The effect of functional movement screen and lower extremity training on hamstring/quadriceps ratio in football players

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Authors’ Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection.

Abstract

Purpose: The aim of this study is to determine the effect of functional movement screen and lower extremity training on hamstring/quadriceps (H/Q) ratio in football players.

Material: 11 players from Sivas Beledyespor, affiliated to the Turkish Football Federation, participated in this study. The average age of the players involved in the study was 25.75±4.45, height averages 178.49±8.72 cm, and body weight averages 69.83±6.47 kg. Players who participated in the study had previously suffered a knee area injury. In addition to team training for 8 weeks, extra exercises to strengthen their hamstring and quadriceps muscles were conducted 3 times a week. Isokinetic force tests and Functional Movement Screen (FMS) tests were conducted in the study. Data obtained were evaluated in SPSS package 24 program.

Results: There was a significant difference in the total score of FMS at the level of p<0.05. Deep squat 13.5%, hurdle step 10.49%, in line lunge 9%, shoulder mobility 3.44%, active straight 6.84%, trunk stability push up 6.84%, rotatuar stability 14.73% and FMS total score 17.24% showed improvement. There was a significant difference in the H/Q ratio between both the right knee and left knee pre-test and post-test at p<0.01 level. The right knee developed at a rate of 600 H/Q at a rate of 17.24% and the left knee developed at a rate of 600 H/Q.

Conclusions: As a result, 8 weeks of extra lower extremity exercises can be said to increase the H/Q ratio of football players. It is also seen that the FMS score has increased. Thus, it is thought that the risk of football players having a sports injury again is reduced.

Keywords: soccer players, lower extremity, exercise, Hamstring/quadriceps ratio, functional movement screen.

Introduction

Muscular strength is one of the most important components of sport, both for high performance and injury prevention. One of the most used methods to assess muscle strength balance between dominant/non-dominant and antagonist/agonist is isokinetic testing [1]. It has been suggested that bilateral strength differences and the ratio between maximal antagonist/agonist torques are related to several specific sport demands [2, 3].

Isokinetic assessment can be used to measure torque values at several joints in the body; the knee is perhaps the joint most commonly tested. This assessment typically involves comparing the involved joint with the uninvolved joint [4]. Isokinetic testing can be used to evaluate quadriceps and hamstrings muscle strength, providing a determination of the magnitude of torque generated, and subsequently, the hamstrings to quadriceps (H:Q) strength ratio [5, 6]. A high incidence of knee injuries has been reported in sports activities such as soccer, handball, basketball, and other ball games [7, 8]. Thus, there is a strong need to assess potential physiological risk indicators to thereby prevent or reduce the occurrence of serious knee injury in athletes involved in high-risk sports [9, 10].

The contraction force of the quadriceps muscle during knee extension produces substantial anterior directed shear of the tibia relative to the femur at extended joint angles [11, 12]. This shear can be counteracted not only by the anterior cruciate ligament (ACL) but also by hamstring coactivation [13]. Thus, low muscle strength of the hamstrings relative to quadriceps has been proposed to increase the risk of noncontact knee joint injuries [14, 15].

In the treatment of knee injuries, it is necessary to evaluate mobility and follow the development [16, 17]. Numerous methods for assessing movement proficiency exist; [18, 19] however, one popular test battery that has been examined in the literature is the functional movement screen [20, 21]. The functional movement screen was originally designed to assess muscle flexibility, strength imbalances and general movement proficiency in a range of performance tests; identify functional deficits related to proprioception, mobilisation and stabilisation; and determine the existence of pain during any of the prescribed movement patterns [22]. Existing data suggest that the functional movement screen protocol to determine injury risk [16] and the effectiveness of training interventions [19] has been examined, the relationship between functional movement screen scores and physical performance remains limited [24]. But there are studies showing its full effect [25]. Few studies have formally investigated the use of the FMS™ and its ability to predict injury in the
athletic population [26, 27].

The aim of this study was to determine the effect of FMS and lower extremity exercises on H/Q ratio in footballers.

Material and Methods

Participants

A total of 11 players played in Sivas Belediyespor, one of the 2. league teams of the Turkish Football Federation (TFF), participated in the study. The average age of the players involved in the study was 25.75±4.45, height averages 178.49±8.72 cm, and body weight averages 69.83±6.47 kg.

Research Design

Players who participated in the study had previously suffered a knee area injury. In addition to Team Training (Table 1) for 8 weeks, extra exercises (Table 2) to strengthen their hamstring and quadriceps muscles were conducted 3 times a week. In this extra exercises, hamstring muscle strength development is higher than quadriceps muscle strength development, aiming to increase the H/Q Ratio. For this reason, movements for 2 hamstrings and 1 quadriceps muscle were applied. In addition, FMS measurements to determine the injury risks of footballers were made with the test method developed by physiotherapist Cook et al [18].

Warm-up procedure

Before the tests, the subjects undertook 5 minutes of low intensity aerobic run and 10 minutes of dynamic and static stretching of lower extremity muscles for general warm-up [28].

