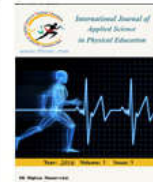




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The Effects of Static and Proprioceptive Neuromuscular Facilitation Stretching with Different Duration on Strength and Range of Motion of Wrist in Female Volleyball Players

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Keywords

Stretching exercises
Warm-up
Flexibility
Handgrip strength

Abstract

The purpose of this study was to investigate the effects of static and proprioceptive neuromuscular facilitation (PNF) stretching with different durations on handgrip strength and range of motion (ROM) of wrist in Female Volleyball Players. 10 female volleyball Players with the mean age of 22.1 ± 4.12 participated in the study, voluntarily. Participants performed one of the 30s and 240s static and PNF stretching protocols, and also control condition (120s rest), in a randomly visits with 2 days in between. Before and after the interventions, handgrip strength and range of motion of wrist were measured. Results showed that the ROM significantly increased in the post-test than pretest after all protocols ($p < 0.05$); But, there was not significant difference between the increase between the groups for the ROM. In addition, the handgrip strength significantly decreased in the control, and 240s static and PNF groups ($p < 0.05$), and insignificant increment was observed for the strength of wrist in the 30s static and PNF stretching groups. Performing short-term stretching during warm-up could increase ROM of wrist without negative effect on the handgrip strength in female volleyball players.

1. Introduction

Strength and flexibility exercises are common components of training programs and performing a stretching routine during warm-up phase of a strength training session is common among athletes (1). Static stretching (2) is considered an effective method for increasing joint range of

motion (ROM) (3) and is often thought to improve performance (4) and reduce the incidence of activity-related injuries (5). Also Proprioceptive Neuromuscular Facilitation (PNF) is a stretching technique utilized to improve muscle elasticity and has been shown to have a positive effect on

active and passive ROMs (6). Results regarding the acute effect of SS on strength performance are controversial. Some studies with the total stretching stimuli duration varying from 120 to 3600s, report the negative acute effect of SS on the muscle strength or power (1, 5, 7-9) In contrast, other studies did not observe any detrimental acute effects of stretching on the muscle strength or power (10, 11). Also conflicting evidence exists regarding the effects of PNF stretching on strength, too (12). PNF stretching prior to exercise has been found to decrease performance when maximal muscle effort is required such as during sprinting, Plyometrics, cutting, weight-lifting and other high intensity exercises (13). Recent studies have investigated effects of short time of PNF and SS on maximal voluntary contraction (MVC) showed PNF technique induced no change on MVC of vastus lateralis (VL) and rectus femoris (14) muscles of the dominant leg (15, 16); however, Miyahara et al (2013) showed PNF and SS induced significant decreases in MVC and significant increases in ROM, although increases in ROM were significantly greater after PNF than after SS (17). It should be considered that the total stimuli duration in the later studies has been noticeably shorter, ranging from 30 to 480s. Indeed, durations of stretching exercises in the studies reporting the negative effect on muscular strength are considerably higher than the recommended range of stretching protocols during warm up phase of training sessions (1). Therefore, it would be worthwhile to investigate the effects

of different protocols of stretch training with different duration on strength and ROM. Knowledge gaps are observed between comparisons of different methods for stretching wrist flexors (static vs. PNF) and their impact on isometric strength, as well as with individuals with strength training experience. therefore, the present study aimed to investigate the effect of static and PNF stretching with different duration on handgrip strength and ROM of wrist in female volleyball players.

1.1 Literature Review

The study included 10 female volleyball players from Broujerd city in Iran with at least 2 years of experience (22.1 ± 4.12 yr., 168.6 ± 2.9 cm, 61.5 ± 4.3 kg) who volunteered to participate. Subjects participated in an explaining session in a two days before starting main exercises and measuring. In this session they knew grouping, date and time of exercise, measuring height and body mass and written and oral consent from each subject. Then, all subjects randomly involved into 4 static and PNF stretch training group including 3 sets of 10s SS, 15 sets of 16s SS, 3 sets of 10s PNF, and 15 sets of 16s PNF and a control condition including 120s of rest with the time range of 2 days in a random order. In the beginning of each session, the warm-up consisted of 1 min of gradual swinging a tennis racket with wrist flexion and extension in the transverse plan and subsequently completed 4 maximum handgrip strength tests using a digital dynamometer (MIE

