Acute Effects of PNF Stretching on Maximum Voluntary Contraction in Men

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ABSTRACT This study aimed to investigate the influence of PNF stretching on the peak torque (PT) isokinetic leg extension PT at 60° and 180°·s⁻¹ in the stretched and unstretched limbs. Twelve college male athletes who were enrolled in a fitness class volunteered to participate in the study. Pre and post PNF stretching exercises isokinetic PT for extension and flexion of the dominant and non-dominant limbs were measured. There was a decrease in the PT for both extension and flexion between the pre- and post-stretching conditions. The reductions in PT experienced in the present study tentatively support the hypothesis that stretching may change the length-tension association.

INTRODUCTION

Stretching is frequently performed before exercise (Adamo et al. 2000) and athletic events (Beaulieu 1981; Young and Behm 2002). Conventionally, it is assumed that escalating joint range of motion will support superior performance (Roelants et al. 2004) and decrease the risk of injury during vigorous exercise (Smith 1994). Earlier studies (Young and Behm 2002; Roelants et al. 2004; Smith 1994; Holcomb 2000; McNeal and Sands 2001; Nelson et al. 2001; Wallin et al. 1985) concluded that stretching depresses maximal force production.

Stretching techniques (static, PNF, dynamic) are considered to increase muscular flexibility to advance range of motion (Cengiz 2015), and help prevent harm in daily life or sports, lessen muscle soreness, and progress muscle potential, and muscular performance (Lim et al. 2014). However, it has been anticipated that static stretching (SS) is related with a reduction in neural input into the muscles. Therefore, it is likely that acute impact of stretching on muscle strength may influence the outcomes of many treatment and conditioning exercises. PNF stretching is also a typical form of stretching. These exercises frequently used in both athletic and clinical settings to augment both active and passive range of motion (ROM) in order to optimize motor performance and treatment (Yuktasir and Kaya 2009).

Many studies have indicated that PNF stretching produces a superior improvement in ROM (Etnyre and Abraham 1986; Ferber et al. 2002; Funk et al. 2003; Magnusson et al. 1996). Although several studies have assessed the effect of PNF stretching on increased ROM (Decicco and Fisher 2005; Sheard and Paine 2010; Yuktasir and Kaya 2009) and vertical jump performance (Bradley et al. 2007; Christensen and Nordstrom 2008), controversial results were existed about the effects of PNF stretching on strength and power. For example, on study reported that no significant differences were observed in jump performances between the PNF stretching and control conditions (Miyahara et al. 2013). Also, the findings of another study indicated that none of the stretching procedures caused a decline in knee extension power (Ma-noel et al. 2008). Yet, some studies found performance decrements after PNF stretching. For instance, a study found PNF stretching reduced bench press endurance while a low volume of SS did not change any outcome (Fowles 2008). In Place et al. (2013) study, the two minutes of PNF stretching did not influence squat jump and countermovement jump outcomes.

The lack of studies on isokinetic strength is quite surprising because trainers commonly use that PNF before or during the recovery after athletic events. Knowledge pertaining to the effects of PNF’s effect on performance is considered necessary to verify whether PNF is useful in improving performance in sports that require high
levels of peak torque. It was concluded that there were minimal effects of PNF stretching on the unstretched limb. The authors hypothesized that if the stretching-induced reduction in force production were the result of a central nervous system (CNS) mechanism, the unstretched as well as stretched limb would be likely affected (Avela 1999). To further analyze this hypothesis, the present study examined the effects of PNF stretching on the PT during concentric, isokinetic leg extension PT at 60° and 180°·s⁻¹ in the stretched and unstretched limbs.

**Objectives of the Study**

This study was intended to investigate the PT of the stretched and unstretched leg extensor and flexor muscles in recreationally active men. It was predicted that PNF would cause a decrease in peak torque of the participants in both dominant and nondominant limbs for extensors and flexors.

