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Original article

Acute effects of static and dynamic stretching exercises on isokinetic strength of hip flexion-extension in male handball players

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Summary. This study aimed to examine and compare the acute effects of static stretching (SS) and dynamic stretching (DS) on the hip flexor and extensor concentric (CON) isokinetic peak torque (PT) at 60°/s and 180°/s angular speeds in well-trained male handball players. A total of 14 male handball players (mean age 20.28±1.06 years; handball experience 11.50±1.45 years; height 180.64±6.34 cm; weight 73.35±6.60 kg; body mass index 22.49±1.90 kg/m2) who train at least 4 days a week, 120 min a day, were recruited in this study. Players were tested for hip flexor and extensor isokinetic PT at 60°/s and 180°/s angular speeds before and 4 min after three different stretching exercise sessions, namely, non-stretching (NS), SS, and DS, with 48-h rest intervals in a randomized crossover study design. Statistical analysis revealed that no significant difference ($p>0.05$) was observed among the stretching exercises in hip CON isokinetic PT values at 60°/s and 180°/s. The findings of our study are that SS exercises do not have a tension deficit in PT; DS exercises showed that PT did not increase the hip flexor and extensor CON isokinetic muscle movement more than SS exercises in male handball players. Based on previous studies, the findings suggest that athletes who are accustomed to static or dynamic stretching movements in male handball players may be less susceptible to stretch-induced power loss.

Key words: handball, static stretching, dynamic stretching, isokinetic strength

Introduction

Submaximal aerobic running is the main component of classical warm-up that increases the body temperature (1). Besides, SS is believed as an essential component in warm-up which degrade the risk of injury and improve performance (2). Although, latest researches stated that pre-exercise SS induced the performances of maximal strength output, jump height, sprint, agility compared to dynamic stretching (DS) (3). Negative effects of SS are based on neural variation such as changes in reflex sensitivity and induced motor unit activation as proofed by reductions in electromyography and mechanical factors (e.g., changes in muscle tendon unit stringency) (EMG) (4). Owing to the negative effects of SS previous to strength and power works, many researchers have proposed the DS exercise (5-7). Yamaguchi et al. (7) stated that development in muscle performance after DS could be related with two factors: the incident of post-activation potentiation (PAP) and the rise of muscle temperature. PAP includes the phosphorylation of myosin regulatory light chains, which improve actin–myosin interaction. This coaction is caused by the optional contraction of the muscle antagonist to target the stretched muscle (8).

Considering at the beginning and during the movement in sports, the explosive strength is highly important. Strength can extend the opponent's decision time as speed increases and increase the likelihood of making mistakes (9). Therefore, some researchers signified to a stretching protocol which will not cause reduces in strength performance. Power and condition trainers have perceived active and DS protocols to make the athletes ready for competitions (10, 11). Kim et al. (12) lined up with that measuring the extensor and flexor strength is a major indicator in observing training effects.

Conflicting results regarding the effects of SS and DS on isokinetic strength were also reported. Some scientists advocated the detrimental effects of SS on isokinetic strength (13-16), while others stated that after SS there were no strength isokinetic deficiencies (17-19).

In the light of these information about literature, the current study aimed to examine and compare the acute effects of SS and DS exercises on isokinetic strength of hip flexor and extensor CON isokinetic peak torque (PT) at 60°/s and 180°/s angular speeds in male handball players.

Materials and Methods

Participants

A total of 14 male handball players (mean age 20.28±1.06 years; handball experience 11.50±1.45 years; height 180.64±6.34 cm; weight 73.35±6.60 kg; body mass index 22.49±1.90 kg/m^2) who train at least 4 days a week, 120 min a day, were recruited in this study.

Study Design

The inclusion criteria were as follows: *(i)* age between 18 and 22 years, *(ii)* male gender, *(iii)* active handball player for at least 5 years, and *(iv)* received specific training period for handball for at least 12 weeks without interruption. The exclusion criteria were determined as follows: *(i)* history of orthopedic problems, such as gluteus maximus-medius-minimus, hamstring, piriformis, adductor magnus-longus-brevis, psoas, iliacus, sartorius, gracilis injuries; fractures, surgery, or pain in the spine or gluteus maximus-medius-minimus, hamstring, piriformis, adductor magnus-longus-brevis, psoas, iliacus, sartorius, gracilis muscles over the past 3 months, *(ii)* missing a testing session during the data collection period, and *(iii)* using ergogenic aid that would affect the isokinetic test. The participants were verbally informed about the study method used as well as the purpose and risks of the study, and written informed consent was obtained from all participants.

