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THE EFFECTS OF PNF & STATIC STRETCHING ON KNEE ROM OF AMPUTEE ATHLETES

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ABSTRACT
DANESHMANDI, H.; ATRI, A. E.; GHASEMI, A.; RAHMANI, P. The effects of PNF & static stretching on knee ROM of amputee athletes. Brazilian Journal of Biomotricity. v. 5, n. 4, p. 255-262, 2011. Flexibility is one of the most important factors in athletic preformance injuries prevantion especially in rehabilatation of athletic disabled. In order to maintain and develop ROM in an amputated limb, the superior joint of the stump should be under effective stretching exercises. Therefore the purpose of the present study was to compare the effects of two methods of static stretching and PNF (HR) on increasing the knee ROM of B.K. amputee athletes. The subjects were consisted of 19 B.K. male amputated athletes, with mean age of 35± 5years; and mean stump length of 19± 7 cm., which they were randomly divided into two groups of static stretching exercises (N=9); and PNF exercises (N=10). ROM_s were measured by use of a"Lighton Flexometer".The exercise protocol of both groups consisted of 12 sessions of 20 minutes. Results were concluded in both training programs of static stretching method and PNF (HR), the ROM of the knee joint increased significantly ($P \leq 0.05$). There was no significant difference between two methods of stretching exercises. The present study showed the effects of flexibility exercises on improvement of ROM of knee joint of B.K amputees. Therefor it emphasizes the requirements of performing static stretching exercises and PNF exercises by the coaches in order to improve physical condition of amputees and to rehabilitate them.

Key words: Flexibility; Range of Motion; static Stretching; PNF; Amputation; Disabled athlete.

INTRODUCTION

Stretching is traditionally used as part of a warm-up to increase flexibility or pain-free range of motion (ROM). Increasing of ROM can promote performances, and reducing the risk of injury. Therefore athletic trainers and other rehabilitation professionals also recommend that their athletes or patients stretch before performing strengthening exercises or strength assessment tests (MAREK et al., 2005). Most of the studies have been conducted to assess the effects of stretching exercises on ROM (KHAMWONG et

al., 2010). There are different techniques for increasing ROM like a statics and PNF stretching. The static technique incorporates a slow stretch of a particular muscle or muscle group, held at the point of discomfort for a period of time ranging from 6 to 60 seconds (BRENT FELAND et al., 2001). It is well known that static muscle stretching techniques enhance ROM. In the literature, the increase in ROM, often reported after passive stretching, which may involve biomechanical, neurological and molecular effects, appear to be understood (YUKTASIRA et al., 2009). Proprioceptive neuromuscular facilitation (PNF) is a popular method of stretching that utilizes inhibition techniques, of these, contract-relax (CR), hold-relax (HR) and contract-relax antagonist-contract (CRAC) appear to be most commonly used. The optimal duration of isometric contractions used in the PNF technique is 3 to 6 seconds (BRENT FELAND et al., 2001). PNF techniques make use of proprioceptive stimulation for the strengthening (facilitation) or relaxation (inhibition) of particular muscle groups. One principle of PNF maintains that voluntary muscular contractions are performed in combination with muscle stretching to reduce the reflexive components of muscular contraction, promote muscular relaxation, and subsequently increase joint ROM (FERBER et al., 2002). Resistance to musculotendinous stretching involves both the mechanical viscoelastic properties of muscle and connective tissue, as well as the neurological reflexive and voluntary components of muscular contractions. PNF stretch techniques are believed to reduce reflexive components that stimulate muscular contraction and thereby enable joint range of motion to increase (FERBER et al., 2002). There was also a report using a single set of PNF stretching which demonstrated a significant increase in flexibility. Improving tissue flexibility has also been mentioned as a means to reduce the risk of soft tissue injury and prevent muscle damage (PEANCHAI et al., 2010). Both mechanical and neural adaptation mechanisms are responsible for these changes during stretching. Studies suggest that autogenic and reciprocal inhibition mechanisms occur during the PNF stretching technique application. An isometric contraction of stretched muscle during applied PNF stretching technique triggers the autogenic inhibition mechanism, creating a subsequent reduction in muscle tension through stimulation of Golgi tendon organs. This mechanism lowers resistance to stretch, and is important in improving ROM.

