Theories & Applications, the International Edition
Printed Version: (ISSN 2090-5262)
Online Version: (ISSN 2090-5270)
July 2013, Volume 3, No. 2 Pages (59 - 70)

Effect of a Specific Rehabilitation Program on the Prevention of Hamstring Muscle Re-injury in Professional Football Players in Egypt

*Ahmed A. Omran**

Abstract
The effective rehabilitation and prevention of HMSI of football playershave been challenging prepositions. In this article, we have shown a full recovery of for the Egyptian football playersfollowing a proposed specific rehabilitation program consisting of football-specific drills,high intensity interval anaerobic training, agility exercises with ball,complex exercises with ball, games skills exercise, and small games with the team. This study involved a deliberately chosen subject group of 18 players with HSMI who have been subjected to a specific rehabilitation programs described herein this work. Causes of HSMI were most frequent (44.44%) in sprinting-and-stop, and sprinting-and-make 3-4 steps, followed by acceleration (27.8%). Less frequent causes are plant-and-kick and slip-and-fall which were of equal frequency (11.1%). Stretching was the least frequent causes (5.6%) among all causes in this study. Applying the described specific rehabilitation program over three Phases, I, II, and III took 24-61 days according to the severity of injury. The time taken for implementing Phase I and II averaged 31.5±7.5days, whereas the time taken for implementing Phase III averaged 50.5±10.5.Progressive games with the team was essential inthe prevention re-injury mechanism of HMSI andinhelping players return to their previous level of the functional profile without putting them at risk for future injury. We believe that the success of the safe return to competitions does not depend on the length or short duration of rehabilitation, but the efficiency of the program in restoring motor functions that have been affected, according to the degrees of injury. The results of this study provide evidence that the risk of re-injury can beminimized or even eliminated by utilizing rehabilitation strategies that incorporate neuromuscularcontrol exercises and eccentric strength training, combined with objectivemeasures to assess musculotendon recovery and readiness to return to competitions.

Keywords: *hamstring muscle strain; re-injury causes; specific rehabilitation; HSMI prevention; football; Egyptian players.*

Introduction

Football hamstring muscle strain injuries (HMSI) are among the most common athletic-related reported injuries worldwide(Yu et al., 2008, Feeley et al., 2008, and Twomey& Taylor, 1994)which are ranked the third most common orthopedic problem after knee and ankle injuries in football teams (Sullivank et al., 2008). Rehabilitation of HMSI impose complicated challenges and are of various mechanism types(Twomey& Taylor, 1994). Injuries occur during motion reach a position with combined extensive hip flexion and knee extension. The injuries are often complex, but 83% involved the semi-membranous and its proximal free tendon (Askling et al., 2008).

The HMSI occur during maximal sprinting activities (Arnasonetet al., 1996; Woods et al., 2004). It was shown that muscle activity is highest during the late swing phase, when the hamstring muscles work eccentrically to decelerate the forward movement of the leg, as well as during foot-strike, in the transition from eccentric to concentric muscle action (Jonhagen et al., 1994) (Yu et al., 2008). Running is also identified as a primary activity type for HSIs and given the high eccentric forces and moderate muscle strain placed on the

* *Ass. Prof. Sport Injuries and Physical Rehabilitation, Department of Biological and Health Sport Sciences, Faculty of Physical Education for Men, University of Alexandria, Egypt.*

hamstrings during running these factors are considered to be part of the etiology of HSIs. However, the exact causes of HMSI remain unknown.Thisinformation is relevant for scientifically establishing muscle injury prevention and rehabilitation programs (Chumanov et al., 2011).

Acute hamstring injury, defined as an initial injury that occurred within the past 10 days (Petersen et al., 2011),are the most prevalent muscle injuries reported in sport. It is characterized as an injury that disables a player to play a match or comply fully with all instructions given by the coach, including sprinting, turning, shooting and playing soccer at full tempo(Arnason et al., 2008, and Arnason et al., 2004).

A rehabilitation program consisting of progressive agility and trunk stabilization exercises is effective in promoting return to sports and preventing injury recurrence in athletes who have sustained an acute hamstring (Petersen et al., 2011). Changes in pelvic position could lead to changes in length-tension relationship or force-velocity relationships (Worrell, 1994). This has led some clinicians to utilize various trunk stabilization and progressive agility exercises for hamstring rehabilitation programs (Bennell et al., 1999, and Jull & Richardson,1994). Trunk stabilization and neuromuscular control exercises have also been shown to be effective in promoting return to sport in athletes with chronic hip adductor pain (Holmich&Uhrskou Pulpits, 1999).

There is mounting evidence that the risk of re-injury can beminimized by utilizing rehabilitation strategies that incorporate neuromuscularcontrol exercises and eccentric strength training, combined with objectivemeasures to assess musculotendon recovery and readiness to return to sport(Heiderscheit et al., 2010). This study was focused on implementing a specific rehabilitation program theorized that progressive stretching and strengthening of the injured tissue would help to remodel and align collagen fibers in the injured tissue. It was considered that stretching could have a role in hamstring muscle strain injury by improving force absorption for a given length of muscle, thereby making the muscle more resistant to stretch injury(Verrall et al., 2006).

