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RESEARCH ARTICLE

Comparison of The Effects of Nordic Hamstring and Single Leg Deadlift Exercises on Hamstring Muscle Strength and Extremity Symmetry Index: An Experimental Study

Nordic Hamstring ve Single Leg Deadlift Egzersizlerinin Hamstring Kas Kuvveti ile Ekstremite Simetri İndeksine Etkisinin Karşılaştırılması: Deneysel Çalışma

Hasan Aka[1], Serkan İbiş[1], Zait Burak Aktuğ[1], Gönül Yavuz[2]

[1]*Faculty of Sports Sciences, Ömer Halisdemir Üniversitesi, Niğde, Türkiye*

[2]*Faculty of Sports Sciences, Sütçü İmam Üniversitesi, Kahramanmaraş, Türkiye*

ABSTRACT

Objective: The aim of this study is to compare the effects of 8-week Nordic hamstring exercise (NHE) and single leg deadlift exercise (SLDE) on hamstring (H) muscle peak torque (MPT), average power (AP) and extremity symmetry index (ESI).

Material and Methods: Thirty competetive male football players between the ages of 18-25 participated in the study. Participants were divided into three groups: control group (CG), Nordic hamstring exercise group (NHEG) and single leg deadlift exercise group (SLDEG). The participants' H muscle strength and ESI values were determined twice with the H-Bord device (IVMES, Türkiye), at the beginning of the training program and at the end of the eight-week program. Repeated Measures Two-Way ANOVA test was used to examine the results of different protocols, pre-post test measurements, and protocol*time interaction effect.

Results: A significant difference was found between CG and NHEG in both leg PT and mean power parameters in favor of NHEG. An improvement was determined in all groups in the right leg peak torque and average power parameters in favor of the post-test. In addition, a statistically significant difference was observed in the ESI parameter from the pre-test to the post-test only in NHEG.

Conclusion: Eccentric exercises NHE and SLDE are effective in improving H muscle strength with no significant differences.

Keywords: Nordic hamstring, extremity symmetry index, football, peak torque, average power

ÖZ

Amaç: 8 haftalık Nordic hamstring gzersizi (NHE) ile single leg deadlift egzersizinin (SLDE) hamstring (H) kası zirve tork (ZT), ortalama güç (OG) ve ekstremite simetri indeksi (ESİ) üzerine etkisinin karşılaştırılmasıdır.

Gereç ve yöntem: Çalışmaya 18-25 yaşları arasında 30 lisanslı erkek futbolcu katılmıştır. Kontrol grubu (KG), Nordic hamstring egzersiz grubu (NHEG) ve single leg deadlift egzersiz grubu (SLDEG) olmak üzere üç gruba ayrılmıştır. H kas kuvveti ve ESİ değerleri antrenman programının başlangıcında ve sekiz haftalık programının sonunda olmak üzere iki kez H-Bord cihazı ile belirlenmiştir.

Bulgular: Verilerin analizinde, farklı protokollerin sonuçlarını, ön-son test ölçümlerini ve protokol*zaman etkileşim etkisini incelemek için, Tekrarlanan Ölçümler iki yönlü ANOVA testi kullanılmıştır. Her iki bacak zirve tork ve ortalama güç parametrelerinde KG ile NHEG'u arasında NHEG lehine anlamlı fark belirlenmiştir. Sağ bacak zirve tork ve ortalama güç parametrelerinde bütün gruplarda son test lehine bir gelişim belirlenmiştir. Ayrıca ESİ parametresinde sadece NHEG'da ön testten son teste istatistiksel olarak anlamlı farka rastlanılmıştır.

Sonuç: H kas kuvvetinin geliştirilmesinde eksantrik egzersizlerden NHE ve SLDE'den bir tanesinin tercih edebileceği, bu egzersizler arasında anlamlı bir farkın olmadığı söylenebilir.

Anahtar Sözcükler: Nordic hamstring, ekstremite simetri indeksi, futbol, pik tork, ortalama güç

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Correspondence: Gönül Yavuz · gonulyavuz@ksu.edu.tr

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INTRODUCTION

Hamstring (H) muscle strength plays an important role in providing knee joint stabilization, as well as directly affecting sports performance parameters such as agility, acceleration, deceleration, and change of direction [1,2]. Especially in team sports, low H muscle strength or insufficient activation increases the risk of injury such as anterior cruciate ligament and H muscle tears, along with other factors, as well as performance losses [3-8]. It has been shown that the most important preventive exercises in minimizing these injuries occurring in the H muscle are eccentric strength exercises and balance/proprioception exercises [9].