**MATERIAL AND METHODS**

**Experimental Approach to the Problem**

Twelve collegiate male athletes who were enrolled in a fitness class, (age, 24.25± 2.56 years; body mass, 69.96± 8.86 kg; height, 172.15 ± 3.6 cm) volunteered to participate in the study. The subjects were healthy and indicated no previous or current knee-, hip- or ankle-related injuries and no noticeable limits in knee ROM. The local ethic committee approved the study and all subjects filled questionnaire informed consent forms prior to testing.

**Experimental Design**

Isokinetic PT for values for extension and flexion of the dominant and nondominant limbs were measured before and after PNF stretching.

**RESULTS**

There was a decrease in the PT for both extension and flexion (Table 1) from pre- to post stretching all conditions. The PT was decreased for both extension (139.25 ±31.96 vs. 136.80 ± 29.07) and flexion (79.41 ±19.60 vs. 75.83 ±21.5) in dominant limbs after PNF stretching at 60°·s⁻¹. There were also similar reductions at 180°·s⁻¹. For nondominant limbs, there were also decreases in PT for extension (147.75 ±37.5 vs. 144.41 ±37.69) and flexion (86.58 ±18.87 vs. 79.16 ±21.31) at 60°·s⁻¹. There were also decreases in PT for flexion (79.58 ±11.68 vs.73.58 ±14.14) and extension (110.08 ±26.79 vs.105.25 ±26.41) at 180°·s⁻¹ for nondominant limbs.

**DISCUSSION**

It has been anticipated that stretching is related with a reduction in neural input into the
muscles and resulted in acute reductions in performance. Two major hypotheses were reported for the cause of the stretching-induced reductions in muscular force–producing capacity: (1) mechanical factors, such as changes in the viscoelastic properties of the musculotendinous unit and (2) neurologic factors, such as reduced motor unit activation (Marek et al. 2005). The purpose of this study was to test these hypotheses and to find out the effects of PNF stretching on the PT, isokinetic leg extension PT at 60°·s⁻¹ and 180°·s⁻¹ in the stretched and unstretched limbs. The results of the study indicated that there was a decrease in the PT for both extension and flexion (Table 1) from pre- to post stretching. Furthermore, the PT was greater at 60°·s⁻¹ than at 180°·s⁻¹.

Previous studies that have evaluated the impact of PNF stretching on many performance outcomes have indicated inconsistent outcomes. For example, one study reported that no significant differences were observed in jump performances between the PNF stretching and control conditions (Miyahara et al. 2013). Another study indicated there were not any differences in the influence of warm up only, dynamic stretching, or PNF stretching on vertical jump heights (Christensen and Nordstrom 2008). Also, in another study, the acute effects of static, dynamic, and PNF on peak muscle power output in women. Concentric knee extension power was assessed isokinetically at 60°·s⁻¹ and 180°·s⁻¹ in twelve active women. The findings of the study concluded knee extension power was not declined for all the protocols and the results recommend that dynamic stretching may augment acute muscular power to a better point than static and PNF stretching (Manoel 2008). However, other studies have found performance decrements after PNF stretching. For instance, one study found that PNF stretching decreased bench press endurance while a low intensity of static stretching did not have a significant effect (Fowles 2000). Another study observed a decrease in vertical jump height after PNF stretching (Church et al. 2001), similar study indicated that vertical jump heights subsequent to PNF stretching were inferior than following the static stretching and/or control conditions (Yuktasir and Kaya 2009). In contrast, another group (Young and Elliott 2001) showed there was not any major in jump heights between the PNF stretching and control groups. These inconsistent consequences (Yuktasir and Kaya 2009; Young and Elliott 2001) may have been the outcome of the differences among the stretching protocols and/or the types of jumping tests performed (Marek et al. 2005) suggesting that the degree of the performance decrease may be in direct amount to the amount of the stretching exercises (Fowles 2000). It is therefore likely that either the extent of the stretching or fatigue may have affected the vertical jumping capability (Marek et al. 2005) or isokinetic knee extension evaluated in these preceding studies (Table 2).

