

Muscles Balance Effects on Enhancing Physical Performance in High School Soccer Players

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ABSTRACT

Background: Exercise program have been introduced to reduce muscle imbalance. **Methods:** 22 male soccer players, 14 to 16years of age, volunteered for the stud with a mean age of 15.3 ± 1.32 years; mean height, 172.16 ± 1.00 cm; mean weight, 60.79 ± 11.34 kg; were studied to examine muscle imbalance differences between quadriceps and hamstring strength using BiodeX Pro Isokinetic Device . Subjects were randomly assigned into two groups to enhance muscle balance, group 1 (resistance training group) participated in supervised program about 60 minute exercise sessions 3 times a week for period of 11 week. The supervised exercise session included strength training for both hamstring and quadriceps. The training program consisted of three parts –a 5 minutes worm-up, 50 minutes the resistance training and a last part is 5 minutes cool-down and stretching exercises. The target exercise intensity was progress from 70%-90 of 1Rm. Group 2 (control group) subjects were instructed not to change their normal training routine. **Results:** Both legs of 22soccer players were evaluated after the completion of the strength training. Experimental group increased their hamstring muscle strength significantly and reduced the H: Q ratio. Muscle strength was significantly greater for the experimental group ($P = .005$) it increased by 50.2% for the right leg and by 49.9 for the left leg. And muscle balance improved from 49.2 to 85.7 for the right leg and from 52.2 to 86.3 for the left leg than for the control group, with increasing strength significant in both quadriceps and hamstring muscle for soccer players ($P < .005$). Experimental group demonstrated a greater percentage increase in hamstring strength compared with control group. Experimental group had significantly greater quadriceps-to-hamstring ratio when compared with control group ($P < .005$). The results also revealed that speed, agility and kicking were all improve with statistical significant after reduced H: Q ratio. Speed improved by 8.4%, agilities improved by 6.1% and kicking distances by 22.2%, shuttle run by 7.6% and kicking on target by 62.5%. Strength training program based on reducing muscle imbalance well effect performance on high school Soccer players. **Conclusion:** Soccer players increase their quadriceps strength greater than their hamstring strength, which will lead to increase muscle imbalance putting them at risk for anterior cruciate ligament injury and reduce their physical performance a. Strength programs training based on improving dynamic control of the knee muscles by emphasizing hamstring strengthening should be instituted for young soccer players.

Keywords: Muscles balance, Muscles imbalance, physical Performance.

Introduction

Soccer is one of the most popular and demanding sport in the world. It involves different intensities at which many different motor actions during match play are performed. In team sports like soccer quadriceps and hamstring muscle groups are involve in several important motor abilities such as Jogging, sprints jumps, duels, feints and kicking are important factors for successful soccer performance. These efforts depend in more extent on the maximal strength of the neuromuscular system particularly of the lower extremities. (Rosene, 2001) The quadriceps muscles play an important role in jumping and ball kicking while the hamstring muscles control the running activities and contribute to the stabilization of the knee turns (Bennell, 2006). Muscle strength of the lower extremities in soccer has been assessed using isokinetic peak torque. (Andrews, 2001; Dadebo, 2004). The musculature around the knee is important in the prevention of injuries as well

