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Research Article

A COMPARISON Ff EFFECTS OF THREE DIFFERENT CONTRACTION RELAXATION RATIO OF PNF TRAINING (CONTRACT-RELAX) ON POSTURAL CONTROL OF BOY STUDENTS

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ABSTRACT
The aim of the present study was that to evaluate the effects of three contraction relaxation ratio of PNF training (contract-relax) on postural control of boy students. Thirty nine nonathletic boy students (Mean±SD; age, 13±1.2 years; body mass, 55±9.8 kg) were assigned to one of the three training groups: ratio of contraction to relaxation durations of 0.5, 1 and 2. Measurements of dynamic balance at the beginning and at the end of 8 weeks of training by using a star excursion balance test. Training program included three sessions per week (CR-PNF) for 8 week. Data were analyzed using dependent t-test and one-way ANOVA. The results of the present study showed significant increases in achievement distance for some directions for three groups. However, no significant difference between groups was found in dynamic balance ($P \leq 0.05$).

Keywords: *Balance, Exercise, Proprioceptive, Neuromuscular, Facilitation*

INTRODUCTION
Control of balance is vital to everyday life. Postural control is complex and on the afferent side involves the central processing of peripheral sensory input from vestibular, visual, and proprioceptive pathways, whereas the efferent side involves the precise recruitment of specific (and varying) populations of motor units (Hassan *et al.*, 2001). Peripheral proprioception involves various sensory receptors, including cutaneous touch and pressure receptors, mechanoreceptors of synovial joints, muscle spindles, and tendon Golgi organs. Muscle spindles are the more important for detecting changes in joint angulation in the mid-range of movement, whereas joint mechanoreceptors (Pacinian corpuscles and Ruffini's end organs), which detect stretch of ligaments and deep tissues, are more important at the extremes of joint movement (Assimakopoulos *et al.,* 1992; Alaranta *et al.,* 1994). Although the somatosensory and vestibular systems are important in the perception of balance, effective postural control relies also on the biomechanics of musculoskeletal system including the stability and structure of the joints and adequate neuromuscular control of the lower extremities (Alaranta *et al.,* 1994). The muscles act via the joints in balancing the body and it is clear that the muscles acting on the hip, knee and ankle joints make a crucial contribution to balance adjustments (Lyytinen *et al.,* 2010). Previous studies showed that proprioceptive receptors play an important role in postural control (Gandevia and Burke, 1992). Since, many sport skills need to muscle spindle feedbacks of agonist and antagonist muscles (Ciscar and Roll, 1996), therefore neuromuscular facilitation has important role in improvement of muscular performances. Proprioceptive neuromuscular facilitation (PNF) techniques make use of proprioceptive stimulation for the strengthening (facilitation) or relaxation (inhibition) of particular muscle groups (Sheard *et al.,* 2009). One of the most commonly used methods of PNF thechniques is contract relax (CR) flexibility interventions (Sheard *et al.,* 2009). As suggested by Chalmers (2004), these techniques focus on the initial contraction and subsequent relaxation of the target muscles (Chalmers, 2004). The efficacy of PNF is generally accepted (Rowlands *et al.,* 2003; Shrier and Gossal, 2000). There exists a broad spectrum of variations in application of technique, Such as duration of contraction phase, duration of the relaxation phase, ratio of contraction to relaxation durations are all potential variables (Sheard *et al.,* 2009). The aim of present study was that to evaluate effects of three contraction relaxation ratio of PNF training (contract-relax) on postural control of boy students.