Despite a thorough and concentrated effort to prevent and rehabilitate hamstring injuries, its occurrence and re-injury rates have not improved over the past 28 years. This failure is most likely due to an over-reliance on treating the symptoms of injury, such as subjective measures of “pain", with drugs and interventions; the risk factors investigated for hamstring injuries have not been related to the actual movements that cause hamstring injuries i.e. not functional; and, a multi-factorial approach to assessment and treatment has not been utilized (Levine et al., 2008). Hamstring muscle weakness was evident in football players with a history of hamstring injury (Slavotinek et al., 2002). The highest risk for injury recurrence within the first 2 weeks of return to sports (Mjölsnes et al., 2004).

Although there are promising new approaches for improving the prevention and rehabilitation of hamstring strains, questions remain regarding the underlying mechanisms. Advance understanding of the causesof HMSI during over ground sprinting was made by investigating hamstring muscle – tendon kinematics and muscle activation. Hamstring muscle exhibited eccentric contraction during the late stance phase as well as during the late swing phase of over ground sprinting. The peak eccentric contraction speeds of the hamstring muscles were significantly greater during the late swing phase than during the late stance phase while the hamstring muscle- tendon lengths at the peak eccentric contraction speeds were significantly greater during the late stance phase than during the late swing phase(Sullivank et al., 2008).

Until recently, prospective hamstring injury prevention measures were lacking and shaped research challenges in this area (Sullivank et al., 2008). However, a significant investigation into prevention of HMSI was carried out(Haqqland et al., 2008). This high re-injury rate suggests that commonly utilized rehabilitation programs may be inadequate at resolving possible muscular weakness, reduced tissue extensibility, and/or altered movement patterns associated with the injury. Further, the traditional criteria used to determine the readiness of the athlete to return to sport may be insensitive to these persistent deficits, resulting in a premature return(Heiderscheit et al., 2010).

It was reiterated by Jeffreys (2006),that regaining muscle strength, flexibility, and function judged by the subject's movement patterns(stand, walk, jog, fast-run, sprint, change of direction) for all positions is a good indicator of the rehabilitation program used. He classified movement functions to three groups; first Initiation movements – Movements that are used to start or change motion, second Transition movements – Movements that are used as preparation for subsequent actions, the aim being to maintain a position from where subsequent action can be effectively and efficiently employed and third Actualization movements. These represent the key movements that ultimately decide the success of the actions. These normally involve a football related skill, or moving to a given position as quickly as possible.

In order to minimize the risk of HMSI, it is believed that the key features of any hamstring injury prevention program in sports such as football requiresan improvementto the training regime so that it more accurately reflects match playing conditions with the goal of improving muscle conditioning, improving fatigue resistance of the hamstring muscle, and tryingto induce a change in the viscoelastic properties of muscle so as to increase energy absorption and decrease load on the muscle-tendon unit for any given length especially in body positions of function and vulnerability to injury(Verrall et al., 2006).

This study aims at evaluating the effectiveness of aspecific rehabilitation program for and investigating the fundamental performance of injured football Egyptian premier league players with acute hamstring strainon the prevention of re-injury of hamstrings strain be evaluating and assessing the recurrence of injury during the first and second weeks after return to sport, and the first year thereafter.

Methods

Subject Sampling

This study involved a deliberately chosen subject group of 18 players with HSMI who have been subjected to a specific rehabilitation programs described herein this work. Ten players of this group were from among 30 players of the first football team of the "Egyptian Olmby Club" who had been injured during the formal matches of the national excellent football tournament (A) of 2008/2009 season. The other eight players of the group were from among 32 players from first football team of "Smouha Sports Club" who had been injured during formal matches of the national excellent football tournament (B) of 2009/2010 season. Subjects agreed not to take non-steroidal anti-inflammatory medication or receive any other form of treatment during the study. Each subject signed an informed consent form. The fundamental description of the injured players from both clubs including age (year), height (cm), weight (Kg), and years played (year) were recorded.

As a head of a medical team of both clubs, the author was allowed to have the subjects under close observation and to follow up details of injury dynamics, time and place of occurrence, unifying administrative dealings with injuries, starting and ending times of the rehabilitation program, unifying methods used for diagnosis of injuries and medics who carried out the diagnosis, center of physiotherapy and the medical follow up. This process allowed stratification for age and eliminating any potential bias these two variables may present. The injuries were classified as first or second degree strains based on Craig'soriginal description (Craig, 1973). He classified the injuries as first, second, or third degree strains. Injury severity was classified in categories according to the duration of absence as; minor (7 days), moderate (8–21 days) and severe (421 days) for recovery. But, this classification system has some subjectivity and there is a lack of research correlating injury grade and time for recovery from injury. Therefore, it was not used in the randomization process (Petersen et al., 2011).

Outcome Measures

The two teams played in weekly competition matches. Each team averaged 30 games in each of the two plying seasons. The number of injured football players and the number of training days missed was recorded for HMSI. The causes of injury incident of hamstring muscle injuries table (Sullivank et al., 2008) was recorded immediately as it happened in accordance with the expected mechanisms. Three specialists in sports injury performed CD analysis for the matches to make sure of the precision in determining the causes of injury incident.All matches and training days were monitored throughout the seasons 2008-2009 and 2009-2010.

