Journal of Strength and Conditioning Research, 2007, 21(4), 1155–1159

The Relationship Between Preseason Range of Motion and Muscle Strain Injury in Elite Soccer Players

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Abstract. Bradley, P.S., and M.D. Portas. The relationship between preseason range of motion and muscle strain injury in elite soccer players. *J. Strength Cond. Res. 21(4):1155–1159. 2007.*—The purpose of the study was to determine the influence of preseason lower-extremity range of motion (ROM) on the risk of muscle strain injury during a competitive season for elite soccer players. Thirty-six elite male soccer players (age, 25.6 ± 4.7 years) had maximum static ROM for 6 movements of the lower extremity measured prior to the 2003–2004 English Premier League season. Player age, body size, dominant limb, and playing position were documented also. All lower-extremity muscle strain injuries were recorded prospectively during the competitive season, as was the total amount of time spent in training and games for each player. Soccer players sustaining a muscle strain injury in the hip flexors or knee flexors had lower preseason ROM ($p < 0.05$) in these muscle groups compared with uninjured players. Similar trends were observed for the remaining muscle groups, but all failed to reach statistical significance ($p > 0.05$). Most significantly, soccer players with lower preseason ROM in the hip flexors and knee flexors had a statistically higher risk for a muscle strain injury to these muscle groups during a competitive season. Age, body size, limb dominance, and playing position were not significant intrinsic risk factors for the development of muscle strain injuries. Screening of flexibility for soccer players should be conducted during preseason, and flexibility training should be prescribed to players with reduced ROM to lower the risk of developing a muscle strain injury.

Key Words. flexibility, injury prevention, joints, football

Introduction

The incidence of injury for elite men soccer players is high (5, 8, 14), with around 85% of all injuries occurring in the lower extremities (9, 13, 24). Approximately 15–25% of soccer injuries can be classified as soft-tissue muscle strains (14, 26) and the majority of these injuries are located in the hip adductors (53%), knee flexors (42%), and knee extensors (5%) (19). Elite English league players are particularly susceptible to hamstring strains (27). A lack of muscle flexibility is a commonly cited intrinsic risk factor for the development of muscle strain injuries (7, 10, 11). Other intrinsic predisposing factors for muscle strain injuries in sport include age, previous injury, body size, and limb dominance (20).

Flexibility is quantified by the range of motion (ROM) available at a joint (1). Previous studies have found that soccer training reduces ROM in players immediately, up to 24 hours posttraining, and progressively over time (18), and soccer players were found to have a lower ROM than nonplayers (7, 12). Knapik et al. (16) found that male military recruits with low hamstring flexibility were twice as likely to become injured as those with average flexibility. Only Ekstrand and Gillquist (7) and Witvrouw et al. (26) have attempted previously to quantify ROM and injury potential in soccer players. Ekstrand and Gillquist (7) found that ROM in the hamstrings and leg adductor muscles in elite Swedish league players in preseason led to increased incidence of injury. Witvrouw et al. (26) also found that hamstring muscle strain injuries in elite Belgian league players were correlated significantly with low hamstring flexibility. They also found that the decreased flexibility of the quadriceps muscles should be considered as an intrinsic risk factor for injury.

With the exception of these, however, research assessing the ROM trends in elite soccer players is scarce and no research has been conducted for elite English players. Training habits and game play patterns in soccer have altered considerably since the work by Ekstrand and Gillquist (7), leaving only Witvrouw et al. (26) as a recent investigation in this area. Therefore, more research is required to further quantify the relationship between lower extremity muscle flexibility and the incidence of injury in elite soccer players. Furthermore, it has been suggested that ROM be considered with other intrinsic factors to further gauge the importance of reduced flexibility in the development of muscle strain injury (26).

Accordingly, the aim of the present study was to determine the effect of preseason ROM on muscle strain injury during the competitive season in elite English league soccer players. The effect of age, limb dominance, body size, and playing position also was investigated in this study (20).

Methods

Experimental Approach to the Problem

In this prospective study, lower-extremity ROM of professional soccer players was measured during preseason and musculotendinous damage to the lower extremity was recorded in season. For each ROM measured, players were placed in an "injured" or "uninjured" group, and the flexibility, age, limb dominance, body size, and playing position between these group were compared.