MATERIALS AND METHODS

Thirty nine nonathletic boy students (mean±sd; age, 13±1.2 years; body mass, 55±9.8 kg; height, 159±15.2cm) were assigned to one of the three training groups: ratio of contraction to relaxation durations of 0.5 (group 1), 1 (group 2) and 2 (group 3), duration of the relaxation phase was 6s for all groups. No subject had a prior history of lower extremity infirmity or pathology within the year prior to testing or at the time of testing and none was suffering from osteoarthritic or musculoskeletal disease that may have affected the ability to perform the tests. Measurements of dynamic balance at the beginning and at the end of 8 weeks of training by using a star excursion balance test (SEBT). Leg length was measured on each limb with participants lying supine. A tape measure was used to quantify the distance from the anterior superior iliac spine to the center of the ipsilateral medial malleolus. The SEBT was performed with the participants standing in the middle of a grid formed by eight lines extending out at 45° from each other. The participant was asked to reach as far as possible along each of the eight lines, make a light touch on the line, and return the reaching leg back to the center, while maintaining a single-leg stance with the other leg (non-dominant limb) in the center of the grid. Participants were instructed to make a light touch on the ground with the most distal part of the reaching leg and return to a double-leg stance without allowing the contact to affect overall balance (Gribble and Hertel, 2003; Kinzey and Armstrong, 1998). When reaching in the lateral and posterolateral directions, participants must reach behind the stance leg to complete the task. After completion of the three trials in the eight directions and another 5-min rest period, the investigator recorded each reach distance with a mark on the tape as the distance from the center of the grid to point of maximum excursion by the reach leg. At the conclusion of all trials, the investigator measured the distances of each excursion with a standard tape measure. If the investigator felt the participant used the reaching leg for a substantial amount of support at any time, removed his or her foot from the center of the grid, or was unable to maintain balance on the support leg throughout the trial, the trial would be discarded and repeated. Excursion distances were normalized to the participant's leg length for further analysis. Normalization was performed by dividing each excursion distance by a participant's leg length, and then by multiplying by 100 (Gribble and Hertel, 2003). Normalized values can thus be viewed as a percentage of excursions distance in relation to a participant's leg length. Training program included three sessions per week (CR-PNF) for 8 week. For stretch application, subjects were positioned supine on a padded table with the dominant thigh fixed by straps at zero degrees of hip flexion. The CR stretch application began with the examiner passively flexing the subject's non-dominant hip to a point of muscular restriction (non-dominant knee as in full extension). When this position was attained, the subject was instructed to extend the hip with maximal force (isometric hip extensor contraction) against examiner resistance for 3s (group 1), 6s (group 2) and 12s (group 3). The subject was then instructed to completely relax the hip musculature while the examiner passively flexed the hip for 6s (for all groups) to a newly attained point of muscular restriction (phase 1) (Ferber *et al.*, 2002). This procedure was then immediately repeated (phase 2). After warm up, these phases were repeated for six times in each session. Each session was about for 25-30 minutes. Data were analyzed using the statistical software package SPSS v16.0. Data were analyzed using dependent t-test and one-way ANOVA. α level was set at 0.05.

RESULTS AND DISCUSSION

Table 1 showed no significant differences ($p>0.05$) between three groups in eight directions of SEBT during pre test.

Table 1: Comparison of normalized excursion distances during pre-test in 3 groups

Antromedial	Medial	Postromedial	Posterior	Postrolateral	Lateral	Antrolateral	Anterior	groups
18±95	6±82	16±98	21±109	22±120	21±118	13±104	15±103	group1
14±86	15±78	21±96	16±100	21±111	20±109	14±102	12±91	group2
21±98	23±81	18±98	22±103	26±113	23±109	21±108	16±98	group3

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Comparison of normalized excursion distances in 8 directions during pre&post test demonstrated in table 2, 3, 4, 5. Group 1 showed significant increase (p=0.000) in normalized excursion distance just in antrolateral direction during posttest in compared to pretest (table 2).

Table 2: Comparison of normalized excursion distances (Anterior and Antrolateral) between pre & post test

P value	Antrolateral-post test	Antrolateral-pre test	P value	Anterior-post test	Anterior- pre test	groups
0.000*	14±124	13±104	0.099	20±110	15±103	group1
0.005*	10±121	14±102	0.013*	11±103	12±91	group2
0.024*	17±121	21±108	0.046*	13±107	16±98	group3

Group 2 showed significant increase in normalized excursion distances in anterior, antrolateral, lateral and posterior directions during posttest in compared to pretest ($P<0.05$).

Table 3: Comparison of normalized excursion distances (Lateral and Postrolateral) between pre & post test

P value	Postrolateral-post test	Postrolateral-pre test	P value	Lateral-post test	Lateral-pre test	Groups
0.464	12±125	22±120	0.241	12±126	21±118	group1
0.052	12±124	21±111	0.012*	11±127	20±109	group2
0.147	14±124	26±113	0.056	19±121	23±109	group3

Comparison of normalized excursion distances during pre&post test in group 3 showed significant increase in anterior (P=0.046), anterior lateral (P=0.024) and medial (P=0.048) directions.

Table 4: Comparison of normalized excursion distances (Posterior and Postromedial) between pre & post test

P value	Postromedial-prepost	Postromedial-pre test	P value	Posterior-post test	Posterior-pre test	3
0.498	14±101	16±98	0.439	17±113	21±109	group1
0.534	12±100	21±96	0.032*	13±109	16±100	group2
0.131	14±105	18±98	0.227	14±109	22±103	group3

Comparison of percentage of improvement in normalized excursion distances (post test-pre test) between three groups showed in figure 1. Results didn't show any significant differences between groups in each direction.