Managing Injuries

The first step in handling the hamstring muscle injury is the implementation of first aid principles, there are few means at our disposal, but it is essential that these be applied veryrapidly "Tight" compression using a cohesive bandage for 20 to 30 minutes, according to the patient's level of tolerance. Immediate, prolonged and repeated cryotherapy starting from applying ice on the injury site to reduce pain, bleeding, and inflammation, and then trunk stabilization of the hamstring muscle to minimize the extend of injury. Taking the weight off the injured lower limb. Elevating the limb. The second step is to seek diagnosis by the medics to diagnose the case and determine the exact damage and degree and location of injury by diagnostic scan, and describe the treatment plan by medications and physiotherapy during the specific rehabilitation program.

Rehabilitation Program

Subject group had three specific treatment phases as described. Phase Iof treatment extended from the occurrence of the injury incident until it is possible for subjects to walk on the injured leg again without pain. Subjects progressed for exercises in phase I to exercises in phase II when they could walk with the same stride length and stance time on the injured and stance timer on the injured leg and do a high knee march in place without pain (Petersen et al., 2011).

The acute stage takes 2-4 days and treatment is focused on control of inflammation by taking off the weight from the patient's leg using crutches, elevating the limb as often as possible. Treatment starts by applying repeated and regular cryotherapy, electrotherapy, and physiotherapy. Cryotherapyis applied by placing ice on the posterior thigh for 20 min every two hours for the duration of the stage. Electrotherapy is carried out by applying electromagnetic short waves pulses (4 to 100 Hz) once daily for 20min to the end of Phase I. Physiotherapy is carried out by manual lymphatic drainage (MLD) involving manual stimulating massage above the injured area. Early motion of the lower extremity in the sagittal plane performed towards the end of the stage.

The sub-acute stage extends to the end of Phase I where subjects were required to perform isometric strength of hamstring, isolated hamstring progressive- resistance exercises, Pain- free stretching, stationery biking, Agility exercises begin with movement primarily in the frontal and transverse plane, Trunk stabilization exercises (refers to muscular activity of the trunk and pelvis to maintain the spine and pelvis in desired neutral posture or alignment, and Static balance. These exercises were carried out daily; and physiotherapy was performed twice daily in a specialized physiotherapy clinic as described in the acute stage.

In Phase II, Continued, isolated, hamstring progressive-resistance exercises, performing movements in the transverse and sagittal plane, dynamic stretching was incorporated with concentric, eccentric hamstring strengthening, Agility, Speed, Dynamic balance exercises, and Control exercises with ball. A rehabilitation program was completed as a daily gymnasium and playground exercise under supervised the author. The players were asked to stretch the hamstring musculature using a contract–relax exercise before beginning sprinting or specific exercises.

In Phase III, the specific functional phase. Subjects progressed to performing high intensity interval anaerobic training, football-specific drills. Speed and jogging exercises with and without ball, Agility exercises with ball, Complex exercises with ball, Games skills exercise, Small Games with the team, and Progressive Games with the team.

Return to Competition

All players were highly motivated to return to competition. Players were allowed to return to training exercises with other players under supervision of the head coach when they were able to demonstrate to the physiotherapist a manual strength test when manually resisting knee flexion in prone with the hip in neutral extension, where they had no palpable tenderness along the posterior thigh, and when they demonstrate to the author subjective readiness after completing agility and running tests.

On the day of returning to training with the team, a functional testing profile was also performed. Thesetests were administered by the author and included a hop-for-height test, hop-for distance test, 3- hop crossover test, and a 40-yard sprint. The hop tests allowed for comparison between the injured and uninjured limbs. If subjects reported posterior thigh 'tightness' or 'twinges' during their running tests, they were allowed to return to training with the team.

Follow Up and Prevention Phase

After returning to competition, the subjects were monitored for two weeks to check out the recurrence incidents that might take place or symptoms related to the injury. A further follow up continued to the end of the competition season. A prevention program involving flexibility training exercises based on a partner contract–relax stretching exercise was carried out. The injured return players were asked to do this exercise after training three times per week and after eachgame. A subject was considered to have a reinjured if there was a specific cause of injury that triggered a return of posterior thigh pain, pain with resisted knee flexion, tenderness to palpation along the muscle tendon unit, and decreased ability to do skills (Perceived strength and power).

Results

The demographical data of the eighteen subjects of Olympy and Smouha clubs players were injured with HSMI during the course of this study are presented in Table 1.No significant difference was found in the variation within each verbalize, including age, height, weight, and years played. Worth noting, is that the three subjects were left-legged and 15 were right-legged.

Injuries varied in severity and were identified as 1st, 2nd, and 3rd degree, where the last is the most severe. Out of the 18 subjects, eight (44%) suffered 1st degree injury, nine (50%) suffered 2nd degree injury, and one (6%) suffered 3rd degree injury(Table 2).Noticeably, the nine subjects with 2nd degree injury included the three left-legged subjects who were injured in their left leg, and resulted in a much greater number of subjects with left leg injury of this group of players as compared to the other group of the 1st and 2nd injuries. Most injuries occurred in the middle area ofthe muscles, with tendency for the occurrence of upper muscle injury in the 1st degree, and for theoccurrence of lower muscle injury in the 2nd degree injury.

Table (1)
Demographic characteristics of a subject sample of hamstring-injured football players of the Egyptian Olympy and Smouha clubs.

