant effects identified. The main effect of Group was significant (F_1=4.76, *P*=.035, 95% CI of the difference: 0.24 to 6.28). The LBP group had less total hip rotation ROM than the NoLBP group (Table 5). The two-way interaction of Group × Side was also significant (F_1=5.70, *P*< .022) (Table 5). Simple effects analyses with a Bonferroni adjustment revealed a significant difference between total right hip rotation and total left hip rotation for the LBP group; total left hip rotation was less than total right hip rotation (F_1=9.20, *P*=.004, 95% CI of the difference: 2.60 to 8.40). There was no significant difference between right and left total hip rotation for the NoLBP group (F_1=1.05, *P*=.312, 95% CI of the difference: −1.67 to 5.09). Based on the interaction findings, the LBP group displayed more asymmetry (right versus left) of rotation motion (medial rotation + lateral rotation) than the NoLBP group. The main effects of Rotation Type and Side were not significant (Rotation Type: F_1=.20, *P*=.66; Side: F_1=.85, *P*=.36). The other two-way interactions and the three-way interaction also were not significant (Group × Rotation Type: F_1=.45, *P*=.51; Rotation Type × Side: F_1=.02, *P*=.91; Group × Rotation Type × Side: F_1=.40, *P*=.53).

DISCUSSION

The purpose of the present study was to examine, in people who regularly participate in a recreation-level, rotation-related sport, whether those with LBP have less total passive hip rotation and more asymmetry of hip rotation motion than people without a history of LBP. In our sample, we found that those with a history of chronic or recurrent LBP demonstrated less total passive hip rotation compared to those without a history of LBP (Table 5). The people with LBP also displayed more asymmetry of hip rotation motion, right versus left, than the people without a history of LBP. The left hip was more limited than the right hip. These findings suggest that the specific directional demands imposed on the hip and trunk during regularly performed activities may be an important consideration in deciding which impairments may be most relevant to test for, as well as to consider in prevention and intervention strategies.

The findings from the current study can not be directly compared to the majority of prior studies (Chesworth et al., 1994; Coplan, 2002; Ellison et al., 1990; Mellin, 1990; Fairbank et al., 1984) because the demands imposed on the hip and trunk during regular activities were not considered in participant selection. Our findings of asymmetry, however, appear to be similar to those of the Vad studies in which the focus was on males who participated in professional tennis (Vad et al., 2003) and professional golf (Vad et al., 2004). In these studies, players with LBP displayed asymmetry in the lead hip compared to the non-lead hip with both medial rotation and FABERE test measures. Specifically, the lead hip was more limited in medial rotation and in the FABERE test maneuver than the non-lead hip. Asymmetry in the hip measures was not identified in the players without LBP. If the FABERE test is an index of hip lateral rotation motion, then the limitations in the FABERE test reported by Vad et al. (2003, 2004) would indicate some limitation in hip lateral rotation in the professional players with LBP. Together these findings would indicate an asymmetry in total hip rotation in the lead hip compared to the non-lead hip in the players with LBP. We do not know if the limitations in left total hip rotation motion identified in the current study are consistent with those related to the lead hip in the Vad et al. (2003, 2004) studies. An operational definition for lead and non-lead hip was not provided. In Vad's studies and in the current study, however, total hip rotation (medial rotation + lateral rotation) in one extremity was more limited than in the other extremity for players with LBP, and the asymmetry of total hip rotation was not found in players without LBP.

The findings from our study also extend those of Vad et al. (2003, 2004). The asymmetry of total hip rotation, right versus left, is present in people with LBP who regularly participate in their sport at the recreational level and appears to be generalizable to both men and women.

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Additionally, we identified that players with LBP had less overall hip rotation motion than players without LBP. Finally, the effects related to hip rotation motion in players with LBP were detected even when other potential explanatory variables were controlled (Table 2).

In the current study the simple effects testing indicated that the LBP group displayed an asymmetry in the amount of total right hip rotation compared to total left hip rotation that was not present in the NoLBP group. We consider the asymmetry of passive hip rotation motion in the LBP group to be of particular importance because our subjects were participating in an activity that repeatedly required full trunk and hip rotation for adequate performance. An asymmetry in end range hip rotation motion when full rotation range of trunk and hip rotation is needed, potentially places an increased demand for asymmetrical movement in other segments; for example, the lumbopelvic region. Previous studies of occupational LBP have identified repetition of asymmetrical trunk movements as a risk factor for the development of LBP (Punnett, Fine, Keyserling, Herrin, & Chaffin, 1991; Marras, Lavendar, Leurgans, Fathallah, Ferguson, & Allread et al., 1995; Marras & Granata, 1997).

