The acute effects of different stretching durations on vertical jump performance in trained male athletes

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Abstract

The purpose of this study was to compare the acute effects of static stretching on vertical jump in trained male athletes. 25 healthy male athletes (age: 20.8 ± 2.3 years) who were National league 1 and 2, basketball, volleyball and handball players participated in the study. Subjects performed a 5 minute warm up followed by each of the following three stretching conditions on separate days with order counterbalanced; 15 second, 30 second, and 45 second duration. The static stretching protocol consisted of 5 stretches targeting muscles used during vertical jump. Before and after each stretching protocol, participants performed 3 trials of vertical jump test.

Statistical analyses indicated that the 30 second and 45 second stretching produced a significant decrease in the vertical jump height (p< 0.05), with no significant effects with the 15 second stretching (p>0.05).

In conclusion, short-lasting stretching can be done before exercises that require explosive strength. However, since 30 second or 45 second stretching protocols would decrease the jump height, they are not recommended in sports branches where millimetric differences have an effect on results.

Key words: Static stretching, vertical jump, performance, warm up.

Introduction

Most athletes perform stretching during warm-up prior to athletic activity (Behm et al., 2001; Alter, 2004). Static stretching is a technique that is often incorporated into many warm-up routines due to its effectiveness in the maintenance and improvement of joint range of motion, which is beneficial to athletes who require higher level of flexibility (Alter, 2004). Strength and conditioning professionals, coaches, athletic trainers and physical therapists recommend stretching prior to strenuous activity or competition because of the common belief that it can improve athletic performance and reduce the risk of muscular skeletal injuries (Cross and Worrell, 1999).

In recent years, however, many authors have reported that stretching before physical activity is detrimental to sports performance especially when this performance requires maximal force production (Kokkonen et al., 1998; Fowles et al., 2000; Behm et al., 2001; Power et al., 2004). Also some studies have shown that acute static stretching reduce strength and power production during jumping, sprinting and strength endurance (Fletcher and Jones, 2004; Nelson et al., 2005; Wallmann et al., 2005).

Some of these studies have concluded that acute static stretching neither helped nor inhibited performance (Knudson et al., 2001; Knudson et al., 2004; Unick et al., 2005; Alpkaya and Koceja, 2007; Samuel et al., 2008).

A number of mechanisms have been put forward to explain the decrease in muscle activation and failure of excitation in performance linked to static stretching, Avela et al., (1999), Fowles et al., (2000) argued that decreased neural drive could be linked either to supraspinal fatigue, or changes in inhibitory as well as disfacilitatory signals originating from the contracting muscle. The other mechanism could be stretch-induced damages to the myotendinous junction and breakages of stable
cross bridge or changes in viscoelastic properties of the muscle due to a reduction of passive and active stiffness of the musculotendinous unit (Avela et al., 1999; Fletcher and Anness, 2007).

A review of the current literature on the effect of acute static stretching on vertical jump shows that the results of many studies conflict with others; some report that static stretching diminishes vertical jump performance (Young and Elliott, 2001; Cornwell et al., 2001; Young and Behm, 2003; Bradley et al., 2007; Hough et al., 2009), but others report that static stretching has no effect at all on vertical jump performance (Church et al., 2001; Knudson et al., 2001; Burket et al., 2005; Unick et al., 2005; Samuel et al., 2008).

Based on review of the available literature, there is still disagreement among many authors concerning the effects of different stretching protocols on muscle performance. Studies have used different variables for stretching interventions and procedures, such as number of repetitions and stretching time. These effects have implications for athletes involved in activities that require explosive strength and power production, and have led some researchers to recommend against the practice of static stretching before such activities, and these conflicting views cause confusion among the coaches, athletes, and the common fitness enthusiasts.

This study was performed in part due to conflicting findings in the previous literature regarding the effects of different duration of the static stretching on vertical jump.

We hypothesized that the longer stretching would cause a greater decrease in vertical jump performance; and thus, the purpose of this study was to compare the acute effects of static stretching protocols of 15 seconds, 30 seconds and 45 seconds duration on vertical jump performance in elite athletes.

