Acute effects of static and dynamic stretching on the sprint and countermovement jump of basketball players

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Abstract

The aim of the present study was to compare the acute effect of static and dynamic stretching on countermovement jump (CMJ) and ten meters sprint performance for basketball players. Twenty semi-professional basketball players, 23.4 ± 0.5 yo, height 185.6 ± 2.8 cm, body mass 84.8 ± 6.2 kg, training age 10.4 ± 2.5 yr, performed a static (SS) and a dynamic (DS) stretching protocol in two different days, a week apart. Participants were randomly assigned to each protocol. Each session included: a) 10 min general basketball warm-up, b) initial evaluation of sprint and CMJ performance, c) five minutes static or dynamic stretching for the lower limbs, according to the protocol, and d) final evaluation of sprint and CMJ. The Photocells Powertimer 300 - PC Upgrade Kit and the jump mat (both from Newtest Powertimers, Oulu, Finland), were used for evaluating CMJ and sprint performance. Countermovement jumps with maximum effort were performed one minute after the intervention, with 30s recovery in between. Then athletes were asked to run 10 m with maximum speed. Athletes achieved better performance in both CMJ height and sprint time, with the DS protocol compared to the SS protocol. In conclusion, in sports of high strength and power demands, such as basketball, the use of dynamic stretching is preferable for its immediate effect on jumping and sprint performance.

Key Words: static stretching, dynamic stretching, sprint, countermovement jump, male basketball players

Introduction

Basketball is a dynamic team sport and one of the most popular sports worldwide. Numerous male and female athletes are involved in basketball training and all of them should develop motor skills at a high level, such as sudden feints, stops, sprint, jumps, agility and flexibility (Latin et al., 1994). Flexibility is a component of fitness and can be either static or dynamic. Static flexibility is usually defined as the ability to move a joint through a normal range of motion (ROM), whereas the ability to move a joint quickly with little resistance to the movement is defined as dynamic flexibility (Van Gyn 1984). In athletes, good flexibility has been proved to positively affect motor dexterity, all forms of motor performance, movement coordination, the precision of racing movements and allows force production through a greater range of motion for a longer time (Van Gyn, 1984). Good joint flexibility also contributes to the enhancement of jumping performance during both vertical and horizontal jumps through better contact of the feet on the ground and the benefit of countermovement of the muscles involved. In sprint, the normal length of the hamstring and iliopsoas muscles allows both longer stride as well as countermovement action, as the elastic energy stored in the tendons during the eccentric phase of the movement augments performance during the subsequent concentric phase (Cavagna et al. 1968, Bosco et al. 1982). On the other hand, warm-up applied to athletes prior to any sport activity is thought to contribute in performance improvement and probably in preventing musculoskeletal injuries (Bishop, 2003). Over the last decades, stretching exercises have been applied prior to exercise to prepare the athletes' body for the upcoming physical activity or competition, resulting in improved performance due to the increased range of motion, and also the reduction of musculoskeletal injuries (Safran et al. 1989, Shellock and Prentice 1985, Smith 1994). Thus, both athletes and coaches usually incorporate stretching exercises into the warm-up preceding nearly any athletic event (Gleim and McHugh 1997). A classical warm up generally includes low-intensity aerobic exercise, followed by a series of stretching routines, and finishes with a sport-specific component (Safran et al. 1989).

Although basketball coaches follow the aforementioned warm-up type, recent studies have examined the effect of static stretching during warm-up and found detrimental impact on performance (Faigenbaum et al. 2006, Fletcher & Monte-Colombo 2010, Pearce et al. 2009, Fowles et al. 2000, Power et al. 2004, Alikhajeh et al. 2012, Little & Williams 2006, Chaouachi et al. 2008, o Nelson et al. 2005, Sayers et al. 2008, Fletcher & Jones 2004, Gelen 2010, Needman et al. 2009, Winchester et al. 2008 Famisis 2015, Papadopoulos et al. 2015). Reductions on vertical jump performance, lower limbs' power (Faigenbaum et al. 2006, Fletcher & Monte-Colombo 2010, Pearce et al. 2009), muscle strength (Fowles et al. 2000; Power et al, 2004), power (Alikhajeh et al. 2012, Little & Williams, 2006), acceleration (Chaouachi et al. 2008, Nelson et al. 2005, Sayers et al. 2008)

and sprint (Alikhajeh et al. 2012, Chaouachi et al. 2008, Fletcher & Jones 2004, Fletcher & Monte-Colombo 2010, Gelen 2010, Needman et al. 2009, Sayers et al. 2008, Winchester et al. 2008, Famisis et al. 2015, Papadopoulos et al. 2015) have been previously reported as a result of static stretching.