It has been shown that coaches ignore eccentric strength training and focus more on concentric strength training, In recent years, eccentric exercises, such as Nordic hamstring (NH) and single leg deadlift (SLD) exercises, which can be applied anywhere and do not require any equipment are included in strength training. There are studies indicating that NHE [10-12], and SLDE [13,14] both provide improvement in H muscle strength. However, the limited number of studies comparing the hamstring muscle peak torque (MPT), average power (AP), and ESI effects of these two exercises, as well as the lack of studies using devices that directly measure eccentric hamstring muscle strength, constitute the originality of our study.

MATERIAL AND METHODS

Participants

It was estimated that the 219±38 power value would be 243 with a 10% difference and calculated with 5% error and 80% power in the G*power 3.1.9.2 program and it was found that at least 24 people should participate in the study. 30 male participants who had no history of lower extremity injuries were included in the study (Table 1). Informed consent form was obtained from the participants. The necessary permission was obtained from the Nigde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee for the study to be conducted (Ethics Committee Decision Number: 2022/08 Date: 17-01-2022). This study was conducted in accordance with the Helsinki Declaration 2008 Principles.

Table 1. Characteristics of the participants

	NHEG	SLDEG	CG
Age (year)	17.90±.994	17.60 ± .699	18.00 ± .816
Height (cm)	170.2±8.753	172.80 ± 9.23	170.40 ± 9.547
Body weight (kg)	59.50±11.14	60.70 ± 6.49	61.00 ± 6.798

Research Design

Participants were randomly divided into three groups: the control group (CG) that did not perform any exercise other than soccer training, the Nordic hamstring exercise group (NHEG) that performed Nordic hamstring exercise in addition to soccer training, and the single leg deadlift exercise group (SLDEG) that performed single leg deadlift exercise in addition to soccer training. While all groups performed the same training with the soccer team 5 days a week, SLDEG and NHEG performed the specific exercise programs 3 days a week for 8 weeks in addition to soccer training immediately after warming up at the beginning of soccer training. All participants' H muscle MPT, AP, and ESI parameters were measured twice, before starting the exercise protocols and 8 weeks after the first measurements.

H Muscle Strength Measurement

The participants' H eccentric muscle strength was evaluated with H-Bord device (IVMES, Ankara, Turkey) [15]. The participants' ankles were fixed with tapes, and they started the movement on both knees of the H Board device, with the body in the same plane as the knees, in a straight and crossed position with the arms in front. Then, the participant slowly let himself go forward without changing his position, with the body in the same plane as the knees, with the knees fixed on the mechanism, and continued the movement until the last point he could reach in this position. While this movement was applied, the MPT as AP parameters of both leg H muscle groups were measured in Newtons by means of sensors located at the points connected to the ankles of

the H-Board device [16]. The movement was performed twice with a 30-second interval and the best score in the study was obtained.

Nordic Hamstring Exercise

Participants commence the exercise in a kneeling posture, with the upper body from the knees upwards maintained in a rigid and aligned manner. The training partner guarantees that the participant's feet remain in contact with the ground throughout the duration of the exercise by exerting pressure on the participant's heels or lower legs. Subsequently, the participant descends the upper body towards the ground as gradually as feasible to optimize loading during the eccentric phase. The hands and arms are employed to mitigate the forward descent and to assist in elevating the body after the chest has made contact with the ground, thereby reducing loading during the concentric phase.

The participants performed the NHE in the 1st week, 2 sets of 8 repetitions; in the 2nd week, 2 sets of 10 repetitions; in the 3rd week, 2 sets of 12 repetitions; in the 4th week, 3 sets of 10 repetitions; Weeks 5-8 were applied as 3 sets of 12 repetitions with 2 minutes of rest between repetitions [16].