Because our sample included only one person who was left-handed we were unable to examine the relationship between hand dominance and specific limitations in hip rotation motion between sides. It is possible that the limitation in left hip rotation compared to right hip rotation contributed to the subjects' LBP problem because 98% of the subjects were right handed and more frequently performed strokes that required transfer of weight onto the left leg while rotating (Table 2). The lack of left hip rotation would then need to be compensated for in other segments. Future research could focus on the relationship between hand dominance and hip rotation by specifically sampling equal numbers of right- and left-handed subjects and comparing their hip rotation measures.

There are some potential limitations of the current study. One potential limitation is we did not formally measure lumbopelvic rotation when obtaining hip rotation measures. We chose to stabilize the lumbopelvic region in order to be assured that we were obtaining full range of hip rotation in each direction. We, therefore, do not know whether lumbopelvic rotation actually occurs when the end of hip rotation motion is achieved, either during hip rotation testing or during an activity that requires full hip rotation. Irrespective of whether lumbopelvic rotation actually occurs, a repeated attempt to achieve hip rotation when the motion is limited has the potential to transfer forces to the lumbar and pelvic region and contribute to accumulation of tissue stress. Development of areas of high stress accumulation in the lumbar region is proposed to contribute to microtrauma and eventually LBP symptoms (Adams, Bogduk, Burton, & Dolan, 2002). A second potential limitation is the cross-sectional design of the study. Thus, we can not be sure if the LBP group developed symptoms because of the identified hip rotation limitations or the LBP group developed limitations in hip rotation because of movements adopted as a result of having a LBP problem. Our LBP and NoLBP groups, however, were equivalent with regard to other important variables that could have contributed to developing a LBP problem (Table 1 and Table 2). Because of the timing of measurement of the variables of interest, however, based on the present findings we can not infer a causal relationship between the identified hip rotation differences and LBP. A third potential limitation is that the sample size of the present study was relatively small (N=48). We conducted post-hoc power analyses for each hip rotation variable that was not significantly different between the LBP and NoLBP group. The range of power estimates for the comparisons that were not statistically significant was .15 to .05, well below the conventionally accepted power level of .80 (Cohen, 1988). There may have been other differences between the 2 groups but we were unable to detect them within the conditions present in our current study. Increasing the sample size potentially could improve our power to detect differences that currently do not reach statistical significance. A final potential limitation is that our people with LBP had relatively low levels of LBP-related disability. The mean ODI score was 16% which would be considered a minimal level of disability (Fairbank et al., 1980). The ODI score likely is related to the fact that our people with LBP were not in an acute flare-up of their LBP problem (Von Korff, 1994). We chose people outside of an acute flare-up because we were interested in examining a person's characteristic movements, rather than movements during a period in which the severity of the LBP symptoms could affect the person's movements. The generalizability of our findings to people in an acute flare-up of their LBP problem may be limited.

CONCLUSION

Among people who participate in rotation-related sports, those with a history of chronic or recurrent LBP displayed less overall hip rotation and more asymmetry (right versus left) in hip rotation compared to those without a history of LBP. These findings are important because they suggest the need for clinicians to consider the movement demands on the hip and the lumbar region during frequently performed activities to the types of impairments measured when examining people with LBP. The findings are also important because they suggest limited hip rotation range of motion may be one of the factors contributing to the development or persistence of LBP in people who regularly perform a rotation-related sport. Thus, passive hip rotation mobility should be considered in the examination, as well as design of preventive and intervention strategies for people who regularly perform activities that require end-range trunk and hip rotation.