Nowadays, more and more athletes incorporate dynamic stretching in their warm-up as recent research supports its positive effect on the joint range of motion when the exercises are performed through full kinematic range (Hedrick, 2000; Zakas 2005, Famisis et al. 2015). However, while dynamic stretching is considered to be beneficial for flexibility, its acute effect on ballistic sports performance, such as sprints and vertical jumps is not well determined. Currently, the majority of the studies have examined the effect of stretching type on either novice or adolescent basketball players. Although training status is a factor that may alter stretching effect on performance (Costa et al., 2009), there is limited information (Annino et al., 2015) about its effect on the performance of semi and/or professional basketball players. Considering that the majority of semi and/or professional basketball players apply static stretching during warm-up and dynamic stretching prior to a basketball match, it would be of great interest to investigate the effect of these different stretching types on vertical jump and sprinting which are essential components of basketball fitness (Latin et al. 1994).

The aim of the present study was to examine the acute effect of static and dynamic stretching exercises during warm-up on countermovement jump and sprint performance in semi-professional basketball players.

Methods

Participants

Twenty (20) semi-professional male basketball players volunteered to participate in the study which took place fifteen days after the end of the season. All participants were healthy and free of any musculoskeletal injury or disease and agreed to avoid heavy physical activity during the study period which was two weeks, one before and one during the study. Height and mass were measured with a Seca 789 scale (Seca, Hamburg, Germany). Basketball players' average age was 23.4 ± 0.5 yo, training age 10.4 ± 2.5 yr, height 185.6 ± 2.8 cm, body mass 84.8 ± 6.2 kg. An accredited sports medicine doctor examined each player physically before the beginning of the experiment. All testing procedures and possible risks and discomforts were fully explained in detail to participants before the start of the study. Each volunteer signed and was given a copy of a written informed consent prior to participation in the study. The study was conducted in accordance to the rules and regulation of the research Ethics Committee of the Aristotle University of Thessaloniki, Greece.

Procedures and stretching protocols All participants performed the following flexibility protocols in two different non-consecutive sessions. The two protocols were administered a week apart. The order of the protocols performed was randomly chosen so that the results would not be affected by the learning factor.

Static stretching (SS) protocol: The first flexibility protocol was performed by the SS experimental treatment group. It included: a) 10 min general basketball warm-up, b) initial evaluation of sprint and CMJ, c) static stretching for 5 min, and d) final evaluation of sprint and CMJ. Each stretching exercise was held for 10s at a terminal point of mild discomfort (feeling full stretching without pain) and was repeated twice for each muscle group (2 x 10s) with a 10s rest in between. For all stretching exercises the stretching positions were performed gently and slowly until the actual end-point of range. The working muscle groups were hamstrings, quadriceps, adductors, hip flexors and soleus. All stretches were performed on both sides. **Dynamic stretching (DS) protocol:** The second flexibility protocol was performed by the second experimental treatment group which was similar to the first, except for the stretching exercises which were executed dynamically in full kinematic range for the same muscle groups: hamstrings, quadriceps, adductors, hip flexors and soleus. Each exercise of the DS protocol was repeated for a total time of 10s, starting in small motion arc and increasing the arc in each repetition so that the last few were exaggerated (Sobel et al. 1995). The cycle was repeated twice for each muscle or muscle group (2 x 10s). All stretches were performed on both sides. The general basketball warm-up was low-intensity aerobic exercise, and included jogging with or without ball, with changes of running direction, as usually performed in the general part of the warm-up prior to a basketball match. The protocols took place in the basketball court by two experienced examiners. During the research, the same examiner was responsible for the same duties. Preliminary instructions on the implementation of each protocol and motivation in carrying out the sprint and jump test were given to all participants. All data collected were recorded in a special recording data protocol by the same examiner.

Running velocity test

Each participant performed two maximal trials of each test of 10 m sprint, with at least 2 minutes rest between trials. Best scores achieved were used for analysis. Photocells Newtest Power timer 300, (PC Upgrade Kit, FIN 90220 Oulu, Finland) were used for recording sprint time. Two pairs of photocells were placed within 10 m distance, as recommended by the manufacturer. The first pair (gate) was placed at the starting line (0 m) and the second (gate) at the finish line (10 m). Each basketball player started running from the upright position 50 cm before the first gate, and tried to reach maximum speed by the end cone, which was positioned 5 meters after the second gate to ensure avoidance of speed reduction before the end line of 10m. Photocells were positioned at a height of 80 cm from the ground as suggested by the manufacturer.

Countermovement jump Athletes' ability to produce force was assessed with a CMJ. Athletes were asked to jump as high as possible starting from a standing position with their arms on hips (akimbo). Three maximal CMJ were

performed on a jump mat (Newtest Powertimer 300 Oulu, Finland), one minute after the intervention, with 30s recovery in between. The highest jump was used for further analysis.

Statistical Analysis

Analysis of Variance (ANOVA) 2x2 with repeated measurements was applied for each dependent variable. Mean values and standard deviation were calculated. When significantly different values were found, a post hoc Scheffe test was applied to determine the statistical significance of the difference in the mean value. A criterion level of $p < 0.05$ was selected for all analyses.

Results

Counter Movement Jump

A significant effect of protocol ($F_{(1,19)} = 156.152$, $p < .001$) and a significant interaction of protocol x time ($F_{(1,19)} = 140.109$, $p < .001$) on CMJ was found. CMJ height was significantly reduced ($p < .01$) after the static stretching protocol while it was significantly augmented after the dynamic stretching protocol ($p < .01$) (Fig. 1).