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as in the enhancement of knee function. The quadriceps and the hamstring muscle groups are the most frequently injured muscle groups during soccer match. Often causing chronic prolonged absence from training. There are several intrinsic and extrinsic factors that contribute to these injuries. Some of these related to muscle strength imbalance. (Dvorak, 2000). Isokinetic testing can be used to evaluate quadriceps and hamstrings muscle strength, and balance providing a determination of the magnitude of torque generated, and subsequently, the hamstrings to quadriceps (H: Q) strength ratio. (Koller, 2006). The H: Q ratio has been used to examine the similarity between hamstrings and quadriceps moment-velocity patterns and to assess knee functional ability and muscle balance. (Dvorak, 2000) (Hiemstra, 2004) (Dadebo, 2004) (Fagenbaum, 2006). This ratio has conventionally been expressed as concentric hamstrings to quadriceps strength (Coombo, 2000. Askling 2003) (Hagglund, 2003) (Koller, 2006). And recently as eccentric hamstrings to concentric quadriceps strength. (Fitzgerald, 2002). Researchers have examined this ratio in both sexes and in different age groups and rehabilitation settings (Moul 1996) (Dvorak, 2000) (Gabbe, 2005). The H: Q ratio is velocity and position dependent and may reflect predisposition to injury. (Rosene, 2001) (Fagenbaum, 2006). This predisposition may result from decreased antagonist hamstrings coactivation during extension loads. (Cameron, 2003). Athletes who did not regularly exercise their hamstrings had a significant decrease in hamstrings activation compared with normal healthy subjects and athletes who regularly exercised the hamstrings during knee flexion-extension movements. Inhibiting antagonist coactivation activity allows for increased torque and efficiency during extension. It has been suggested that a highly developed quadriceps muscle contributes to decreased antagonist hamstrings coactivation, thereby increasing susceptibility to anterior cruciate ligament (ACL) injury (Cameron, 2003). The normal H: Q ratio is considered to be 50% to 80% as averaged through the full range of knee motion, with a higher ratio at faster speeds. (Rosen, 2001). As the ratio approaches 100%, the hamstrings have an increased functional capacity for providing stability to the knee (Coombs, 2002). This increased knee stability may reduce the possibility injury and enhance performance. As early as (1955) Steindler generalized that absolute knee extension muscle force should exceed knee flexion force by a magnitude of 3:2. Hcon/Qcon of 0.66 values for the knee flexor –extensor ratio has been reported and have general consensus as a normative value for this conventional H/Q ratio. (Rosene, 2001; Dadebo, 2004; Gabbe, 2005; Fagenbaum, 2006).

Our purpose was to investigate muscle imbalance and restoring a normal strength and muscle balance on the thigh muscles due to its effects on Enhancing physical Performance in High School Soccer Players

METHODS

22 male soccer players, 14 to 16 years of age, volunteered for the study with a mean age of 15.3 ± 1.32 years; mean height, 172.16 ± 1.00 cm; mean weight, 60.79 ± 11.34 kg; table (1). Were studied with quadriceps and hamstring strength test. Subjects were randomly separated into 2 groups experimental (n=15) and control group (n=7) to examine muscle imbalance. All subjects gave written informed consent to participate in study. To measure the H:Q ratio, we used the Biodex Pro Isokinetic Device (Biodex Medical Systems, Shirley, NY) to perform knee concentric flexion and extension movements. And between right and left limbs. Measurements were taken at 60, 120, and $180^\circ \cdot s^{-1}$. Subject was restrained when seated in the chair by 2 straps across the torso and by a strap placed across the thigh midway between the anterior superior iliac spine and superior border of the patella. Once the subject was secured in the chair, the range-of-motion limits were determined and set. The starting position was 90° of knee flexion, and the endpoint was 0° of full knee extension. Once the subject was seated and secured, he performed 5 repetitions at $60^\circ \cdot s^{-1}$, 10 repetitions at $120^\circ \cdot s^{-1}$, and 15 repetitions at $180^\circ \cdot s^{-1}$. Before the isokinetic test, subjects performed 5 repetitions at $60^\circ \cdot s^{-1}$ as a warm-up. Criteria for participation in the studies included the following: any documented history of knee ligament or meniscal damage or current injury to the thigh musculature, no known heart disease, not having chronic disease or taking medication that prevented their participation in structured exercise training, and any other condition that may interfere with interpretation of the study results. Individuals who participated in the study were volunteers and were not given any kind of remuneration. The subjects were informed about testing procedures, possible risks and discomfort that might ensue, a written informed consent was obtained. Once muscle imbalance was determined, Subjects table (1) were randomly

assigned into two groups, group 1 (the exercise group) assigned to supervised exercise program. Group 2 were control group. The control subjects were similar in the physical characteristic to the exercise group. All variables were assessed at baseline and after the exercise training program by using the same study protocols and methods.