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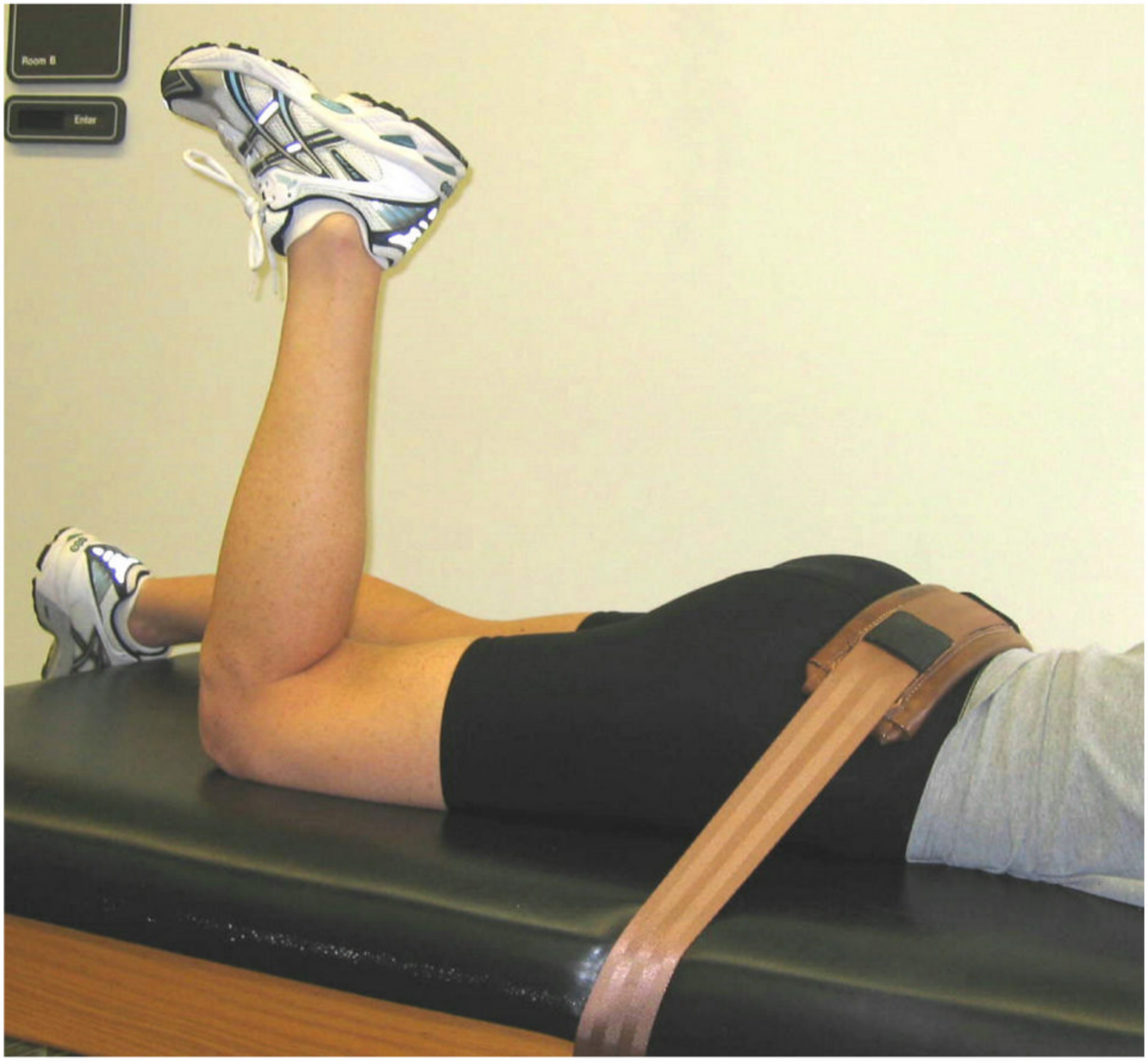

Figure 1.
Test position for measuring passive hip rotation motion. The subject was positioned prone on a plinth with his hip in neutral abduction and adduction, the knee flexed to 90° and his pelvis stabilized with a belt. The non-tested lower extremity was placed in approximately 20° of abduction so as not to interfere with motion of the tested extremity.

Figure 2.
Example of placement of hand held inclinometer for measurement of passive left hip lateral rotation.

Table 1

Characteristics of people with and without a history of a low back pain (LBP) who participate in rotation-related sports (RRS).*

Variable	Groups: History of LBP (N=24)	Groups: No History of LBP (N=24)	Statistical and Probability Values
Handedness (frequency)	Right = 24 Left = 0	Right = 23 Left = 1	Insufficient variability for statistical analysis
Employment status (%)			
• Currently employed	10 (42)	12 (50)	χ^2=0.35; *P*=0.84
• Homemaker	1 (4)	1 (4)	
• Student	13 (54)	11 (46)	
Education (%)			
• Completed high school	1 (4)	0 (0)	χ^2=1.87; *P*=0.76
• Completed 1–3 years college	8 (33)	7 (29)	
• 2 year associate or technical degree	2 (9)	1 (4)	
• Completed college	8(33)	11 (46)	
• Completed post-graduate education	5 (21)	5 (21)	
Number of people reporting participation in RRS* before age 18 (%)	17 (71%)	17 (71%)	Insufficient variability for statistical analysis
Frequency of participation in RRS before age 18 ± SD (times/week)	3.56 ± 1.79	2.88 ± 1.58	t=−1.16; *P*=0.25
Duration of participation in RRS before age 18 ± SD (minutes/session)	88.43 ± 30.97	78.53 ± 53.70	t=−0.65; *P*=0.52
Frequency of participation in RRS after age 18 ± SD (times/week)	2.96 ± 1.57	2.70 ± 1.55	t=−0.48; *P*=0.63
Duration of participation in RRS after age 18 ± SD (minutes/session)	96.09 ± 51.96	85.65 ± 44.30	t=−0.73; *P*=0.47
Number of reports of primary RRS (%)			
• Racquetball	11 (46)	6 (26)	χ^2=5.31; *P*=0.38
• Squash	3 (13)	2 (8)	
• Tennis	8 (33)	14 (58)	
• Racquetball and squash	1 (4)	0 (0)	
• Golf	1 (4)	2 (8)	
Number of reports of most frequent primary stroke or swing with RRS (%)			
• Forehand	19 (80)	20 (84)	χ^2=4.94; *P*=0.29
• Backhand	1 (4)	1 (4)	
• Serve	0 (0)	1 (4)	
• Overhead and backhand	3 (12)	0 (0)	
• Iron shots	1 (4)	2 (8)	