Fig. Pre and post static and dynamic protocol CMJ height, * = $p < .001$

10 m sprint

A significant effect of protocol ($F_{(1,19)} = 116.762$, $p < .001$), time ($F_{(1,19)} = 15.115$, $p < .001$), and a significant interaction of protocol x time ($F_{(1,19)} = 144.382$, $p < .001$) on 10 m sprint was found. Sprint time was significantly reduced ($p < .01$) after the dynamic stretching protocol while it remained unchanged after the static stretching protocol ($p > .01$) (Fig. 2).

Fig 2. Pre and post static and dynamic protocol 10m sprint time, *= $p < .001$

Discussion

Stretching is a major component of the warm-up process for a basketball player before entering into a match. In addition, player must be able to perform maximum effort jumps and short distance sprints, as soon as they enter into the match. In the present study, the acute effect of static and dynamic 20s (2 x 10s) stretching on CMJ and 10 m sprint in semi-professional basketball players was investigated.

It was found that athletes following the SS protocol had an immediate reduced performance in 10 m sprint (increased time) while they improved their performance after following the DS protocol. The results are in agreement with previous findings (Fletcher and Anness, 2007, Fletcher and Jones, 2004, Little and Williams, 2006; Nelson et al., 2005, Chaouachi et al., 2008, Paradisis et al., 2013, Vasileiou et al. 2013, Papadopoulos et al., 2015, Famisis, 2015). Similar were the CMJ results. CMJ height scores decreased after SS but improved after DS. The CMJ results are in accordance with the findings of McNeal and Sands (2003), Young and Behm (2003), Paradisis et al. (2014), Carvalho et al. (2012), Fletcher & Monte-Colombo (2010). The results indicate that DS is in favor of better immediate performance in jumping and short distance sprints. However, when

comparing the effect of each type of protocol on each dependent variable the percentage of deterioration or improvement differs. More specifically, the SS deteriorates by 1% the sprint performance and by 3% the CMJ height while DS improves by 3% the 10 m sprint time and by 5% the CMJ height. Thus, SS seems to affect more negatively the CMJ performance than the 10 m sprint time while DS seems to affect more positively the 10 m sprint performance. Paradisis, et al. (2014) have reported a reduction of 2,5% in sprint time and 6,3% in CMJ height in young boys and girls after a SS program of a total duration of 6 weeks, but no previous relevant reports were found regarding the SS acute effect in order to compare the results of the present study.

The mechanisms responsible for the reduction in sprint and CMJ after static stretching or their improvement after performing dynamic stretching are not fully clarified. Several factors, which probably play a negative or positive role in sprint and CMJ, have been previously reported such as neural inhibition (Behm et al. 2001), mechanical factors (Nelson and Sidaway 2002), reduced muscle temperature after SS (Mohr et al. 2004) and reduced blood flow (Poole et al. 1997). However, the precise mechanism that leads to stretch-induced sprint impairment is still not clear (Behm et al. 2001). Regarding the CMJ, Kubo et al. (2007) reported that pre-stretch augmentation of both CMJ and Drop Jumps (DJ) was related to tendon stiffness. Another theory to explain changes in performance through stretch modalities is that of changes in muscle stiffness. Static stretches have been shown to decrease the stiffness of the musculotendinous unit (MTU) (Avela et al. 1999; Evetovich et al. 2003; Kubo et al. 2001; Rosenbaum and Hennig 1995, Wilson et al. 1991), leading to decreases in performance due to an alteration in the force-length relationship of a muscle (Fowles et al. 2000). Static stretching may increase tendons' compliance which affects negatively jump performance due to the prolonged contact time and the non-effective transmission of energy during the stretch shortening cycle (SSC).

However, in a previous study (Fletcher and Monte-Colombo 2010), in the SS condition, this reduced stiffness was compounded by a concomitant reduction in neural activation (reduced EMG, causing reduced peak torque and time to peak torque), resulting in generally worse performance and muscle function measures than warm-up alone. On the contrary, the improved sprint and CMJ performance after DS may be due to the elevated muscle and body temperature during the dynamic muscle stretching (Little and Williams 2006). According to Bishop (2003), additional warm-up time leads to increased muscle temperature and motor conduction velocity, while static stretching reduces the heart rate and the muscles and body temperature (Fletcher and Monte-Colombo 2010).

Increased muscle and body temperature and increased heart rate seems to cause an increased sensitivity of nerve receptors (Fletcher and Monte-Colombo 2010), which may increase the motor conduction velocity and improve muscle contraction, so that it is faster and more powerful (Shellock and Prentice, 1985). Hedrick (2000) also reported that increased muscle temperature helps muscles to contract more powerfully and to relax faster. Although in the present study muscle temperature was not measured, the sweating observed in all the participants indicated an increase of muscle and body temperature which may explain the improvement in sprint performance.

Conclusion

The present results indicate that dynamic stretching is a better way to stretch muscles during warm-up before a basketball match, as after dynamic stretching an improved performance is achieved in power activities such as 10 m sprinting and CMJ which are crucial components of modern basketball.

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