In addition, tension during the maximum isometric contraction of the stretched target muscle results in less resistance to length changes in the same muscle. Alternatively, concentric contraction of an antagonist muscle causes reciprocal inhibition. Because of this reciprocal inhibition, an active reduction in resistance takes place in the target muscle. A reduced excitability of motor neurons located in the stretched muscle, causing reciprocal inhibition, provides muscle compliance by allowing muscle lengthening (DAVIS et al., 2005, YUKTASIRA et al., 2009). While many studies have observed differences between using a static stretch, (PNF), or ballistic stretching. research has not demonstrated indisputably that one technique is better than another. Both PNF and static stretching are commonly advocated techniques (BABAULT et al., 2010, BRENT FELAND et al., 2001, YUKTASIRA et al., 2009).

PNF stretch techniques have been demonstrated to increase joint range of motion as compared to non-PNF stretch techniques. Tanigawa compared PNF stretch techniques to passive mobilization and reported that the PNF procedure resulted in greater gains in ROM. Sady et al (1982) compared PNF, static, and ballistic stretch techniques on shoulder, trunk, and hamstring muscles and reported that the PNF stretch procedures achieved significantly greater gains in ROM at all three joints compared to the other stretch techniques (FERBER et al., 2002, SADY et al., 1982). Although, effects of static and PNF stretching (e.g., acute, long-term, etc.) have been well documented in sport sciences, there have been only a limited amount of studies evaluating the same factor for

rehabilitation purposes. Hence, conducting similar studies on patients and/or healthy persons regarding static stretching (SS) and PNF stretching on B.K amputee athletes might produce new data regarding their rehabilitation processes. In this research, we focus on the effects of static stretching and PNF stretching on B.K amputee athletes and the comparison of these two methods (YUKTASIRA et al., 2009).

Material and methods

19 B.K (Below Knee) male amputee athletes volunteers, participated in this study. Mean age of subjects was 35±5 years and mean stump length of was19±7 cm (Table 1). Stump length from the knee joint to the end of lower limb was between 14-26 cm. All the subjects had different sport experiences but most of them were swimmers. With exception of their disability they also were healthy. All subjects were informed about the experimental procedures. The personal information, medical and sports records of them collected by questionnaire and interview. The subjects of the study were randomly divided into two groups: a static stretching (SS) group (n=9), a HRPNF stretch group (n=10) .The data were collected in two stages. The first measurement (pre-test) was taken day the stretching training, and the second (post-test) a day after the training program. The knee joint ROM measurements in Pre-test and Post-test were performed by using active knee extension test (AKET) method in supine position. This was done by the same tester and by using “Lighton flexometer” with the reliability of 90-99%. Wide strap and special horizontal metal bar have done the fixations of pelvic and hip. All the measurements repeated three times and the mean of three measures was used for data analysis.

Measurement protocol: Before the performing this test, we marked lateral epicondyle of femur and center of lateral surface of knee, to determine any changes in knee extension and great trochanter. Then subject lay on the bed that had fixed two ventricle lever on each side to grip. Researcher fixed pelvic and opposite leg from the femur area with special bands. Then subject hold femur and knee joint at 90°. After it researcher measure and control the femur position to make sure. “Ligthon flexometer “ also had fixed on lateral surface and 2.5 cm down from the head of fibula and regulate on 0° status then, we asked subject to extend his leg as he can, until lock the flexometer and measure the angel at the end of range of motion (DELPINO et al., 2000). All the pre and post-test performed in the morning and before doing any warm-up activity. However, to equate the conditions, we perform post-test one day after the end of intervention for both groups.