Medical Research Ltd, Leeds, UK) with the upper limb in a position of elbow extension and forearm pronation (18). Previous research has shown that three to four trials are needed to eliminate warm-up and learning effects in maximal grip strength testing (11). Subjects were instructed to exert maximal force during 4 test measurements with 1-min rest between tests and the highest of the 4 recorded measurements were used in the analysis (18). Then, the ROM wrist was measured, using a standard handheld goniometer. This test has also been performed for 3 times with 30s in between and the best effort was recorded after 3 times and the highest of the 3 recorded measurements were used in the analysis. After one minute, the subjects performed stretching exercises according to the mentioned training protocols or continued the control condition. One PNF technique that can trigger the reflex is commonly called "hold-relax" that was used in the study. Stretching exercises consisted of SS or PNF stretching of the wrist flexors of the dominant arm. Rest period between the stretches was set at 20s. One minute after the last stretching exercise, post tests were administered the same as pretests.

Statistical analysis was carried out using ANOVA repeated measurements followed by paired t test. One-way ANOVA and Tukey post hoc test were also performed to detect significant differences between the group means. All data were analyzed using SPSS statistical software (v. 21.0) and statistical significance was set at $p < 0.05$.

2. Results

The results of the strength and ROM variables before and after the execution of the stretching and control protocols are described in Tables 1. As is shown in table 1, there is a significant increase from pre to posttest for the ROM in all stretching groups except for the control group. In the group of 3 sets of 10s SS ($t = -4.3$; $P = 0.002$) in the group of 15 sets of 16s SS ($t = -4.8$; $P = 0.001$), in the group of 3 sets of 10s PNF ($t = -6.5$; $P = 0.001$), and in the group of 15 sets of 16s PNF were equal to ($t = -10.5$; $P = 0.001$). Also, there was not a significant difference between the ROM increase between the groups ($F = 12.1$; $P = 0.081$) (figure 1).

For the handgrip strength, as is shown in table 1, the handgrip strength had an insignificant increase in the group of 3 sets of 10s SS ($t = -0.1$; $P = 0.919$), a significant decrease in the group of 15 sets of 16s SS ($t = 1.5$; $P = 0.001$), an insignificant increase in the group of 3 sets of 10s PNF ($t = 4.2$; $P = 0.189$), a significant decrease in the group of 15 sets of 16s PNF ($t = 3.7$; $P = 0.006$), and a significant decrease in the control group ($t = 4.9$; $P = 0.001$). There wasn't significant difference between the groups for the changes of handgrip strength ($F = 4.2$; $P = 0.214$).

Table 1. Pre to post test scores of handgrip strength and ROM in the groups.

	ROM (degree)		Handgrip strength (kg)	
	Posttest	Pretest	Posttest	Pretest
3 sets of 10s SS	79.3±7.1*	76.0±6.8	18.6±6.3	18.4±4.3
15sets of 16s SS	79.5±7.3*	72.1±7.7	18.7±6.2†	20.7±6.5
3 sets of 30s PNF	77.7±6.1*	71.1±6.9	18.4±5.2	18.0±4.8
15sets of 16s PNF	83.8±5*	73.7±5.8	18.0±4.2†	20.2±3.8
Control (240s)	76.0±8.5	77.1±8.8	15.9±6.8†	18.3±5.7

The values are Mean ± SD; *: Significant increase in compare to the pretest ($P < 0.01$); †: Significant decrease in compare to the pretest ($P < 0.01$).

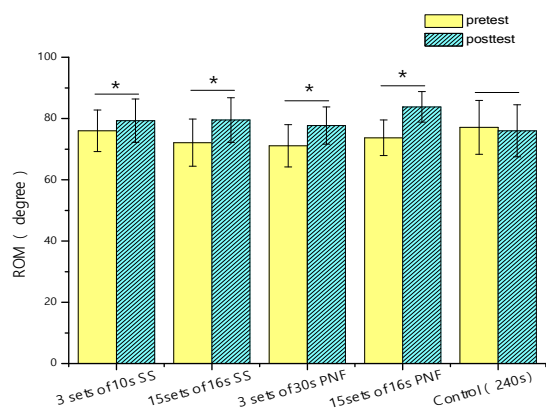


Figure 1. Pre to post test scores of ROM in the groups. *: Significant difference between pretest and posttest.