Material and Method

Subjects
Twenty five trained healthy males (height= 186.4 ± 7.5, weight= 85.4 ± 8.1 kg, age= 20.8 ± 2.3 years) participated in this study. All subjects were recruited from National league 1 and 2 athletes (8 basketball players, 8 volleyball players, and 9 handball players). The average playing experience at the high level was 4 years. This population was chosen because each subject had previous jumping experience as a part of their training and competition practices. After a full explanation of the procedures and risks involved, all subjects signed an informed consent approved by the university’s human studies committee. Subjects were informed that study was for research purposes and were encouraged to give maximal effort through the entire testing procedure. Subjects were instructed not to engage in lower – body exercise 24 hours before their test, to eliminate any potential muscle soreness or fatigue.

Experimental Protocol
In this study we wanted to compare the acute effects of three different static stretching protocols on vertical jump performance in trained males. Subjects acted as their own control group and each subject attended the laboratory on four separate occasions separated by a minimum of 24 hours. Tests were given during a week interval in the league schedule, when there were no practices. Before the first day of testing, participants were required to attend an orientation visit in which they were familiarized with the testing procedures. During familiarization period, the assistant demonstrated each stretch and vertical jump procedure and subjects performed 5 trials of the jumps to reduce the likelihood of learning effect during the study.

After completing familiarization period, subjects returned to the lab for three more days. Before the vertical jump test, each subject walked for five minutes on a treadmill at a brisk but comfortable self-selected pace as part of a general phase of the standard warm-up and performed a series of three stretches under the supervision of an assistant. After completing one of three stretching protocols, each subject completed three trials of vertical jump.

Stretching
The static stretching protocol was applied in three different durations; 15 seconds, 30 seconds and 45 seconds. The researches demonstrated the proper stretching technique prior to each testing routine and monitored the subject’s movements throughout stretching to ensure that each stretch was performed correctly. Each subject carried out unassisted static stretch exercises. The holding point of the stretch was set at the maximal possible length without feeling pain or discomfort. Each stretch was completed 3 times with a 15 second recovery periods between stretches. The time of stretching was measured by a handheld stopwatch. The order in which the muscle groups were stretched was randomized.
The static stretching protocol consisted of the following 5 stretches targeting muscles used during a vertical jump and applied for both legs:

- **Standing quadriceps stretch**: Subjects stood on one leg with a posterior pelvic tilt and with one hand against a wall for balance. Subjects held their feet to bring the knee into flexion as far as possible, keeping the knee perpendicular to the floor, until a strong stretch sensation was felt in the quadriceps.
- **Standing calf stretch**: Subjects were asked to lean against a wall bending the front leg at the knee and keeping the other leg fully extended behind the body. The subjects were instructed to lean forward with a slight bend in the front knee. The heel of the back leg remained in contact with the floor. The same stretching practice was done with the back leg in bent position.
- **Seated hamstring stretch**: Subjects were seated with their legs straight and their feet upright. The subjects were then instructed to lean forward and attempt to grasp the toes bending at the hip.
- **Forward lunge**: Subjects were stood and instructed to take a long step forward with the right or left leg and flex the knee over the foot, keeping the foot on the floor and the back leg straight. Without changing the position of the knee on the floor, subjects lowered the front of the hip downward.

**Vertical Jump**

The vertical jump height was measured with a contact mat system (Newtest 2000, Finland). The subjects were instructed to stand in the middle of the contact mat with his hands on his hip and his feet shoulder width apart. The subjects then instructed to jump as high as fast as possible. Each subject was instructed and verbally encouraged to give a maximal effort during vertical jump test. Three jump trials were performed with a 15-second rest interval between each trial. After all stretching conditions, there was one minute period before the subject performed the vertical jump test.

**Statistical Analyses**

The averages of the jumps score of the each condition were used for statistical analysis. The data were evaluated by repeated measures (ANOVA). When a significant F value was found, post hoc tests were applied. The level of significance was set at p≤0.05 and all analyses were carried out using SPSS 15.0 (SPSS, Inc., Chicago, IL). To increase reliability, all the pre-conditions were analyzed for each volume of stretching to make sure that those averages were all within 1 SD of each other.

**Results**

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Pre Mean / SD</th>
<th>Post Mean / SD</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 s Stretching</td>
<td>49.00 ± 5.1</td>
<td>49.75 ± 4.0</td>
<td>+0.75</td>
</tr>
<tr>
<td>30 s Stretching</td>
<td>48.80 ± 5.8</td>
<td>47.00 ± 6.0</td>
<td>-1.80</td>
</tr>
<tr>
<td>45 s Stretching</td>
<td>49.50 ± 4.3</td>
<td>47.30 ± 5.1</td>
<td>-2.20</td>
</tr>
</tbody>
</table>

![Figure: Mean vertical jump height (cm) for each condition](image)

The means and standard deviations for each condition are presented in table 1. The 15 second stretching showed no significant decrease or increase in vertical jump height (p>0.05). However,
vertical jump height decreased statistically for 30 second stretching and 45 second stretching conditions (p< 0.05).