Exercising individuals participated in supervised program about 60 minute exercise sessions 3 times a week for period of 11 week. These sessions consisted of three parts, a warm-up period lasts for 5 minutes, the second parts is a supervised exercise session which lasted about 50 minutes and included strength training for both the hamstring and the quadriceps. The last part consisted of 5 minutes cool-down and stretching exercises. The target exercise intensity was progress from 70%- 95% of 1Rm for the hamstring, and from 70% to 80% of 1Rm for the quadriceps, to maintain strength. Group 2 subjects (control group) did not participated in any type of strength activity and trained on their normal training sessions. Speed, agility and accuracy of kicking were also assisted and tested pre- and post exercise training to evaluated muscle balance on performance.

Table 1 Mean Physical Characteristics of study subjects

<i>Subjects Characteristics</i>	<i>Group 1(experimental)</i>	<i>Group 2 (control)</i>
<i>Age (yrs)</i>	15.3	15.5
<i>Weight (kg)</i>	60.79	60.78
<i>Height (m)</i>	1.72.16	1.72.5
<i>Training experience.</i>	3.2	3.2

Statistical analyses

Statistical analysis was carried out using SPSS package (copy 10). The comparisons between pre-exercise and post-exercise values were analyzed by a nonparametric Wilcoxon's test for statistically significant. Numerical values are expressed as mean \pm Sd. (Mann Whitney U) test was used to compare the two groups in pre and post measurements. A value of ($p < 0.05$) was considered statistically significant.

Results:

22 male soccer players, 14 to 16 years of age, volunteered for the stud, were studied to evaluate muscle balance and thigh strength. The results of the study show that muscle imbalance was 49.8 in the right leg compare to 52.0 in the left leg. Table (2). This is more than the suggested value of 0.6 for the muscle balance between the hamstring and the quadriceps. After the intervention of resistance training program muscle imbalance was reduced significantly by 26.7% from 49.8 in the left leg to 85.2 . and from 52.0 in the left leg to 86.3. ($p>.000$)There was a statistical significant decreased in muscle imbalance in both legs and a reduction in H: Q ratio. Muscle strength also increased with statistical significant for both hamstring and quadriceps, it increased for the quadriceps from 26.8 to 30.5 and increases for the hamstring from 13.3 to 25.7. There was statistical significant increase in speed after the completion of the resistance training from 5.43 second on the speed test to 4.94, with 8.9% improvement pre –to post measurement. The results of the study also revealed that there was a statistical significant change in agility from 13.12 to 12.3 second ($p>0.000$) with 6.1 % differences'. Between pre and post measurements'. Also there were statistical significant differences between pre and post training measurement in favor of post training on kicking distance, kicking distance increased from 23.7 meter before training to 28.7 meter with 17.0% improvement. The subjects also decreased their time on the shuttle run test from 11.8 second before training to 10.9 second after the completion of the training. Subjects also improve their kicking on target skill significantly from 1.5 to 4.0 with 62.5% increment, on the kicking on target test.

Table 2 Means and St.d for muscle imbalance and other variables measured for both groups