Determination of isokinetic knee strength

The lower extremity (knee) Isokinetic muscle strength of the football players involved in the study were measured by Isokinetic dynamometer. Players were given a total of 10 min warm-up before the test. Football players were administered concentric-concentric Isokinetic knee strength test with 10 repetitions of 60°sec⁻¹ angular velocity on both legs 2 times, with the first measurement and the last measurement 8 weeks later.

Determination of Functional movement screen

According to the FMS method, athletes are given 0-3 points from each move. The athlete gets ‘3’ points if he makes the move perfectly, ‘2’ points if he makes the move with a few errors, ‘1’ points if he makes it with many errors, and ‘0’ points if he cannot make the move painfully. A maximum of ‘21’ points can be scored at the end of the method. Athletes below 14 points may be at risk of injury.

Statistical Analysis

The data obtained were evaluated in SPSS package 24 program. The Wilcoxon test from non-parametric tests was used for the detection of H/Q ratios and FMs of football players. The level of significance in the study was considered to be p<0.05.

Results

According to the table, there were no significant differences between deep squat, hurdle step, in line lunge, shoulder mobility, active straight, trunk stability push up and rotatuar stability in the FMS test battery. However, there was a significant difference in the total score of FMS at the level of p<0.05. Deep squat 13.5%, hurdle step 10.49%, in line lunge 9%, shoulder mobility 3.44%, active straight 6.84%, trunk stability push up 6.84%, rotatuar stability 14.73% and FMS total score 17.24% showed improvement. There was a significant difference in the H / Q ratio between both the right knee and left knee pre-test and post-test at p<0.01 level. The right knee developed at a rate of 600 H/Q at a rate of 17.24% and the

| Table 1. Percentage distributions of football players based on the duration of team training for 8 weeks |
|-------------------------------------------------|----------------------------------|
| Training Type                                    | Percentage Distributions of Training |
| Warming and regeneration                         | 23. 56%                           |
| Aerobic and Anaerobic endurance                  | 27. 06%                           |
| Speed and coordination                           | 9. 55%                            |
| Strength                                         | 15. 92%                           |
| Technical, tactical and game forms               | 23. 88%                           |

<table>
<thead>
<tr>
<th>Table 2. Strength training program applied to football players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>-Leg extension</td>
</tr>
<tr>
<td>-Leg curl</td>
</tr>
<tr>
<td>-Standing single leg curl</td>
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<td></td>
</tr>
</tbody>
</table>
left knee developed at a rate of 600 H/Q.

Development of lower extremity exercises except for normal training for 8 weeks are given in Figure 1 and Figure 2.

**Discussion**

Predict injuries all athletes, technical staff and by health professionals, although this is the most desirable destination; determining force ratios and muscle force ratios, the risk of injury, balance, coordination tests, environmental conditions, visual reaction time, and fatigue tests of multifactors assessment is required a contribution of many factors, such as proprioceptive [29].

Isokinetic testing of the H/Q ratio provides a quantitative measurement of torque from agonist and antagonist muscle contraction surrounding the knee joint [30]. This ratio has also been examined as a possible screening tool for predisposition to injury [31]. When the knee is injured, the H/Q ratio is often used as a rehabilitative goal due to the importance of the flexor-extensor strength balance in overall knee stabilization [32]. Reduced function of the antagonist hamstrings due to activities that emphasize loads on the knee extensors may result in muscular imbalances between the hamstrings and quadriceps, thereby possibly predisposing athletes to injury. This predisposition may be due to the surrounding

### Table 3. Comparison of pre-test and post-test measurements related to FMS and H/Q ratio of football group

<table>
<thead>
<tr>
<th>Variables</th>
<th>FMS and H/Q ratio</th>
<th>( \overline{x} )</th>
<th>SS</th>
<th>Change (%)</th>
<th>Z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Squat</td>
<td>Pre-Test</td>
<td>2.00</td>
<td>0.77</td>
<td>0.27 (13.5%)</td>
<td>-1.936</td>
<td>.082</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>2.27</td>
<td>0.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre-Test</td>
<td>1.81</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>2.00</td>
<td>0.44</td>
<td>0.19 (10.49%)</td>
<td>-1.491</td>
<td>.167</td>
</tr>
<tr>
<td>Hurdle step</td>
<td>Pre-Test</td>
<td>2.00</td>
<td>0.63</td>
<td>0.18 (9%)</td>
<td>-1.491</td>
<td>.167</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>2.18</td>
<td>0.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In line lunge</td>
<td>Pre-Test</td>
<td>2.90</td>
<td>0.30</td>
<td>0.10 (3.44%)</td>
<td>-1.000</td>
<td>.341</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>3.00</td>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder mobility</td>
<td>Pre-Test</td>
<td>2.63</td>
<td>0.50</td>
<td>0.18 (6.84%)</td>
<td>-1.491</td>
<td>.167</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>2.81</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active straight</td>
<td>Pre-Test</td>
<td>2.81</td>
<td>0.40</td>
<td>0.18 (6.84%)</td>
<td>-1.491</td>
<td>.167</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>2.63</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trunk stability push up</td>
<td>Pre-Test</td>
<td>2.81</td>
<td>0.40</td>
<td>0.18 (6.84%)</td>
<td>-1.491</td>
<td>.167</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>2.63</td>
<td>0.40</td>
<td></td>
<td></td>
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<tr>
<td>Rotatuar stability</td>
<td>Pre-Test</td>
<td>1.90</td>
<td>0.30</td>
<td>0.28 (14.73%)</td>
<td>-1.936</td>
<td>.082</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>2.18</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FMS Total Score</td>
<td>Pre-Test</td>
<td>15.90</td>
<td>1.64</td>
<td>1.37 (17.24%)</td>
<td>-3.155</td>
<td>.010*</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>17.27</td>
<td>1.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right knee 60° H/Q ratio (nm)</td>
<td>Pre-Test</td>
<td>49.92</td>
<td>2.09</td>
<td>8.61 (17.24%)</td>
<td>-8.461</td>
<td>.003**</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>58.53</td>
<td>2.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left knee 60° H/Q ratio (nm)</td>
<td>Pre-Test</td>
<td>53.04</td>
<td>3.88</td>
<td>7.3 (13.76%)</td>
<td>-10.163</td>
<td>.003**</td>
</tr>
<tr>
<td></td>
<td>Post-Test</td>
<td>60.34</td>
<td>2.53</td>
<td></td>
<td></td>
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</tbody>
</table>