Basic verbalizes	Olympy(n=8)		Smouha(n=10)		t	P
	Range	Mean± SD*	Range	Mean± SD		
Age (year)	21-29	25.5± 3.1	24 – 37	28.0± 4.4	1.4	0.175
Height (cm)	174-180	177.0± 1.8	175 – 189	178.1± 4.7	0.69	0.495
Weight (kg)	68-77	73.0± 2.8	68 – 83	72.5± 5.0	0.27	0.793
Year played (year)	9-15	12.5± 2.3	11 – 24	15.0± 4.2	1.6	0.126

Table (2)
Incidence of hamstring strain injuries in the subject football players.

Degree of injury	No. injured (%)	Leg injured			Injured area of muscle		
		Right	Left		Upper	Middle	Lower
1st degree	8 (44.0)	4	4		3	5	0
2nd degree	9 (50.0)	2	7		1	6	2
3rd degree	1 (6.0)	1	0		0	1	0
Total injury	18	7	11		4	12	2

Causes of injuries triggering HSMI were most frequent (44.44%) in sprinting-and-stop, and sprinting-and-make 3-4 steps, followed by acceleration (27.8%). Less frequent causes are plant-and-kick and slip-and-fall which were of equal frequency (11.1%). Stretching was the least frequent cause (5.6%) among all causes occurred in this study (Figure 1).Applying the described specific rehabilitation program over three Phases, I, II, and III took 24-61 days according to the severity of injury (Table 3).The time taken for implementing Phase I and II averaged 31.5±7.5days, whereas the time taken for implementing Phase III averaged 50.5±10.5.

Subjecting rehabilitated subjects to functional testing prior to returning to competition revealed a complete recovery of the players (Table 4), as demonstrated by the low standard deviation from the mean. Further comparison between the fitness of injured and uninjured legs showed no significant difference between the achievement of test 1&2, 7&8, and 9&10 tested by t-in pairs, but there is significant difference between the achievement of test 4&5. Subjects were allowed to return to completion, and were observed over a year of follow up on the 1st injury. No recurrence of injury has occurred during the first eight months. However, three subjects had a second injury before the end of the year (Figure 2).

Figure (1)
Causes of injuries responsible for causing hamstring strain in a sample of the subjects.

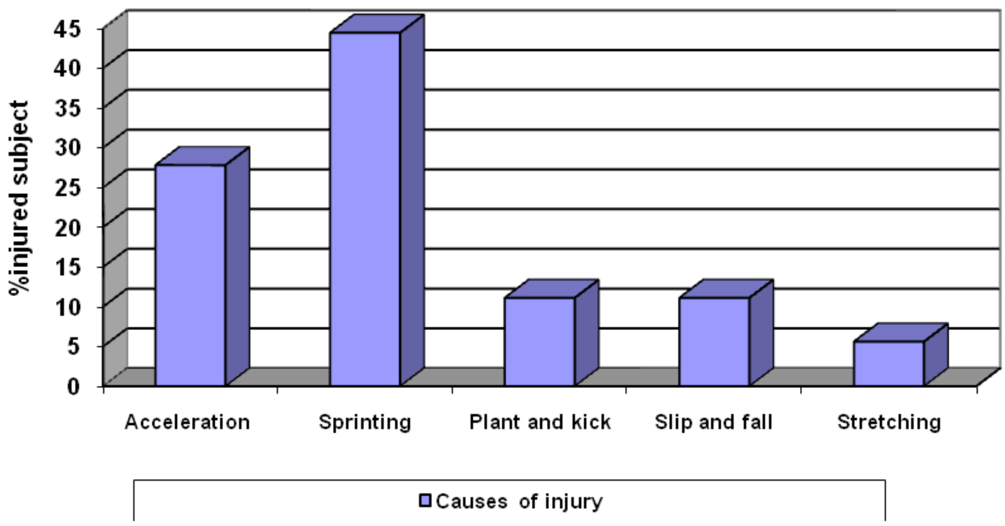

Table (3)
Time of recovery from the incidences of hamstring strain injuries to return to Compactions following a specific rehabilitation program in the subjects.

Rehabilitation phases	Range (days)	
	1st& 2nd degree	3rd degree
Phase I	5-7	9-16
Phase II	12-20	17-30
Phase III	7-12	14-15
Total no of days	24-39	40-61
SD±Mean	7.5± 31.5	10.5 ±50.5

Table (4)
Analysis of functional testing after rehabilitation from hamstring strain injuries and before returning to compactions in the subjects

No.	Test	Range	Mean±SD	Test no.	t-in pairs	P
1	Hop for height injured leg (cm)	23.0-37.0	32.1±3.4	1&2	-.903	.379
2	Hop for height uninjured leg(cm)	29.0-37.0	32.9±1.9			
3	Hop for height 2 legs (cm)	34.0-39.0	35.9±1.5			
4	Hop for distance injured leg (m)	1.8-2.3	2.0±0.1	4&5	-4.172	.001
5	Hop for distance uninjured leg (m)	2.0-2.6	2.2±0.2			
6	Hop for distance 2 leg (m)	2.1-2.8	2.3±0.2			
7	3 - hop crossover test injury leg (m)	5.3-8.6	6.6±0.8	7&8	-.444	.662
8	3 - hop crossover test uninjured leg (m)	5.7-8.6	6.6±0.9			
9	40 - yard sprint (sec.)injured players	3.7-5.9	4.97±0.63	9&10	1.465	.152
10	40 - yard sprint (sec.)normal players	3.7-5.9	4.68±0.54			

Figure (2)
Incidence of re-injury rate after1-2 match and after one year of return to competition.