Subjects

Thirty-six elite male soccer players from the same team with a mean (*SD*) age of 25.6 ± 4.7 years had their lower extremity ROM measured prior to the 2003–2004 English FA Premier League season. During the competitive season, the team's medical staff of state-registered physiotherapists prospectively recorded all lower extremity muscle strain injuries and the total amount of time spent in training and games for each player. A recordable injury was defined as any musculotendinous damage to the lower extremity sustained during training or competition that prevented the player from participating in normal training or competition (3, 21). To control for previous injury, players who were receiving treatment for a muscle strain injury and those who had incurred a lower extremity muscle strain injury in the previous 2 months were excluded (11). Consequently, we did not record recurrent injuries in the same player throughout the season. Of the 42 players who reported back for preseason training, 6 were excluded from this study due to current injury or transfer to another club prior to or during the 2003–2004 season. Injury and exposure data were documented for the remaining 36 players. All players were informed fully of the experimental procedures and produced written informed consent prior to participation. The appropriate institutional ethics committee approved the study.

Procedures

Maximum static ROM for 6 movements of the lower extremity (22) were measured for the dominant and nondominant kicking leg of each player using a 2-dimensional image-based analysis (Figure 1). A stationary video camera (Panasonic SHM20; Matsushita Electric Corp. of America, Secaucus, NJ) operating at a frame rate of 25 Hz was placed perpendicular to the plane of motion at a distance of 10 m (23). Reflective skin markers were placed in the sagittal plane at the trunk (base of the 10th rib); hip (greater trochanter); knee (femur/tibia joint line); ankle (lateral malleolus); heel (calcaneous) and the foot (head of the 5th metatarsal). These markings then were digitized manually using customized software (DigiTEESer; University of Teesside, UK) to identify pelvic, thigh, shank, and foot positions and corresponding joint angles. To determine the reliability of the ROM measurements, data were collected from players and were analyzed repeatedly. The intraclass correlation coefficients (R) were 0.92, 0.95, and 0.91, for the hip, knee, and ankle angles, respectively, with no significant differences between mean values for test vs. retest. Age (year), body mass (kg), limb dominance, and playing position were recorded at the time that ROM was tested. Playing position was categorized as goalkeeper ($n = 6$); defender ($n = 12$); midfielder ($n = 10$); or forward ($n = 8$).

Statistical Analyses

Descriptive statistics were performed on each variable to confirm the assumptions of normality. Because the whole data showed normality in every case, group and regional differences were evaluated using independent and paired-sample t-tests. For each ROM test, the data were separated into a muscle strain injury group and a no-injury group. To determine whether ROM, age, body size, limb dominance, and playing position were important intrinsic risk factors in the development of subsequent muscle strain injuries, a multivariate statistical analysis of all measured variables was performed with the use of a forward stepwise logistic regression procedure, a technique also used in previous research of this kind (26). The forward stepwise logistic regression allowed the comparison of uninjured and injured groups of players, considering risk factors as continuous or categorical variables; it is the criterion statistical model for this type of research problem (26). Significance was accepted at the $p \leq 0.05$ level of confidence and all results are reported as mean $\pm$ *SD*. All statistical analyses were performed using SPSS for Windows (version 11.5; SPSS, Inc., Chicago, IL).

Results

Thirty-two players sustained a clinically diagnosed muscle strain injury of the lower extremity during the competitive season, giving an overall injury rate of 9 injuries per 1,000 hours of training or game play. The knee flexors were the most frequently injured muscle group (29%), followed by the hip flexors (24%), knee extensors (18%), ankle plantar-flexors (15%), hip extensors (12%), and ankle dorsiflexors (2%).

There was a significant difference ($p < 0.05$) in the ROM of the hip and knee flexors between the players who had incurred a muscle strain and the uninjured players. For each of these muscle groups, the injured players showed a reduced mean ROM. Players sustaining muscle strain injuries to the hip extensors, knee extensors, ankle plantar-flexors, and dorsiflexors showed no difference ($p > 0.05$) in ROM compared with uninjured players (Table 1).

A multivariate stepwise logistic regression (ROM, age, body size, limb dominance, and playing position were included) identified a low ROM of the knee flexors ($p < 0.01$) and hip flexors ($p < 0.05$) as a significant contributing factor for a subsequent muscle strain injury. Other ROM measures, body size, age, and playing position were nonsignificant contributing factors for injury ($p > 0.05$). The injured group of players did not show a significant difference ($p > 0.05$) with regard to the number of injuries sustained between the dominant and nondominant kicking leg for each of the muscle groups. There was no significant difference found in exposure time for training and game play between injured and noninjured players.