Experimental Protocol

Participants began with a 5-min standardized warm-up (cycling at 90 W at 60–70 rpm) for NS, SS and DS sessions.

Non-stretching (NS) session: Participants had no stretching exercises.

SS session: This session consisted of rear foot elevated, the couch, glute and sumo squat stretch exercises for 3×30 sec with 20 sec resting intervals between the repetitions in the same position. Each stretch was executed to the point of discomfort, which was subjectively determined.

DS exercises: This session consisted of straight leg kick, butt kick, groin and rear foot elevated stretch exercises. The participants were instructed to execute the exercises in a repetitive manner and as fast as they could. In this session, exercises were executed at each joint for 3×30 sec with 20 sec resting intervals between repetitions.

Isokinetic tests were performed before and after each stretching session.

Isokinetic testing

The study data were collected using a Cybex-Humac Norm-brand Isokinetic Dynamometer. Isokinetic tests were conducted according to the study of Manoel et al. (20). Tests included a total of 3 days with at least 48-h resting intervals. The order of NS, SS, and DS sessions was randomized for each participant in a crossover study design. The tests were applied in dominant leg for 60°/s and 180°/s angular speeds in a CON manner. Each session began with a 5-min standardized warm-up (cycling at 90 W at 60–70 rpm), then 2.5-min rest was given. The dynamometer's seat was positioned in the supine position with zero degree in every ankle before the test start. The participants who randomized systematically before, were subjected to pre-test. Then, participants performed applying NS, SS and DS sessions. 4-min rest was given. In tests which 3 sub-maximal trials were followed by 3 maximal efforts, 2-min of relaxation intervals were given between the angular speeds. The PT values of the participants were recorded as "Newton meter (Nm)" in all pre- and post-tests. Table 1 presents the detailed flowchart of the study.

Statistical analysis

The statistical analysis was initially performed using the "Shapiro–Wilk" normality test, and all variables presented with normal distribution. Therefore, statistical differences between the pre- and post-test at each session were evaluated using the "Paired t-test." Statistical differences among post-tests after three stretching exercises were evaluated using "Repeated Measures ANOVA" according to the 95% reliability. So findings are presented as descriptive analyses, ANOVA results and an alpha level of $p<0.05$ considered statistically significant for all analyses. All data analyses were conducted using the statistical package program.

Results

Table 1. Flowchart of the study

NS	SS	DS
	5 min submaximal warm-up 2.5 min resting 3 submaximal trial	
	60°/sec isokinetic pre-test	
	2 min resting 3 submaximal trial	
	180°/sec isokinetic pre-test	
No Stretching	**Static Stretching**	**Dynamic Stretching**
	4 min resting 3 submaximal trial	
	60°/sec isokinetic post-test	
	2 min resting 3 submaximal trial	
	180°/sec isokinetic post-test	
	Cool Down	

Table 2. Descriptive Statistics of Players' Demographic Information

	Minimum	Maximum	Mean	SD
Age (years)	18.00	22.00	20.28	1.06
Handball Experience (years)	9.00	14.00	11.50	1.45
Height (cm)	172.00	191.00	180.64	6.34
Weight (kg)	62.00	85.30	73.35	6.60
BMI (kg/m²)	18.48	25.89	22.49	1.90

Table 3. Comparison of Isokinetic PT at 60°/sec from Different Stretching Sessions

Stretching Type (Nm)	Test Sequence	Mean±SD	F	p
NS	Pre-test	281.34±8.88	10.09	.190
	Post-test	283.66±9.07		
SS	Pre-test	283.33±9.01		
	Post-test	281.63±8.08		
DS	Pre-test	298.70±8.54		
	Post-test	301.50±7.81		

Table 4. Comparison of Isokinetic PT at 180°/sec from Different Stretching Sessions

Stretching Type (Nm)	Test Sequence	Mean±SD	F	p
NS	Pre-test	186.14±22.51	8.33	.280
	Post-test	188.40±25.03		
SS	Pre-test	185.92±25.68		
	Post-test	184.00±24.20		
DS	Pre-test	191.92±23.70		
	Post-test	195.64±24.09		

Discussion

As the main findings of the current study were analyzed, SS exercises did not find stretch-related power deficit in PT, and DS exercises were not higher in handball players than SS exercises in increasing the hip joint CON isokinetic muscle strength. Prior to the study, we assumed that SS may have strain-related PT deficits in the hip joint at both angular velocities of 60 ° / s and 180 ° / s compared to DS. Based on the results of this study, we were unable to confirm our hypothesis due to the lack of previous studies describing the acute effects of SS and DS on hip flexor and extensor isokinetic PT in handball players.