*RRS = rotation related sport

Table 2

Characteristics matched between groups of people with and without a history of a low back pain (LBP) who participate in rotation-related sports.

	Groups		
Variable	**History of LBP (N=24)**	**No History of LBP (N=24)**	**Statistical and Probability Values**
Gender (number)	M=17, F=7	M=18, F=6	χ^2=0.10; *P*=0.75
Mean age ± SD (y)	26.17 ± 7.27	26.96 ± 7.74	t=0.37; *P*=0.72
Mean body mass index ± SD (kilograms/meter^2)	24.71 ± 3.09	25.01 ± 3.57	t=0.31; *P*=0.76
Mean total Baecke Activity score(Baecke et al., 1982) ± SD (3–15)	8.38 ± 0.69	8.87 ± 1.25	t=1.67; *P*=0.10

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Table 3

ICC values, 95% confidence intervals and standard error of the measure (in degrees) for passive right and left hip medial and lateral rotation measures.

Movement	ICC (3,1) values	95% Confidence Interval for the ICC values	Standard error of the measure (in degrees)
Right hip lateral rotation	.92	.66 – .98	1.40
Right hip medial rotation	.98	.92 – 1.00	3.63
Left hip lateral rotation	.94	.78 – .99	2.05
Left hip medial rotation	.98	.92 – 1.00	4.50

Table 4

Characteristics of people with low back pain (LBP).

Variable	Value
Mean number of years of LBP ± SD (minimum and maximum)	7.02 ± 5.73 (1–25)
Mean number of episodes* of LBP in the prior 12 months ± SD	9.29 ± 2.66
Mean verbal numeric pain intensity rating (Downie et al., 1978) over previous week ± SD (0–10)	2.77 ± 1.80
Mean Oswestry Disability Index (Fairbank et al., 1980) score ± SD (0–100%)	15.9 ± 8.3
Number involved in litigation for LBP problem	0
Number receiving disability benefits for LBP problem	0

* The operational definition of a flare up proposed by Von Korff (Von Korff, 1994) is used to identify a LBP episode. A flare-up is operationally defined as a phase of pain superimposed on a recurrent or chronic course which consists of a period, usually a week or less, when the LBP is markedly more severe than usual for the patient. If the person is out of a flare-up he should be able to identify the beginning and the end of the flare-up period.

Table 5

Passive hip rotation range of motion (ROM) measures in degrees, standard error of the mean and associated 95% confidence intervals for mean values for subjects with and without low back pain (LBP) who participate in rotation-related sports.

	Groups			
Variable	History of LBP		No History of LBP (Mean Values± SD)	
	Mean ROM ± SE*	95% Confidence Interval	Mean ROM ± SE*	95% Confidence Interval
Total hip rotation†	54.15 ±2.51	59.02 – 48.37	61.21 ± 1.78	63.89 – 56.53
Left total hip rotation	51.55 ± 2.50	56.85 – 46.25	62.17 ± 1.20	65.30 – 57.03
Right total hip rotation††	56.84 ± 2.75	61.68 – 50.10	60.26 ± 2.03	63.46 – 55.07
Left lateral rotation††	24.63 ± 1.23	27.35 – 21.91	31.15 ± 1.55	34.36 – 27.95
Right lateral rotation	28.29 ± 1.55	30.58 – 24.01	30.43 ± 1.33	32.18 – 26.69
Left medial rotation	26.92 ± 2.33	31.87 – 21.97	31.01 ± 1.73	33.59 – 26.44
Right medial rotation	28.55 ± 2.61	34.09 – 23.01	29.83 ± 1.56	33.05 – 26.62

*Standard error of the mean.

†Main effect of Group: The LBP group had significantly less total hip rotation than the NoLBP group.

††Group × Side interaction: The LBP group had significantly less left hip rotation than right hip rotation. There was no difference between right and left hip rotation for the NoLBP group.