Single Leg Deadlift Exercise

To begin, the athlete stood on one leg with the core stabilized. In the descending phase, the knee joint of the loaded leg was slightly flexed, and the hip joint flexed while keeping the spine neutral. The hip and knee joints of the unloaded leg are maintained in extension, and the body is tilted so that the spine is parallel to the floor as much as possible. The distance of the athlete's movement depends on the athlete's flexibility of

the hamstrings. Once the lowest point of the movement was reached, the athlete returned to the start position-while contracting the hamstrings and gluteus maximus muscles. The athletic trainer instructed the athletes to avoid spinal movement, hip rotation, and abduction of the loading leg during the SLRDL [17,18]. The exercise was applied to both extremities.

The participants performed the SLDE in the 1st week, 2 sets of 8 repetitions; in the 2nd week, 2 sets of 10 repetitions; in the 3rd week, 2 sets of 12 repetitions; in the 4th week, 3 sets of 10 repetitions; Weeks 5-8 were applied as 3 sets of 12 repetitions with 2 minutes of rest between repetitions.

Statistical Analysis

In this study, the assumption of normal distribution of quantitative variables was examined with visual (histogram and probability plots) and analytical (Shapiro-Wilk Test) methods. Quantitative variables were expressed as mean and standard deviation since they showed normal distribution. Repeated Measures two-way ANOVA test was used to examine the results of different protocols (CG, NHEG, SLDEG), pre- and post-test measurements, and protocol*time interaction effect. Mauchly sphericity test was used to test the homogeneity of variances and Greenhouse-Geisser correction was applied when necessary. Partial eta squares (ηp2) were calculated for the magnitude of the effect between the groups. When statistically significant differences were detected between the study protocols, multiple comparison analyses were performed using the Tukey method. $p < 0.05$ was considered significant.

RESULTS

A statistically significant difference was found in the right leg peak torque (F=20.68; p=0.000, eta=0.48) and right leg average power (F=29.42; p=0.000, eta=0.52) parameters from pre-test to post-test in all groups. A statistically significant difference was found in the left leg peak torque (F=19.10; p=0.000, eta=0.41) and left leg average power (F=24.45; p=0.000, eta=0.47) parameters from pre-test to post-test in CG and NHEG. A statistically significant difference was found in the ESI (F=8.96; p=0.006, eta=0.424) parameter from pre-test to post-test in NHEG. There was a statistical difference between the groups in the parameters of right leg peak torque (F=10.11; p=0.001; eta=0.45), left leg peak torque (F=9.38; p=0.001; eta=0.41), right leg mean power (F=10.56; p=0.000; eta=0.43) and left leg mean power (F=9.56; p=0.001; eta=0.41). In the Benforroni correction, this difference was determined in favor of NHEG compared to CG.

Table 2. Intra-group and inter-group comparison table

n=32	Pre	Post	Δ	%	Two-way Repeated ANOVA			
Variable	M±SD	M±SD	T_B-T_{end}	T_B-T_{end}	Time	Group	Time*Group	Tukey
Right Leg Peak Torque (W)								
CG	144.60±40.84	176.10±36.23*	31.50±4.61	21.78	F = 20.68 p < 0.000 η_p^2 = .43	F = 11.10 p < 0.000 η_p^2 = .45	F = 18.15 p < 0.027 η_p^2 = .00	NHEG>CG
NHEG	237.10±49.97	268.70±64.00*	31.60±14.03	13.32				
SLDEG	191.00±50.35	219.20±38.42*	28.20±11.93	14.76				
Left Leg Peak Torque (W)								
CG	146.60±35.19	182.70±44.77*	36.10±9.58	24.62	F = 19.10 p < 0.000 η_p^2 = .41	F = 9.38 p < 0.001 η_p^2 = .41	F = 1.05 p < 0.364 η_p^2 = .07	NHEG>CG
NHEG	237.70±41.03	265.20±51.77*	27.50±10.74	11.56				
SLDEG	197.30±62.49	212.30±46.49	15.00±16.00	7.60				
Right Leg Average Power (W)								
CG	131.80±31.76	163.20±29.91*	31.40±1.85	23.82	F = 29.42 p < 0.000 η_p^2 = .52	F = 10.56 p < 0.000 η_p^2 = .43	F = .89 p < 0.915 η_p^2 = .07	NHEG>CG
NHEG	218.70±50.22	254.60±61.80*	35.90±11.58	16.41				
SLDEG	179.60±53.78	209.50±42.13*	29.90±11.65	16.64				
Left Leg Average Power (W)								
CG	133.80±27.66	168.80±39.77*	35.00±12.11	26.15	F = 24.45 p < 0.000 η_p^2 = .47	F = 9.56 p < 0.001 η_p^2 = .41	F = .72 p < 0.494 η_p^2 = .05	NHEG>CG
NHEG	219.30±37.37	248.70±48.10*	29.40±10.73	13.40				
SLDEG	182.00±62.94	200.70±4.90	18.70±17.04	10.27				
Extremity Symmetry Index (%)								
CG	100.01±11.36	102.18±9.53	2.11±1.83	2.16	F = 8.96 p < 0.006 η_p^2 = .24	F = 1.35 p < 0.275 η_p^2 = .09	F = .92 p < 0.408 η_p^2 = .06	
NHEG	92.54±8.68	100.76±5.85*	8.22±2.83	8.88				
SLDEG	98.39±7.01	104.59±9.75	6.20±2.74	6.30				