\( P<0.05^* \quad P<0.01^{**} \)

![Functional Movement Screen](image-url)

**Figure 1.** Football group pre-test and post-test FMS results
ligamentous structures supporting most of the imposed load and decreased antagonist hamstrings coactivation during extension loads [33]. There was a significant difference in the H/Q ratio between both the right knee and left knee pre-test and the last test at p<0.01 level. The right knee developed at a rate of 600 H/Q at a rate of 17.24% and the left knee developed at a rate of 600 H/Q. Leg extension, leg curl and standing single Leg curl exercises applied to the lower extremity for 8 weeks were found to increase the H/Q Ratio positively significantly. It is known in the literature that imbalance in the H/Q Ratio is associated with weak hamstring muscle [34]. Balancing this ratio by reducing the force of the quadriceps is not possible since, exercises towards increasing hamstring strength should be performed. Given this situation, studies in which only hamstring-based exercises are performed to increase the H/Q strength ratio are available in the literature. For example, in this 2004 study, Mjolsnes divided 21 male players into Nordic hamstring crunchers and hamstring curl crunchers and had them performed for 10 weeks. The study concluded that the H/Q ratio of Nordic hamstring crunchers increased, but there was no change in the H/Q ratio of hamstring leg curl crunchers [35]. Holcomb determined that 6 weeks of hamstring-based resistance exercises they performed on 12 international women football players significantly increased the H/Q ratio of the athletes [36]. There were no significant differences between deep squat, hurdle step, in line lunge, shoulder mobility, active straight, trunk stability push up and rotatoru stability in the FMS test battery. However, there was a significant difference in the total score of FMS at the level of p<0.05. Deep squat 13.5%, hurdle step 10.49%, in line lunge 9%, shoulder mobility 3.44%, active straight 6.84%, trunk stability push up 6.84%, rotatoru stability 14.73% and FMS total score 17.24% showed improvement. In the literature, they reported the average FSM total score of 29 women football players as 15±2 [37]. In another study, 15 women’s soccer players reported an average FSM total score of 13.4, indicating eight injuries during the season [16]. They examined 27 women’s soccer players from the direction of FSM and reported them as 16.5±2.1 in the post-season [38]. As up-to-date information on injury mechanisms and ways to prevent is revealed, changing training schedules may have improved these scores, which determine the risk of injury. To support our findings, Sprague et al. and Chimera et al [36, 37]. The studies also reported scores were made before them by Chorba et al. the results in his study are higher [16]. As a result, 8 weeks of extra hamstring-weighted strength exercises applied to football players can be said to increase the H/Q Ratio. The positive effect of lower extremity exercise programs performed according to the FMS system on FMS score in football players and the low level of FMS score are thought to be directly related to injuries. While the tests suggested in this respect may give a hint of a general situation determination, the exact risk of injury should include a more comprehensive assessment. Additionally, we believe that using the FSM test, which includes more comprehensive assessments for identifying injuries, will provide athletes with more detailed information. Future studies on this issue will guide the use of tests interchangeably or the deficiencies can be completed with other tests. Conclusion As a result, 8 weeks of extra hamstring-weighted strength exercises applied to football players can be said to increase the H/Q Ratio. The positive effect of lower extremity exercise programs performed according to the FMS system on FMS score in football players and the low level of FMS score are thought to be directly related to injuries. While the tests suggested in this respect may give a hint of a general situation determination, the exact risk of injury should include a more comprehensive
assessments. Additionally, we believe that using the FSM test, which includes more comprehensive assessments for identifying injuries, will provide athletes with more detailed information. Future studies on this issue will guide the use of tests interchangeably or the deficiencies can be completed with other tests.

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Conflict of interest
The authors declare no conflict of interest.

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