Discussion

Previous literature has postulated that a lack of muscle flexibility is an important intrinsic risk factor for the development of muscle strain injuries in sport (10, 11, 15). Age, body size, and limb dominance also are widely considered as intrinsic risk factors for muscle strain injury (20).

Almost 90% of the elite players received a muscle strain injury during the competitive season. Most of these injuries occurred in the hip and knee flexors, which is consistent with previous work (27, 19). A very strong relationship was found between preseason ROM in the hip and knee flexors and incidence of muscle strain injury in these muscle groups. Typically, players who injured the knee or hip flexor muscles during the season had a preseason ROM approximately 3° less than that of the uninjured players. Ekstrand and Gillquist (7) also found that muscle tightness in the hamstrings or knee flexors of soccer players led to increased incidence of hamstring injury, and Witvrouw et al. (26) observed that low preseason hamstring flexibility significantly correlated with risk of injury during a competitive season. In our study, low preseason ROM in hip flexors also correlated with the development of an in-season muscle strain injury in these muscles. Krivickas and Feinberg (17) found a significant relationship between increased iliopsoas muscle tightness and injury in male collegiate athletes. A possible explanation for low ROM in the hip and knee flexors producing a higher injury rate may be that these muscles frequently are used at maximal ROM during high speed movements, such as sprinting (25) as required in a soccer game (6). Players with a greater range of movement may have a “flexibility reserve” with respect to such activities, which

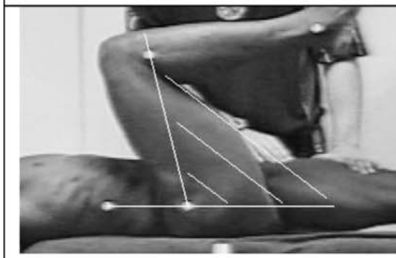
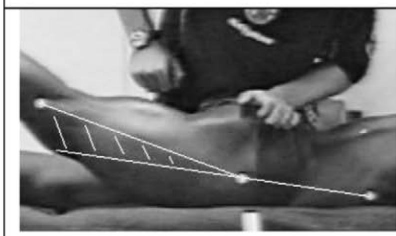
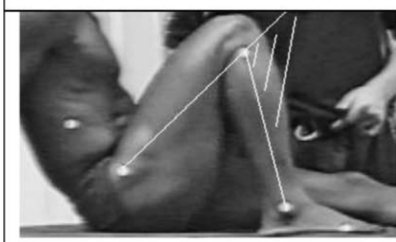
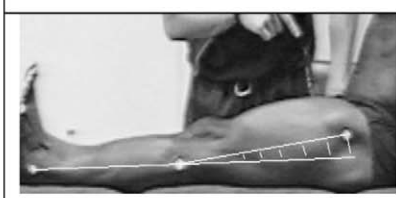
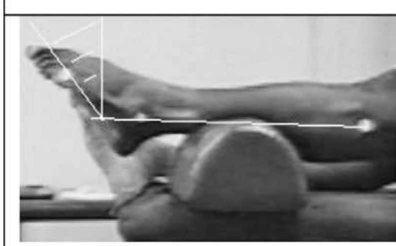
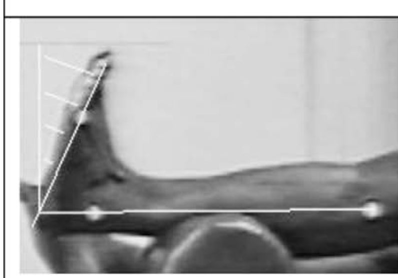
ROM Test	Muscle Group Measured
 a) Hip Flexion	**Hip Extensors -** Gluteus Maximus; Semitendinosus; Semimembranosus; Biceps femoris.
 b) Hip Extension	**Hip Flexors -** Illiopsoas; Sartorius; Tensor faciae latae; Adductor Longus (also adductor); Pectineus (also adductor); Rectus femoris.
 c) Knee Flexion	**Knee Extensors -** Rectus femoris; Vastus intermedius; Vastus lateralis; Vastus medialis.
 d) Knee Extension	**Knee Flexors -** Semitendinosus; Semimembranosus; Biceps femoris; Gracilis; Popliteus; Gastrocnemius.
 e) Ankle Plantarflexion	**Ankle dorsiflexors -** Tibialis anterior; Peroneus tertius; Extensor digitorum longus; Extensor hallucis longus.
 f) Ankle Dorsiflexion	**Ankle Plantarflexors -** Soleus; Peroneus longus; Peroneus brevis; Gastrocnemius; Tibialis posterior; Flexor digitorum longus Flexor hallucis longus.