*Δ= change; Pre= preintervention; Post= postintervention; η_p^2: Kısmi eta kare; * There is a significant difference between the pre-test and post-test values (p<0.05 level); CG= Control Grubu; NHEG= Nordic Hamstring Exercise Group; SLDEG= Single Leg Deadlift Exercise Group*

DISCUSSION

Athletes competing in team sports such as football, which are inherently hard and have a lot of dual combat, have a high risk of injury [19-21]. These athletes are most exposed to knee injuries (31.8%) and H injuries (12-16%) in the lower extremity [20, 22-24]. H injuries, which cause performance losses, are characterized by acute pain in the posterior thigh due to damage to the H muscle fibers [25]. Therefore, it is thought that improving the H muscle strength of athletes is of vital importance for coaches and athletes. Studies on H muscle strength, which is an important variable in both maximizing performance and preventing injuries in athletes, have also indicated that there is an improvement in H muscle strength and a decrease in injuries as a result of NHE and SLDE exercises applied to adult athletes [10-12]. Petersen et al. stated in their study on football players that NHE increased H strength development and also reduced the risk of H injuries [26]. Similarly, Askling et al. and Arnason et al. stated that NHE was the most effective exercise in increasing H muscle strength and preventing H injuries [10,27]. Ono et al. found that the other exercise method used in our study, SLDE, increased H muscle strength and reduced the risk of H injuries [13].

Hegyi et al. applied the NHE and SLDE exercises to 12 male participants and reported that the loads applied to the long head of the biceps femoris and the semitendinosus muscles during these exercises were not the same [28]. Another study examined the effects of SLDE and NHE applied for 6 months on isokinetic H strength, H/Q ratio, and H muscle architecture, and as a result of the study, it was determined that only SLDE had positive effects on H muscle hypertrophy, H muscle strength and H/Q ratio [13]. This different result presented by Ono et al. may be due to the fact that the exercise programs they applied in their study were applied for a much

longer period than our study, such as 6 months, and the frequency and number of repetitions in the exercise protocols had different contents [13]. Another study investigated the effects of NHE and SLDE on fatigue in the H muscle after repeated sprinting. As a result of the study, it was determined that SLDE is an effective exercise to reduce the effects of fatigue and protect against H injuries, and it was also determined that the strength increase was higher in SLDE [14].

Although some of the above-mentioned studies show that NHE is more effective in developing H muscle strength, and some show that SLDE is more effective, there is no consensus on which exercise provides better outcomes. In our study, although the H muscle strengths of the groups increased, but contrary to the studies in the literature, no difference was found between SLDEG and NHEG.

Limiting the sample to male football players competing in amateur league represents a limitation of the present study.

CONCLUSION

Athletes aiming to enhance their H muscle strength can opt for either SLDE or NHE, as both exercises facilitate similar improvements.

Ethics Committee Approval

The study was approved by the local ethics committee (approve date 17.01.2022 and number 2022/08) and performed according-to Helsinki declaration criteria.

Conflict of Interest

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions

Concept: HA, ZBA; design: HA, ZBA, GY; supervision: HA, ZBA, GY; materials: ZBA, GY; data collection and processing: HA, ZBA, Sİ; analysis and interpretation: HA, Sİ; literature review: HA, ZBA, GY; writing manuscript: HA, Sİ, GY; critical review: ZBA, Sİ. All authors contributed to the final version of the manuscript and discussed the results and contributed to the final manuscript.

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