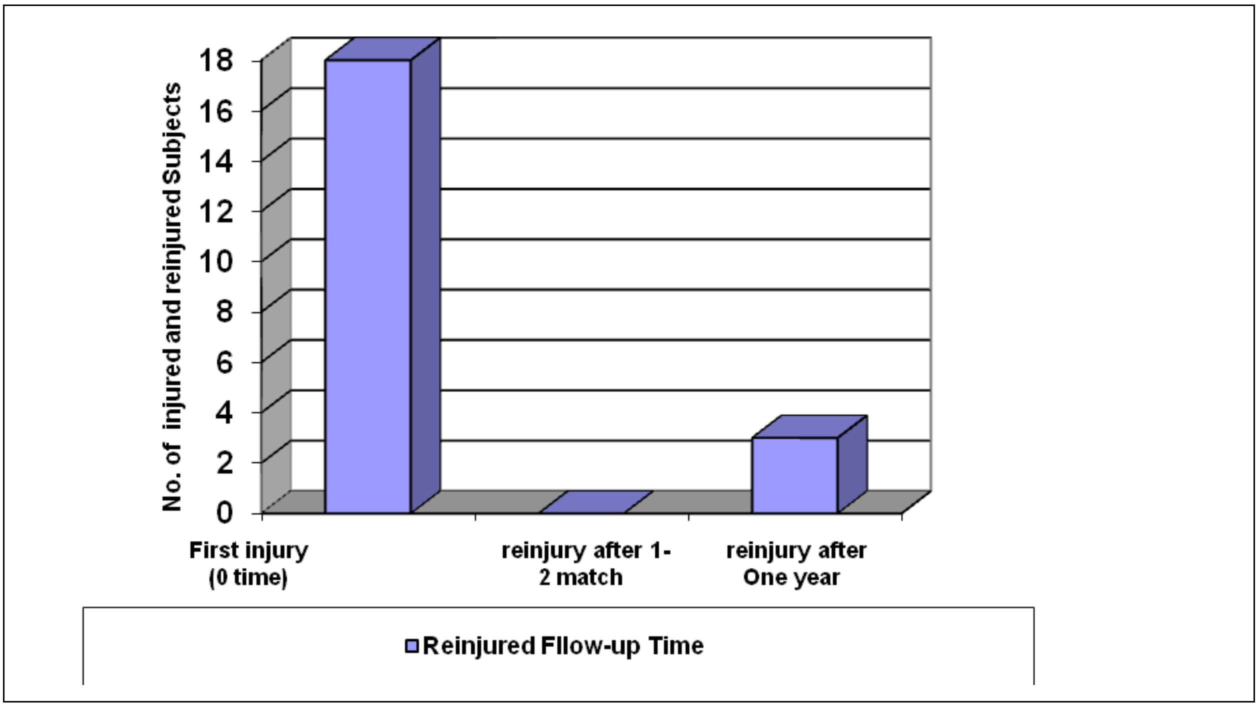

Table (5)
Analysis of functional testing between all subjects after rehabilitation from the 1st injury and three subjects who were reinjured after one year of return to competition.

Test	All subjects after rehabilitation			Three reinjured subjects		P*
	Range	Mean±SD		Range	Mean±SD	
Hop for height injured leg (cm)	23.0-37.0	32.5±3.5		28.0-34.0	30.3±3.2	0.340
Hop for height uninjured leg(cm)	29.0-37.0	32.7±1.9		32.0-35.0	33.7±1.5	0.448
Hop for height 2 legs (cm)	34.0-39.0	35.9±1.6		36.0-36.0	36.0±0.0	0.893
Hop for distance injured leg (m)	1.9-2.3	2.1±2.1		1.8-2.1	2.0±0.2	0.395
Hop for distance uninjured leg (m)	2.0-2.6	2.2±0.2		2.0-2.2	2.1±0.1	0.250
Hop for distance 2 leg (m)	2.1-2.8	2.3±0.2		2.1-2.3	2.2±0.1	0.268
3 - hop crossover test injury leg (m)	5.3-8.6	6.6±0.8		6.0-7.9	6.7±1.1	0.890
3 - hop crossover test uninjured leg (m)	5.7-8.6	6.7±0.9		5.9-7.7	6.6±1.0	0.869
40 - yard sprint (sec.)	3.7-5.9	5.1±0.6		4.2-5.0	4.5±0.5	0.146

***p(probability) value based on independent samples t test**

The recurrence of injury in three subjects towards the end of the year after returning to completion was not considered for rehabilitation in this study. However, their performance data in the original functional tests after the rehabilitation following the 1st injury was retrieved and compared with the performance data of the 18 subjects in the functional tests after rehabilitation (Table 5). This comparison showed no significant difference between them in any of the tests performed.

Discussion

The study focused on measuring movement functions as indicators of the effectiveness of the suggested rehabilitation program. Comparisons were made between injured and un-injured limbs of the injured subjects, and between injured and un-injured subjects. It would have been interesting to compare the effectiveness of the suggested program with another, however limited resources and the small number of subjects were the obstacles. The data in Table 1demonstrates that the subjects addressed in this study are of similar demographical characteristics. Therefore, their injuries were not relevant to the specific variations among them. As was described by (Verrall et al., 2006, and Woods et al., 2004), subjects were considered to have a hamstring strain if they had an injury likely leading to strain injury of hamstring muscles, tenderness to palpation within the muscle tendon unit of the hamstring, pain with resisted prone knee flexion, pain with passive tension testing using a passive straight leg raise test.