Table 1. Demographic data of subjects

	Age	Height	Weight	Stump length
Static stretching	36.2	176.9	72.8	18.5
PNF stretching	33.0	174.1	75.3	19.4

Training Protocol: The exercise protocol of both groups consisted of 12 sessions of 20 minutes training and three times per week. The exercise program including 5 minutes of general warming-up by pedaling on ergometer with 50-Wt.workload and then stretching exercises specialized for each group.

Static stretching training: Training sessions of group 1 (S.S) were performed in odd days, which consisted of 5 types of stretching exercises with 4 times repetition. During a protocols over stretching principal also considered (Moller et al., 1985).

Hold–relax PNF stretching training: Training sessions of group 2 (PNF) were performed

in even days. The PNF exercises were adapted from "PNF patterns and techniques" by Margaret (1954). The hold- relax technique (HR) was used in this research. The PNF patterns sequence for each exercise was as follows: With resistance of partner, subject exerted 3 stages of maximal isometric contraction of the antagonist muscle groups for 6 seconds. Subjects relaxed for 2 seconds then exerted 4 stage of maximal isotonic contraction of the agonist muscle groups for 10 seconds (MARGARET et al., 1956; MILLER et al., 1995; MOLLER et al., 1985). At the end of training sessions, post-test were performed and then the collected data were analyzed by SPSS (P≤ 0.05). To compare the results of pre-test and post-test within each group and to compare the results of two groups of PNF and S.S groups, T-test (P≤ 0.05) was used and the following results were found.

Results

The results of this study showed both training programs significantly increased the ROM of knee joints (P≤ 0.05). Therefore the present study showed the effects of flexibility protocol exercises on improvement of ROM of knee joints of B.K. amputees. The results are presented in tables 2 & 3. There was also no significant difference between two protocols of flexibility exercises (P≤ 0.05). (table 4).

Table 2. t test of static stretching

Group	Pre test	Post test	ROM increase	t	p
Static	62.66	73.11	10.44	9.33	0.05*

(*)Significant at p≤ 0.05

Table 3. t test of PNF stretching

Group	Pre test	Post test	ROM increase	t	p
PNF	65.1	74.9	9.8	7.31	0.05*

(*)Significant at p≤ 0.05

Table 4. t test of ROM increasing

Group	Pre test	Post test	ROM increase	n	SD	P value
Static	62.66	73.11	10.44	9	2.35	1.11
PNF	65.1	74.9	9.8	10	4.73	1.38

DISCUSSION

The present study was designed to assess the effects of two different stretching techniques performed 12 sessions, exercises 20 min in each session. At the end of protocol both stretching exercises significantly increased in ROM knee joint (P≤ 0.05).

In addition there was no significant difference between two methods of stretching exercises. However the descriptive data showed trend to PNF. The study showed that the HRPNF were significantly increase the knees ROM of subjects (P≤ 0.05). The results of this study proved the past findings of others researchers (MARGARET et al., 1956; SADY et al., 1982). This finding comes to no surprise because the literature reports similar

positive findings on ROM related to different stretching methods.