Table 5: Comparison of normalized excursion distances (Medial and Antromedial) between pre & post test

P value	Antromedial-post test	Antromedial-pre test	P value	Medial-post test	Medial-pre test	groups
0.765	12±94	18±95	0.105	9±88	6±82	group1
0.074	11±95	14±86	0.082	10±87	15±78	group2
0.877	15±99	21±98	0.048*	18±94	23±81	group3

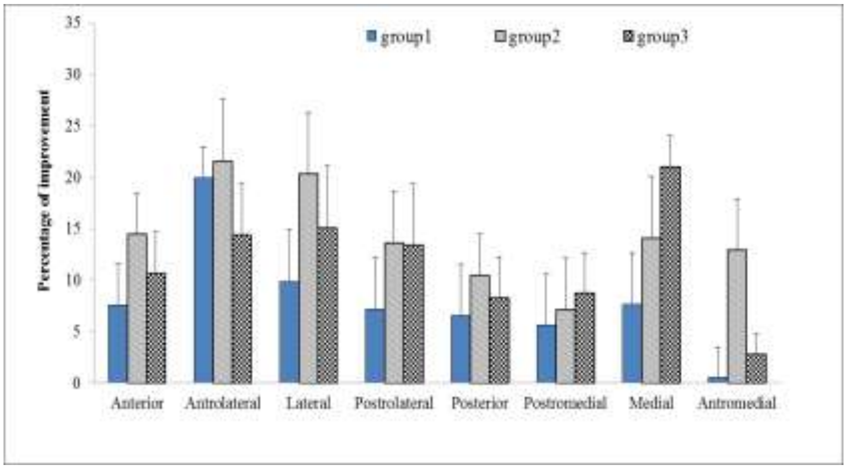

Figure 1: Comparison of percentage of improvement (post test minus pretest) in three groups

The aim of the present study was that to evaluate the effects of three contraction relaxation ratio of PNF training (contract-relax) on postural control of boy students. Generally, results showed significant increase in normalized excursion distances (some directions) during post test in compared to pre test in three 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 range of motion (Prentice, 1983; Azevedo *et al.*, 2011). PNF stretching is one of the most effective stretching techniques which has been claimed to increase muscle flexibility (Khamwong *et al.*, 2011). There was also a report using a single set of PNF stretching which demonstrated a significant increase in flexibility (Spernoga *et al.*, 2001). It is generally recognized that stretching decreases the stiffness of the muscle–tendon complex (Wilson *et al.*, 1992). Changes in the stiffness of the muscle–tendon complex would be expected to affect the force transmission, the rate of force transmission and the rate of muscle length change. More specifically, increased slack in parallel and series elastic components would increase the electromechanical delay by slowing the period between myofilament cross bridge kinetics and the exertion of tension by the muscle–tendon complex. In addition, the detection and monitoring of the muscle tension by the Golgi tendon organs would be delayed since a more compliant tendon would not transmit the tension information to the Golgi tendon organs as rapidly as a stiffer muscle–tendon complex (Nagano *et al.*, 2006). Furthermore, increased muscle–tendon complex length and decreased stiffness of the muscle–tendon complex would negatively affect muscle spindles, whose sensitivity is dependent on the length and length change of the intrafusal receptors (Nagano *et al.*, 2006). Therefore, the sensory mechanisms (e.g., Golgi tendon organs, muscle spindles), information transmission structures (afferent feedback), and the actuators (muscles) of the neuromuscular system may all have been affected through stretch (Behm *et al.*, 2004). As the integration of these components in the standing balance control system seems to be nonlinear (Hatzitaki *et al.*, 2004), it will be very difficult to pinpoint the mechanism(s) that caused the results of this study. Many researchers in the field of sports sciences have investigated the effects of stretching on sports performances. However, effect of PNF technique has not yet been evaluated on dynamic balance and it may prove that the use of PNF could have some potential benefit. Results of this study showed significant increase in normalized excursion distances (some directions) after three different contraction relaxation ratios of PNF trainings that showed dynamic balance improvement in three groups. But, results didn’t show any significant differences in percentage of improvement in normalized excursion distances between three groups (Figure 1). The mechanisms of human balance control have attracted the interests of many researchers. The importance of this field of research becomes clear when one considers that a deterioration in the ability to simply stand upright results in a seriously impaired quality of life (Nagano *et al.*, 2006). According to the findings of the present study it could be concluded that a longer contraction time dose not lead to a greater increase in dynamic balance.

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