Hamstring muscles injury most commonly occurs due to a high-force lengthening contractions at the hamstrings muscle tendon junction or anywhere between the origin and insertion, and results in pain and tissue damage. Table 2 shows that the nine subjects with 2nd degree injury included the three left-legged subjects who were injured in their left leg, and resulted in a much greater number of subjects with left leg injury of this group of players as compared to the other group of the 1st and 2nd injuries. Most injuries occurred in the middle area of the muscles, with tendency for the occurrence of upper muscle injury in the 1st degree, and for the occurrence of lower muscle injury in the 2nd degree injury. It was reported that muscle activity is highest during the late swing phase of sprinting, when the hamstring muscles work eccentrically to decelerate the forward movement of the leg, as well as during foot-strike, in the transition from eccentric to concentric muscle action (Jonhagen et al., 1994, and Yu et al., 2008), or due to inadequate muscle strength (Yamamoto, 1993,Jonhagen et al., 1994, and Woods et al., 2004)), imbalance in the hamstring to quadriceps strength ratio or side-to-side imbalances (Yamamoto, 1993). This may be a result of the game becoming physically demanding, with higher speed and intensive play (Tumilty,1993, and Thelen et al., 2006). However, the exact causes of HSIs remain unknown, but it is believed that these factors and more interact to varying degrees depending on the injurious activity type (Ekstrand et al., 2012).

The highest causes of injuries (44.44%) causing HSMIwas found duringin sprinting-and-stop, and sprinting-and-make 3-4 steps (Figure 1). This finding was similar to that reported by Arnason et al., 1996, and Woods et al., 2004. They found that muscle activity is highest during the late swing phase, when the hamstring muscles work eccentrically to decelerate the forward movement of the leg, as well as during foot-strike, in the transition from eccentric to concentric muscle action (Jonhagen et al., 1994, and Yu et al., 2008). The less causes of injuries (27.8%) found during acceleration, can be explained by the high eccentric forces and moderate muscle strain placed on the hamstrings during running. Lesser frequent causes are plant-and-kick and slip-and-fall which were of equal frequency (11.1%). Stretching was the least frequent causes (5.6%) among all causes occurred in this study. However, the exact causes of these remain unknown.

The rehabilitation program was designed to increased high intensity interval anaerobic training “training as the game is played”, especially in Phases III. Electrotherapyin Phase Iwas conducted toimprove and stimulatethe return of blood through the veins disrupted by the trauma, and enables the lower limb to be rested. This makes it possible to work the leg through light muscular contractions.

Phase II of the rehabilitation program appeared to control the early range of motion for dynamic activities by controlling the direction of movement. Frontal plane movements is not known to increase the length of the hamstring muscle tendon unit as much as sagittal plane movements. This potentially allows early loading of the injured tissue and return of quick movements without overstressing the healing tissue (Petersen et al., 2011). Orchard and Best (2002)suggest early loading of muscle tendon unit to avoid secondary atrophy, and simultaneously being careful to avoid overstressing the scar tissue(Orchard and Best, 2002). As a result of the exercises with variable speeds and direction resulted in an improved efficiency of anaerobic muscles working on the lower end and behind the thigh muscles. This also allows the lower-extremity muscles to function at a higher velocity while maintaining a protected range of motion (Petersen et al., 2011).

PhaseIIIis the functional phaseof the rehabilitation program that emphasize increasing the amountof high intensity anaerobic interval training (simulating the requirements of sportitself). The purpose of this program was to increase maximal range of motion through systematic stretching over time. It also involved development of a specific football training exercise undertaken with the athlete in a position of trunk flexion and encouraged the athlete to undertaken passive isometric stretching exercise with the hamstring muscle in a relatively fatigued state (Verrall et al., 2006). The high intensity interval anaerobic training that more accurately reflected match playing conditions, stretching whilst the muscle was fatigued and the implementation of sport specific training drills was implemented. Jull and Richardson (Jull & Richardson,1994)have hypothesized that the ability to control the lumbopelvic region during higher-speed skilled movements may prevent hamstring injury, as it would enable the athlete to better cope with the running stressors encountered during the game situation.

Hamstring injures often result in significant recovery time, along with a lengthy period of increased susceptibility for recurrent injury (Mjölsnes et al., 2004, Tumilty, 1993, and Verrall et al., 2006). Because of the prolonged recovery time associated with this type of injury, correct diagnosis, based on history and palpation and adequate information to the subject are essential (Askling et al., 2008). In this study, the specific rehabilitation program took 24-61 days according to the severity of injury over three Phases, I, II, and III (Table 3). Phase III took almost twice as long time (50.5±10.5 days) as was required for Phases I and II (31.5±7.5 days).In another study, players missed up to a few weeks of participation (Sullivank et al., 2008), ranging from 9 to 104 weeks before returning to competition; not without being especially at risk (Askling et al., 2008). It was also found that the actual times to return to pre-injury level of performance for sprinters were 16 weeks, ranging from 6 to 50 weeks(Askling et al., 2006).