FIGURE 1. Method of joint range of motion measurement and muscle groups tested.

Table 1. Independent *t*-tests between the uninjured and injured groups of players (mean ± *SD*).

Muscle groups	Uninjured players (°)	Injured players (°)	Significance
Hip flexors	12.9 ± 4.2	9.9 ± 3.0	0.03*
Hip extensors	98.1 ± 10.6	102.1 ± 11.4	0.39
Knee extensors	138.7 ± 4.7	138.2 ± 4.1	0.76
Knee flexors	179.5 ± 2.5	182.1 ± 2.6	0.01†
Ankle dorsiflexors	42.7 ± 6.9	45.3 ± 10.3	0.62
Ankle plantar-flexors	18.4 ± 4.2	18.7 ± 7.3	0.88

* Significantly lower range of motion than uninjured soccer players: $p < 0.05$.
† Significantly lower range of motion than uninjured soccer players: $p < 0.01$.

reduces muscular tension and thus helps them to avoid injury (2).

Strong relationships were not observed between preseason ROM in knee extensors, hip extensors, ankle dorsiflexors, and plantar-flexors and the incidence of muscle strain injury in these muscles in a soccer season. Arnason et al. (3) supported this finding, but Witvrouw et al. (26) found a significant relationship between preseason tightness in the quadriceps and in-season injury. A possible explanation for the conflicting findings is the smaller number of injuries in the knee extensors, hip extensors, ankle dorsiflexors, and plantar-flexors compared with the hip and knee flexors. The smaller sample in these categories could decrease statistical power and thereby reduce the likelihood that a strong relationship would be observed between the variables. A larger sample in our study might have found stronger relationships, but due to the elite nature of the group, it was not possible to obtain more players. Overall, there appeared to be a trend where decreased ROM in the knee extensors, hip extensors, ankle dorsiflexors, and plantar-flexors increased the risk of injury in these muscle groups, but more research is needed to validate these findings.

No significant relationships were found between muscle strain injury and age, limb dominance, body size, or playing position, which opposes the findings of previous work (10, 11, 15). The age range of the players in this study was narrow, which may explain why a significant relationship was not found between ROM and age (20). Likewise, body mass did not vary greatly within the group, and although playing in different positions, the players all followed a similar preparation and game play routine. This may explain why no significant relationship was established for these variables. In this study, we only considered ROM and a small number of intrinsic risk factors that could be related to injury. We did not examine intrinsic variables such as aerobic fitness, muscle strength, postural stability, reaction time, limb girth, and anatomical alignment or extrinsic factors such as shoe type, playing surface, and joint bracing, which can contribute to muscle strain injury (20). Future work should include these variables to further clarify the soccer players most at risk of muscle strain injury.

The results of this investigation suggest that assessment of preseason muscle flexibility, particularly for the hip and knee flexors, is essential in elite soccer players to identify players with reduced ROM. Previous research has demonstrated that stretching exercises can increase muscle flexibility (4). Therefore, it is recommended that players identified as having an "at-risk" ROM are prescribed an appropriate flexibility training program.

Practical Applications

We found that preseason ROM is a significant factor in predicting in-season muscle strain injury in elite soccer players. In contrast, no strong relationships were found between muscle injury and age, playing position, body size, or limb dominance. It is suggested that the ROM of elite soccer players be measured during preseason so players with a low ROM, especially in the hip and knee flexors, are prescribed an appropriate flexibility training program. Recently, strength and power reduction has been linked to acute stretching, so we suggest that any flexibility development work should be performed after other practice. Further study is needed to integrate ROM data with other performance-related risk factors such as aerobic fitness, muscle strength and postural stability, reaction time, limb girth, and anatomical alignment to increase our understanding of the soccer players most at risk for muscle strain injury.

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Acknowledgments

The authors wish to acknowledge the significant contribution of Chris Barnes, Grant Downey, and Gary Henderson toward the completion of this work. We also acknowledge the contribution of Dr. Peter Olsen to the format and presentation of this paper.

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