For that reason, this study could support ours Kapo et al. (21). Researchers reported in their study that different and better results on PT at 60°/s and 180°/s in favor of DS compared with proprioceptive neuromuscular facilitation in 50 male athletes from different sports disciplines, such as karate, taekwondo, box, football, and athletic sprint.

Similar to the results of our study, Egan et al. (19) reported that SS did not affect the isokinetic PT at 60°/s and 300°/s angular speeds during any of the post-stretching intervals. In contrast with our study, ekir et al. (22) defined that SS significantly decreased the muscle strength in eccentric (ECC) and CON modes at 60°/s and 180°/s angular speeds in well-trained track and field athletes.

On the contrary, some researchers reported that SS exercises have generally no stretching-induced PT loses in muscles (4, 14, 17, 18). Ayala et al. (17) reported that short pre-exercise SS and DS of stretching routine do not elicit stretching-induced loses or improvements on isokinetic CON and ECC strength and power at different speeds (60°/s, 180°/s, and 240°/s). However, Marek et al. (15) and Miyahara et al. (13) reported different results than the previously mentioned studies. Marek et al. (15) reported that stretching-induced deficit in the strength of extension at 60°/s and 300°/s angular speeds. As reported, two factors have been proposed to explain the stretching-induced strength loses (19); first one is the mechanical factors associated with decreased musculotendinous stiffness that may alter the length–tension relationship and second one is the neural factors caused by decreased muscle activation.

We found that majority of the studies in the literature involved the effects of different stretching exercises on the isokinetic strength of the knee muscles. In this regard, results of the current study also suggested that differences in isokinetic ankle flexion and extension PT after NS, SS, and DS are not significant. Yamaguchi and Ishii (24) reported that the effect of 30-sec static stretching exercises on isokinetic strength was not found significant. Balcı (25) defined SS and DS exercises have no effect on the effect of concentric isokinetic strength. In a study examining the mechanomiographic responses of concentric isokinetic muscle contractions, it was concluded that the reduction-induced reduction in slow and fast angular velocities may not be velocity-specific (16). In addition, some researchers found that stretching exercises had no effect on force, and suggested that this was related to SS time and severity (26).

In previous studies, there are different findings on unknown effects of SS and DS on isokinetic power (27); however, these may be related to the duration and intensity of the SS exercise, the training or competitive experience level of athletes (19, 28) and the isokinetic test rates (29). Ayala et al. (17), the total SS duration per ≤60-90 s isolate muscle group may not have changes in strength and stress due to CON and ECC isokinetic muscle movements. In addition, well-trained athletes who are accustomed to static or dynamic movement actions as in handball may be less susceptible to the stretching-induced strength deficit. These results should only be considered in male handball players who can perform SS and DS prior to training and competition without strength loses (19, 22, 30).

The limitations of this study are: (a) failure to evaluate the effects of SS and DS through EMG. Therefore, the results are interpreted in the literature according to the findings of previous studies. (b) when conducting isokinetic tests, it was observed that players were familiar with low warm-up and tests and rested for a long time between stretching sessions and post-test. For this reason, more specific test protocols should be developed for this type of future research. (c) difficulty of positioning participants in the supine position and aligning the dynamometer axis with the large trochanter of the femur same as in the study of Zapporoli and Liberto (31). (d) small sample group limited results. Therefore, larger working groups may be needed.

Conclusion

According to the our findings and the results of similar studies supporting it, as the causes of changes in isokinetic PT parameters; It can be said that in sports activities, the application of the set numbers and stretching times higher than the normal ratios recommended in the literature and causing neurogenic inhibition in SS exercises and exhaustion in DS exercises. In addition, it can be considered that for a long time, a minimum effect on power performance is observed, but insufficient increase in blood parameters is observed. In sports, where slight positive increases, strength and performance differences affect the competitive outcome, it is recommended that stretching protocols applied in warm-up are performed according to the requirements of the related sports branch. In our study, considering the fact that short-term maximal loadings are related to force performance in a sport such as handball, where explosive strength and continuity in strength are combined with the flawless playing feature, these are recommended to do that mechanical and neuromuscular factors including the appropriate set numbers and stretching times to reach strong positive increase rates are considered.

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