Variables	experimental and control groups				Improvement%	
	Mean and Sd for the experimental group		Mean and Sd for the control group			
	Pre	post	Pre	post		
Right leg	49.8 (± 5.9)	85.2 (± 8.5)	45.9 (± 8.6)	45.6 (± 9.3)	50.3%	
Left leg	52 (± 9.64)	86.3 (± 10.5)	55.3. (± 10.3)	55.2 (± 9.3)	49.9%	
Hamstring strength	13.3 (± 9.6)	25.7 (± 7.6)	14.1 (± 2.5)	14.7 (± 2.3)		
Quadriceps strength	26.8 (± 10.4)	30.5 (± 9.0)	26.0 (± 2.3)	26.8 (± 2.4)		
Speed(30m) S	5.43 s ($\pm .52$)	4.97S (+.29)	5.38 (+16)	5.37 ($\pm .16$)	8.4%	
Kicking distance (M)	23.7 (± 0.8)	28.7 (± 1.2)	23.4 ($\pm .8$)	23.6 ($\pm .88$)	17.0%	
Kicking accuracy (On target)	1.5 ($\pm .8$)	4.1 ($\pm .5$)	1.73 ($\pm .8$)	2.2 ($\pm .41$)	62.5%	
Shuttle run (25/m)S	11.8 (± 0.8)	10.9 ($\pm .04$)	11.0 ($\pm .16$)	10.1 ($\pm .16$)	7.6%	

Discussion

The primary goal of this study was to identify muscle imbalance and its effects on some physical and skillful variables. The soccer players in our study were high school soccer players. Subjects constituted a very homogenous group with respect to age, training and competitive levels. Muscular strength is one of the most important components of physical fitness, and its necessary both for high performance and injury prevention (Bennell, 1998., Gur, 1999., Askling 2003). In clinical and scientific research, knee joint and thigh muscle function have been described using a variety of techniques. One of the most used methods to assess muscle strength balance between hamstring and quadriceps H: Q ratio, which provides a quantitative measurement of torque from agonist and antagonist muscle contraction surrounding the knee joint, (Maffulli., 1996., Hewett., 1999., Cameron, 2003., Koller, 2006). This ratio has also been examined as a possible screening tool for predisposition to injury (Askling, 2003). 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 (Dadebo, 2004) 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 ligamentous structures supporting most of the imposed load and decreased antagonist hamstrings coactivation during extension loads (Koller, 2006) Several investigators have examined the H:Q ratio after ACL injury, using different test velocities and examining the consequences of proprioception relative to the H:Q ratio after ACL injury.(Bennell, 1998; Cameron, 2003)

The results of our study show that that a preseason hamstring: quadriceps muscle ratio of less than 0.6 increased the risk of hamstring injury and effects performance. A preseason isokinetic screening will be useful to identify athletes at risk. Hamstring muscle weakness has been proposed as a risk factor in hamstring injuries and effects performance. (Field, 2005). Any athletes with a strength imbalance could undergo a strengthening program to decrease the risk of hamstring injury and improve performance. Isokinetic measurement of hamstring muscle strength revealed significant differences before and after training. Hamstring strength increased by 25% which decreased the muscle imbalance and increase muscle balance. These findings are in agreement with those of (Hiemstra, 2004; Holm, 2008). They found out that increasing muscle balance by decreasing muscle imbalance effects hamstring pattern injuries and effect performance. It has been shown that eccentric hamstring training concentric and eccentric hamstring muscle training and strengthening program to

restore the normal hamstring: quadriceps ratio led to a significant decrease in the normal hamstring: quadriceps ratio led to a significant decrease in the hamstring injury rate in the following season (Doherty, 2001) In our study a significant difference between quadriceps and hamstring strength and imbalance before and after strength training. Published data in the literature have showed that strength imbalance to be a risk factor for hamstring injuries and a decline in performance. Our study shows that a conventional H: Qratio of less than 0.6 significantly increased the risk of hamstring injury and decline in performance. This corroborates with a similar prospective study on professional football players in which the investigators found a substantially increased risk of hamstring injury when the hamstring: quadriceps ratio was less than 0 .6. Fagenbaum(2003) studied the correlation between preseason strength and flexibility in female collegiate athletes and found that a hamstring: quadriceps ratio of less than 0.6 increased the risk of lower limb injury and effects speed and agility. Muscular imbalance has been shown to affect injury patterns and performance in soccer athletes. Before training, athletes exhibit imbalances between hamstrings and quadriceps muscle strength. Soccer athletes tend to be quadriceps dominant, contracting the quadriceps muscles in response to anterior tibia translation. If the hamstrings are ignored during training, quadriceps dominance in the trained soccer athlete influences the H: Q ratio when compared with the nonathletic. To reduce the incidence of knee injury and improve performance in soccer player, conditioning should include measures to increase the H: Q ratio (Hagglund, 2001., Gabbe, 2005., Foreman, 2005). The sport represented in our study (soccer) requires typical movements (running, jumping, cutting, deceleration, and acceleration). Strength and conditioning professionals and athletic trainers should exercise caution when executed training and conditioning programs. Attention must be given to proper muscle balance between agonist and antagonist muscle groups due to a possible increased risk of injury as a result of muscular imbalance. (Carlson, 2008).