**Discussion and Conclusion**

The purpose of this study was to compare the acute effects of 15 second, 30 second, 45 second duration of static stretching protocols on vertical jump performance in the trained athletes. One of our findings is that the static stretching for 15 second neither improves nor decreases vertical jump performance. This result is similar to those of several researchers. Measuring jump heights following static stretching, Unick et al. (2005) found no significant difference in vertical jump height, whereas Young and Elliot (2001) observed no significant differences in squat jump height. Their stretching protocol was 4 different lower body stretching of 3 times for 15 seconds. Another study on short-time stretching by Holt and Lambourne (2008) found no significant improvement or decrease in vertical jump performance. Their stretching procedure was 5 seconds and 3 repetitions for each muscle of 5 passive stretches. In another study, Robbins et al. (2008) found no significant decrease in vertical jump following of 2 - 4 sets for 15 second static stretching.

The major finding of this study was that there was a significant decrease in vertical jump performance for 30 second and 45 second duration. Young and Behm (2003) examined vertical jump performance following 4 stretches (2 sets of 30 seconds) that focused on stretching the quadriceps and ankle plantar flexors. A significant decrease found in both drop jump and concentric jump performance as a result of static stretching. Hought et al., (2009) reported that vertical jump performance was significantly reduced after static stretching of four muscle groups for a set of 30 second. Similarly, Brandy et al., (2007) found a decrease in vertical jump after 30 seconds, while Power et al. (2004) found a decrease after 45 seconds.

Some researchers have cited a decrease in motor neuron excitability as a possible reason for the decrease in jumping performance (Fowles et al., 2000; Behm et al., 2001; Young and Elliott, 2001). Avela et al. (1999) examined that prolonged and repeated stretching on the H reflex and found a depression in the H reflex after stretching.

The present study focused on 5 muscles chosen for their function as major muscles used in the vertical jump. In this study, we used, 3x30 second duration and 3x45 second duration on each muscle, and it seems feasible that MTU stiffness might have decreased in response to increase in the length of the muscle fascicul, thereby reducing their ability to generate force and causing subsequent decreases in vertical jump performance. In the same study, performance on vertical jump decreased by 3.82 %, following 30 second stretching duration and 4.65 % following 45 second stretching duration as compared to precondition respectively.

The exact mechanism for the stretch – induced decline in performance is not known: however authors have speculated that a decrease in neural factor including impairments in muscle activation and changes in MTU stiffness are the cause (Kokkonen et al., 1998; Fowles et al., 2000; Behm et al., 2001; Cornel et al., 2001). Contrary to the findings of this study, Samuel et al.,(2008), and Çenginz et al., (2011) have reported that static stretching with 30 seconds did not cause any vertical jump height changes. Also Power et al., (2004) found no difference on jumping performances after 45 second of static stretching.

The explanation of these results may be related to differences in the number of static stretching exercises, and the total stretching time used. In this study, subjects performed 5 exercises for the muscle groups and repeated them 3 times.

According to Kokkonen et al.(1998): Nelson et al., (2005): Sekir et al. (2009) stretch – induced strength loss have used stretching protocols with ≥ 4 min total stretch duration, and therefore, the stretching was probably not sufficient to decrease passive muscle stiffness.

Significantly different applications of stretching in different studies in terms of intensity, frequency, and duration can be partly responsible for the different findings. Furthermore, the rest period between
stretching and vertical jump could be another reason for the varying results between studies which have different results.

In this study and the others that found muscle activation and MTU stiffness to decline for prolonged periods involved intense stretching that is not comparable with sports stretching because of their excessive length and concentration (Fowles et al., 2000; Behm et al., 2001).

In the studies done, the interval between stretching and the vertical jump test is 1-2 minutes, which means that the time given according to the requirements of test procedures can be insufficient for the muscles to recover. When competitions and workouts are observed, the athletes generally do not start activities that directly require explosive strength right after static stretching and continue their preparations with dynamic moves, which last longer than the duration in the studies.

Depending on the findings of our study it can be concluded that athletes can safely apply up to 15 second stretching per muscle group that requires high levels of jumping performance. However, 30 second and 45 second stretching per muscle group seem to decrease the vertical jump performance.

References