A number of studies have demonstrated that ROM significantly increased after the PNF stretching exercise protocols. Handel et al (1997) found up the increasing in active and passive ROM after 8 weeks of CRPNF stretching training. Similarly Schuback et al (2004) observed the effectiveness of a self-stretch incorporating PNF components involving a therapist-applied PNF technique. The researchers found both stretching regimes resulted in a significant increase in hamstring flexibility (SCHUBACK et al., 2004). Hutton (HUTTON., 1992) pointed out that PNF stretching activities causes a neural inhibition **o**f muscle group being stretched. The neural inhibition reduces reflex activity which causes greater relaxation and decreased resistance to stretch. Similarly Rees et al (REES et al., 2007) examined the effect of PNF stretching (three times per week for 4 weeks) on musculotendinous unit (MTU) stiffness of the ankle joint. The researchers found an increase on ankle ROM (7.8%), maximal isometric strength (26%), rate of force development (25%) and MTU stiffness (8.4%). The increased MTU stiffness after the training period is explained by adaptations to maximal isometric muscle contractions applied in PNF stretching bouts. As a stiffer, MTU system is linked with an improved ability to store and release elastic energy, PNF stretching should benefit certain athletic performance due to a reduced contraction time or greater mechanical efficiency. As in the case of PNF stretching on the positive effect on ROM, findings of the present study support previous investigations using static stretching protocols of long durations as well (BANDY et al., 1997; CHAN et al., 2001; DECOSTER et al., 2004; NELSON et al., 2004). The results showed that 30 sec of static stretching protocols resulted in significant gains in ROM of the hamstring muscle group. This gain in ROM obtained in the static stretching experimental group is in agreement of similar studies on the effects of the duration of static stretching. For example, Nelson et al (NELSON et al., 2004) found an increase on ROM after a (30 s 3 days per week for 6 weeks) bout of static stretching of the hamstring muscle.

Decoster et al (DECOSTER et al., 2004) investigated the effectiveness of standing and supine hamstring stretching (each leg three times for 30 s each) in hamstring flexibility. The gains in the ROM after 6 weeks of statically stretching the hamstring muscle for 30 s are quite similar to gains by the static stretching group in the present study. In another study, Cipriani et al (CIPRIANI et al., 2003) compared two static stretching protocols on hip ROM, for a variety of durations, including 30 s. The two protocols were a 10 sec duration and a 30 sec duration stretch. They found no differences between the two protocols. In addition, stretch tolerance improves the joint flexibility. Magnusson et al (MAGNUSSON et al., 1998) reported that static cyclic stretching increases joint ROM by increasing stretch tolerance while viscoelastic characteristics of the muscle remain unaltered. When the differences observed between the static stretching and PNF groups were compared, there were no significant differences in improvements made in ROM. Worrell et al (WORRELL et al., 1994) found no differences on increase ROM between PNF and static stretching techniques. Similarly, Godges et al (GODGES et al., 1989) observed that both static stretching and soft-tissue mobilizitation with PNF significantly increased ROM in both hip extension and flexion. Davis et al (DAVIS et al., 2005) studied the effects of three stretching protocols (self-stretching, static stretching and PNF techniques) on the length of the hamstring muscle group during a 4-week training program. Obtained results indicated that that static stretching, involving one repetition for 30 s 3 days per week, increased hamstring length in young healthy subjects. On the other hand, self-stretching and PNF-R stretching, involving one repetition for 30 s, 3 days per week, was not sufficient to significantly increase hamstring length. In our present study, ROM values increased significantly in the PNF group. The increase in ROM is different to that obtained by Davis.

The difference in PNF effectiveness between Davis and our study may be associated with repetition. The four repetitions, were used in our study whereas Davis used one repetition. Taylor et al (1990) suggested that maximal muscle–tendon unit elongation occurs after approximately four stretches (repetitions).

The flexibility is specific to the various joints throughout the body; therefore it needs more investigations in different joints with more population specially in amputee athletes. Comparing the results of various flexibility training studies remains difficult since various combinations of sets, repetitions, duration, frequencies and techniques are found in literatures. Future research efforts should be directed toward the standardization of both testing and training procedures.

However, there are no more researches have been done on amputee athletes. The results of this study showed the effectiveness of PNF exercises on disables. Therefore, all trainers and coaches can apply statics stretching and PNF stretching in same population.

PRACTICAL APPLICATIONS

The effects of flexibility exercises has been identifying on improvement of ROM of knee joints of B.K. amputees. Therefore it emphasizes the requirements of performing static stretching exercises and PNF exercises by the coaches in order to improve physical condition of amputees and to rehabilitate them.

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