At whatever cost, subjects were not allowed to return to competition before a full recovery is reached. Previous studies showed that immediate return of football players after recovery from HMSI results in weakens performance, and exposure to recurrence of injuries (Tumilty, 1993).The risk of recurrence causes is the main problem for stakeholder including coaches, players, rehabilitation specialist, and club managers alike. The ability to treat these injuries effectively is critical to helping athletes return to their previous level of activity without putting them at risk for re-injury (Ali & Leland, 2012). The rehabilitation program was shown to prevent hamstring reinjures by improving hamstring muscle conditioning and developing increased fatigue resistance. This was demonstrated by subjecting rehabilitated subjects to functional testing prior to returning to competition revealed a complete recovery of the players (Table4).Functional testing of the 18 subjects following the completion of the rehabilitation program showed that the players could perform 90-100 % of the test values of the uninjured leg. Basedon these results, subjects were allowed to return to competition, and the non-occurrence of injuries for a the first eight months, immediately after returning to competition, inFigure 2 is a further evidence of a successful specific rehabilitation program.

The comparison presented inTable 5shows no significant difference between the performance data of three reinjured subjects in the original functional tests after the rehabilitation following the 1st injury as compared with the performance data of the 18 subjects after rehabilitation. Despite, it is reported that previously injured players have more than twice as high a risk of sustaining a new hamstring injury (Engebretsen et al., 2010), this study shows no inferior fitness of the reinjured subjects to the fitness of the subject group, indicating no repeating of injury and no relevance of the re-injury to the original injuries addressed in this study. The high rate of reported recurrent injuries suggests that our current understanding of HMSI and re-injury risk is incomplete(Oparetet al., 2012). The prevention of recurrence of injury upon return to competitions should remain subject to the ability of natural performance of the functional tests.

The effectiveness of this program is justified by the complete restoration of target movement functions that were affected by the injury, the aim being to regain muscle strength, flexibility, and function judged by the subject’s movement patterns(stand, walk, jog, fast-run, sprint, change of direction) for all positions subsequent to the suggested rehabilitation program. As reported by Jeffreys (2006), measuring movement functions offers key measures that ultimately decide the success of the rehabilitation program. Through our study, we felt movement measures provided good indicators of readiness for sports. This suggests that the program offers an expansion to other reported programs which can be further tested on a larger group, and perhaps compared with other programs.

Measuring the strength imbalance between agonists and antagonists muscles was not possible due to the lack of measuring devices, in clubs or colleges of physical education in Egypt. From that point, we recommended that there should be an effort made for the provision of modern measuring devices to measure the strength imbalance in future studies.

Conclusion

The effective rehabilitation and prevention of HMSI of football playershave been challenging prepositions. In this article, we have shown a full recovery of for the Egyptian football playersfollowing a proposed specific rehabilitation program consisting of football-specific drills,high intensity interval anaerobic training, agility exercises with ball,complex exercises with ball, games skills exercise, and small games with the team. Progressive games with the team was essential inthe prevention re-injury of HMSI andinhelping players return to their previous level of the functional profile without putting them at risk for future injury. We believe that the success of the safe return to competitions does not depend on the length or short duration of rehabilitation, but the efficiency of the program in restoring motor functions that have been affected, according to the degrees of injury. The results of this study provide evidence that the risk of re-injury can beminimized or even eliminated by utilizing rehabilitation strategies that incorporate neuromuscularcontrol exercises and eccentric strength training, combined with objectivemeasures to assess musculotendon recovery and readiness to return to competitions.

Acknowledgment

I wish to thank Prof. HamdiK. Kaream for performing the diagnosis of injuries and providing the physiotherapy for the subject injured players in his own clinic and thank Captain Mushir Osman the technical coach of the Olympy and Smouha Clubs for his participation in the analysis of the causes of injury. I also wish to thank Dr. ShehataFarag of the Institute of Health for conducting the statistical analysis. Last but not least, I would like to thank the injured players participating in this course of study.

References

1. Ali K. and Leland JM., 2012: Hamstring strains and tears in the athlete, Clinical Sports Med., 31(2):263-272

2. Arnason A., Andersen TE., Holme I., Engebretsen L., and Bahr R., 2008: Prevention of hamstring strains in elite soccer: an intervention study, Scand. J Med Sci. Sports, 18:40-45

3. Arnason A.,Gudmundsson A., Dahl HA.,and Johansson E., 1996: Soccer injuries in Iceland, Scand, J Med. Sci. Sports, 6: 40–45

4. Arnason A., Sigurdsson SB.,Gudmundsson A.,Holme I.,Engebretsen L.,and Bahr R., 2004: Risk factors for injuries in football, Am. J Sports Med., 32: 5S -16S

5. Askling C.,Saartok T., and Thorstensson A., 2006: Type of acute hamstring strain affects flexibility, strength , and time to return to per-injury level, Brit. J Sports Med., 40(1): 40-44

6. Askling C.,Tengvar M.,Saartok T. and Thorstensson A., 2008: Proximal hamstring strains of stretching type in different sports, injury situations, Clinical and magnetic resonance imaging share characteristics, and return to sport. Am. J Sports Med., 36(9)1799-1804

7. Bennell K., Tully E.,and Harvey N., 1999: Does the tort-ouch test predict hamstring injury - Australian rules footballers? Aust. Physiotherapy, 45: 103-109

8. Chumanov ES.,Heiderscheit BC.,and Thelen DG., 2011: Hamstring musculotendon dynamics during stance and swing phases of high-speed running, Med. Sci. Sports Exerc., 43(3): 525-532