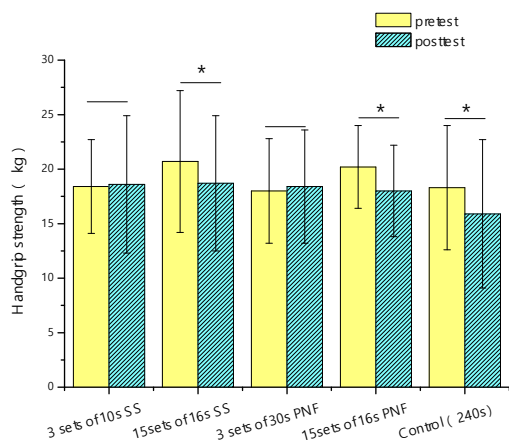


Figure 2. Pre to post test scores of handgrip strength in the groups. *: Significant difference between pretest and posttest.

3. Discussion

The present study investigated effect of static and PNF stretching with different duration on strength and ROM of wrist. The results of the assessment in the present study was the lack of negative effect of the short protocols of stretching (3 sets of 10s SS and 3 sets of 10s PNF) on the handgrip strength, despite their positive effects on the ROM of wrist in female volleyball (figure 1), and the negative effect on the handgrip strength in protocols of stretching (15 sets of 16s SS and 15

sets of 16s PNF) has been observed (figure 2). The handgrip strength after 120s of rest decreased significantly. Therefore, it could be explained that with shortening the time of static or PNF stretch, decrement in the strength starts to discolor.

In the present study, ROM of the wrist improved significantly in the all of stretching groups, while did not improved in the control group (table 1). Our study in accordance with previous researches demonstrated that the PNF stretches that incorporate a shortening contraction of the antagonistic muscle to lengthen the target muscle achieve great gains in ROM (19-21) and also SS caused significant increase in ROM, too. This result is in conjunction to the previous reports in this field (7, 10, 22). For example, Depino et al 2000, showed increase in the ROM after about 2min SS. It has been reported that increases in ROM after shorter stretching duration (up to 2.5min) may be as a result of increases in stretch tolerance, while this increase after longer duration of stretching (7.5 min) may be owing to decreases in musulotendinous stiffness (4). In this regard, Rubini et al 2007, in their review mentioned stretching induces diminished muscle-viscosity and enhanced muscle-elasticity and therefore improved flexibility (1).

According with previous research, our results reveal that decreases in the strength after the prolonged SS. (9, 23-25). Our findings are also according to the results of studies which report no negative effect of 1 to 3 sets of 10 to 30s stretching on the handgrip strength, vertical jump,

tennis serve performance and explosive strength (26, 27). Previous reports showed increases in strength after a bout of PNF stretching (15, 16, 23, 28, 29). The rationale behind the studies was the notion that PNF stretching has been shown to produce an increase in musculotendinous unit stiffness which is believed to be linked to an increased ability to store and release elastic energy. To explaining the stretching-induced force deficit after long duration: Previous protocols showed that Such stretching durations may elicit neural and excessive mechanical force inhibitory mechanisms (30). Fowles et al reported that long term SS, most of the decreases in muscular force-generating capacity were attributable to intrinsic mechanical properties of the musculotendinous unit rather than neural factors. These researchers suggested that a persistent Golgi tendon organ reflex, fatigue-related mechanisms, or pain feedback could be related to the above mentioned force deficit mechanisms (31). Herda et al. claimed that inhibition of gamma loop function could be a cause of stretching-induced force deficit, like that of vibration-induced mechanism (32). our results extend the findings of previous studies and suggest that both PNF and SS with long duration reduce the strength. In conclusion, it could be claimed that performing short-term static and PNF stretching protocols, like three sets of 10s, during warm-up before a training session or competitions, can results enhanced ROM without any muscle strength decrement.

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