The present study indicated that there were decreases in PT for both extension and flexion following PNF stretching. Previous reports indicated similar results (Miyahara et al. 2013; Marek et al. 2005). However, the findings of the current study are unique in demonstrating decreases in muscle strength in both extension and flexion conditions as a result of the PNF stretching exercises. Nevertheless, the results of this study extend the findings of previous studies (Yuktasir and Kaya 2009; Young and Elliott 2001) and recommend that PNF stretching decrease the force producing abilities of the leg extensors and flexors during MVC concentric isokinetic muscle actions at 60°·s⁻¹ and 180°·s⁻¹. Similar findings have been observed in some other studies. For example, one study indicated reductions in PT, MP, and EMG amplitude as a consequence of both

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**Table 2: Comparison of conditions**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Condition</th>
<th>T value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension</td>
<td>Dominant (Pre-PNF vs Post-PNF)</td>
<td>-2.061</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>Nondominant (Pre-PNF vs Post-PNF)</td>
<td>-2.759</td>
<td>0.019</td>
</tr>
<tr>
<td>Extension</td>
<td>Dominant (Pre-PNF vs Post-PNF)</td>
<td>-3.766</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>Nondominant (Pre-PNF vs Post-PNF)</td>
<td>-3.664</td>
<td>0.004</td>
</tr>
<tr>
<td>Flexion</td>
<td>Dominant (Pre-PNF vs Post-PNF)</td>
<td>-3.493</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Nondominant (Pre-PNF vs Post-PNF)</td>
<td>-5.536</td>
<td>0</td>
</tr>
<tr>
<td>Flexion</td>
<td>Dominant (Pre-PNF vs Post-PNF)</td>
<td>-5.698</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Nondominant (Pre-PNF vs Post-PNF)</td>
<td>-2.855</td>
<td>0.016</td>
</tr>
</tbody>
</table>
PNF STRETCHING AND PEAK TORQUE

static and PNF stretching (Bradley 2007). Another study evaluated the effects of PNF stretching and static stretching on the MVC. These results suggested that the PNF stretching and SS reduced the maximal isometric strength.

Also recent studies indicated controversial results about the effects of PNF on strength. Keese et al. (2013) found that preceding PNF stretching did not decrease number of repetitions performed in multiple sets of the leg curl. Therefore, it was recommended that a modest level of PNF could be used prior to resistance exercise with a minimum depressing effect. Higgs et al. (2009) investigated if three weeks of PNF stretching training could effectively augment the knee flexion range of motion without having an unfavorable outcome on the peak isokinetic torque of the quadriceps. Reis et al. (2013) aimed to examine and evaluate the effects of PNF and SS on MVC and EMG activity in indoor soccer players. The findings of the study confirmed that PNF or SS techniques induced no decline on MVC and muscle EMG activity in indoor soccer players. It is likely, thus, that either the amount of the stretching or fatigue may have affected the vertical jumping abilities or isokinetic knee extension subsequent to the PNF stretching conducted in previous studies (Marek et al. 2005).

It was reported that previous studies have recommended that the angle-torque relationship during MVC muscle actions may offer information concerning the length-tension association of the muscle fibers. It is likely, thus, that stretching-induced changes in the length-tension association may be manifested through alterations in the angle-torque affiliation (Marek et al. 2005).

CONCLUSION

In the present study, the PT decreased for both extension and flexion between pre- and post PNF stretching. Concerning the mechanisms causing the stretching-induced performance deficit, the reductions in PT experienced in the present study tentatively support the hypothesis that stretching may change the length-tension association.

RECOMMENDATIONS

The outcomes of this study have implications for sports facilitators and men who execute PNF stretching prior to performance actions. Further studies are considered necessary to detect the essential mechanisms that impact the time course of stretching-induced reductions in MVC for active and inactive population of various ages.

REFERENCES


Lim Kl, Nam HC, Jung KS 2014. Effects on hamstring muscle extensibility, muscle activity, and balance of