9. Craig TT., 1973: Comments on sports medicine, Chicago, USA, Am. Med. Assoc.

10. Ekstrand J., Healy JC.,Waldén M., Lee JC., English B., andHägglund M., 2012: Hamstring muscle injuries in professional football: the correlation of MRI findings with return to play, Br. J Sports Med., 46(2): 112-117

11. Engebretsen AH.,Myklebust G.,Holme I.,Engebretsen L.,and Bahr R., 2010: Intrinsic risk factors for hamstring injuries among male soccer players. A prospective cohort study, Am. J Sports Med., 45(2): 112-117

12. Feeley BT.,Kennely S., Barnes RP., Muller MS., Kelly BT., Rodeo SA., and Warren RF., 2008: Epidemiology of National Football League training camp injuries from 1998 to 2007., Am. J Sports Med. 36(8) : 1597-1603

13. Haqqland M., Walden M.,and Ekstrand J., 2008: Lower re-injury rate with a coach–coach controlled rehabilitation program in amateur male soccer: a randomized controlled trial, Aus. J Physiotherapy, 54(1): 74 – 82

14. Heiderscheit BC., Sherry MA.,Silder A.,Chumanov ES.,and Thelen DG., 2010: Hamstring strain injuries: recommendations for diagnosis, rehabilitation, and injury prevention, J Orthop. Sports Physith., 40(2): 67-81

15. Holmich P. and Uhrskou Pulpits, 1999: Effectiveness of physical training as treatment for long–standing adductor–related groin pain in athletes: randomized trial, Lancet, 353: 439-443

16. Jeffreys I.,2006: A motor development approach to enhancing agility Part One. Strength and Conditioning J, 28 (5). 72-76.

17. Jonhagen S., Nemeth G., and Eriksson E., 1994: Hamstring injuries in sprinters. The role

of concentric and eccentric hamstring muscle strength and flexibility. Am J Sports Med.,22:262–266

18. Jull GA.,and Richardson CA., 1994: Rehabilitation of active stabilization of the lumbar spine in: Twomey LT. Taylor JR. e.ds. Physical therapy of the low back. clinician physical therapy 2nd Ed. London U.K: Churchill Livingston, 251 – 271

19. Levine WI.,Bergfeld JA.,Tessendorf W.,and Moorman CT., 2008: 3rd intramuscularly corticosteroid in the National Football league, Am. J Sports Med., 28: 297-300

20. Mjölsnes R.,Amason A.,and Osthogen T., 2004: A 10-Week randomized trail comparing eccentric vs. concentric hamstring strength in well trained soccer players, Scand. J Sci. Med. Sports, 14(5) 31–37

21. Opar DA., Williams MD., and Shield AJ., 2012:Hamstring strain injuries: factors that lead to injury and re-injury, Sports Med., Mar 1;42(3):209-226

22. Orchard J. and Best TM., 2002: The management of muscle Strain injuries, an early return versus the risk of recurrence, Clin. J Sport Med., 12: 3-5

23. Petersen J.,Thorborg K., Nielsen MB.,Budtz-Jørgensen E.,and Hölmich P., 2011: Preventive effect of eccentric training on acute hamstring injuries in men's soccer: A cluster-randomized controlled trial, Am. J Sports Med., 39(11): 2296-2303

24. Sherry M. and Best TM, 2004: A comparison of two rehabilitation programs in the treatment of acute hamstring strains, J Orthop. Sports Physioth, 34: 116-125

25. Slavotinek JP.,Verrall GM.,and Fon GT., 2002: Hamstring injury in athletes the association between MR measurements of the extent of muscle injury and the amount of time lost from competition, Am. J Roenlgenol., 179: 1621-1628

26. Sullivank O., Ceallaigh BO., Connell KO.,and Shafat A., 2008: The relationship between previous hamstring injury and the concentric is kinetic knee muscle strength of Irish Gaelic Footballers, BMC Musculoskeletal Disord., 6: 9-30

27. Thelen DG.,Chumanov ES., Sherry MA.,and Heiderscheit BC., 2006: Neuromuscular skeletal models provide insights into the mechanisms and rehabilitation of hamstring strains. Exerc. Sport Sci. Rev., 34(3): 135-141

28. Tumilty D., 1993: Physiological characteristics of elite soccer players, Sports Med., 16: 80–96

29. Twomey LT. and Taylor JR., 1994: Physical therapy of the low back, clinician physical therapy 2ed Ed., London U.K, Churchill Livingston, 251–271

30. Verrall GM.,KalairgiahY.,Slavotinek JP.,and Sprigging AJ., 2006: Assessment of player performance following return to sport after hamstring muscle strain injury, J Sci. Med. Sport, 9(1-2): 81–99

31. Woods C., Hawkins R.,Maltby S.,Hulse M., Thomas A., and Hodson A., 2004: The football association medical research program: An audit of injuries in professional football –analysis of hamstring injuries, Br. J Sports Med., 38: 36–41

32. Worrell TW., 1994: Factors associated with hams tiring injuries. An approach to treatment and preventative measures, sports Med, 17: 338-345

33. Yu B., Queen RM., Abbey AN.,Liuy Moorman CT., and Garrett WE., 2008: Hamstring muscle kinematics and activation during over ground sprinting, J Biomech., 41(15) : 312-316