Conclusion: A soccer player athlete tended to increase their quadriceps strength greater than their hamstring strength, putting them at risk for increasing injury and affects their overall performance. Prevention training programs based on improving dynamic control of the knee by emphasizing hamstring strengthening should be instituted for boys' soccer player. Restoring a normal strength and profile decreases the muscle injury incidence and enhance performance.

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أثر التوازن العضلي في تطوير الإنجاز الرياضي عند لاعبي كرة القدم في المرحلة الثانوية

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ملخص

هدفت هذه الدراسة التعرف إلى أثر التوازن العضلي لعضلات الفخذ الأمامية والخلفية على بعض المهارات البدنية والإنجاز الرياضي. 22 لاعب كرة قدم من المرحلة الثانوية من 14 - 16 سنة تطوعوا لهذه الدراسة وكان متوسط أعمارهم 15.3 سنة ومتوسط اطوالهم 172.16 سم ومتوسط أوزانهم 60.79 كغ. بعد أن تم قياس الفرق في القوة العضلية بين مجموعة عضلات الفخذ الأمامية والخلفية لتحديد معدل عدم التوازن بينهم باستخدام جهاز Biodex وتم أيضاً قياس القوة العضلية لعضلات الفخذ الأمامية والخلفية ومن ثم تم توزيع عينة الدراسة ويشكل عشوائي إلى مجموعتين مكافتين مجموعة ضابطة وأخرى تجريبية، خضعت المجموعة التجريبية لبرنامج تدريسي باستخدام الأثقال وذلك لزيادة القوة العضلية خاصة لعضلات الفخذ الخلفية ولخفض معدل عدم التوازن بين عضلات الفخذ الخلفية والأمامية وقد تكون البرنامج التدريسي من ثلاثة مراحل: المرحلة الأولى فترة إحماء لمدة خمس دقائق، المرحلة الثانية تطبيق البرنامج التدريسي ولمدة خمسين دقيقة، المرحلة الثالثة تمرينات تهدئة لمدة خمس دقائق وكانت شدة البرنامج التدريسي متدرجة من 70 - 95% من 1 RM وأشارت نتائج الدراسة إلى أنه يوجد فرق في عدم التوازن بين عضلات الفخذ الأمامية والخلفية وبمقدار 49.2 وقد تم تحسين هذا الفرق بعد الانتهاء من تطبيق البرنامج ليصبح 85.7، أيضاً القوة العضلية لعضلات الفخذ زادت بمقدار 28.8% ومن نتائج الدراسة أيضاً أثر البرنامج التدريسي في السرعة، التي تحسنت بمقدار 8.4% والرشاقة تحسنت بمقدار 6.1%， مسافة الركل تحسنت أيضاً بمقدار 22.1% والتوصيب على الهدف تحسن بمقدار 62%， وكان معدل التحسن في كل متغيرات الدراسة دال إحصائياً ولهذا يوصي الباحث بزيادة الاهتمام ببرامجه تدريبية موجهة لتنقليل الفرق بين قوة عضلات الفخذ الأمامية والخلفية عند اللاعبين لما له من أثر في الإنجاز الرياضي.

الكلمات الدالة: التوازن العضلي، عدم التوازن العضلي، الإنجاز الرياضي.

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