The influence of acute arm vibration on coordination in Physical Education

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Today, some researchers have focused on the impacts of new and easily applicable non-invasive methods on physical education. The purpose of this study is to examine the vibration-related acute change in rotary pursuit coordination performance soon after arm vibration. In the study, 27 students in School of Physical Education and Sport were divided randomly into two groups. In order to eliminate the effect of learning, vibration and non-vibration rotary pursuit test was applied to each group rotationally. Group 1 (n_{group1}=14) was subjected to 4 rotary pursuit (40 s) tests each involving 3 vibration (30 s, 50 Hz, 2 mm) interventions. Two weeks later, the same participants were subjected to rotary pursuit tests with 30 s. rests instead of vibration interventions. Group 2 (n_{group2}=13) first received the non-vibration test and then the vibration test in the same order. According to the results of repeated measure of ANOVA, a significant improvement (F{(3,24)}=9.08, p=0.00) was found in the rotary pursuit performance with vibration (1^{st}: 28.28±5.21, 2^{nd}:29.59±4.61, 3^{rd}: 30.51±5.31, 4^{th}: 31.42±4.29 s). A significant improvement was not found (F{(3,24)}=1.80, p=0.17) in the rotary pursuit coordination practice without vibration (1^{st}: 27.42±4.80, 2^{nd}:28.54±4.45, 3^{rd}: 29.03±3.58, 4^{th}: 28.60±4.21 s). The study revealed that acute hand vibration positively affected rotary pursuit coordination. This positive impact is considered to have originated from the reconstructive effect on the sense of joint position of acute vibration. It is believed that the results of this research might inform physical education teachers working on hand-eye coordination.

Key words: Physical Education, coordination, vibration, intervention, rotary pursuit.

INTRODUCTION

Today, the sports industry tends to evaluate the anatomical and physiological needs of athletes with due regard to the characteristics of the sports branch they deal with and thus improve the performance of athletes. With time, athletes have been subjected to an intensive analysis and research process. This inevitable analysis process evolves in the direction of increasing the performance of athletes without using ergogenic aids. As a result, athletes are searching for more efficient, reliable and noninvasive intervention to improve their performance (Apple et al., 2010). As indicated in the references, vibration training may improve strength, neuromuscular performance and efficacy of this performance (Abercromby et al., 2007; Cardinale and...
The researches using acute and chronic vibration practices seem to be revealing differing results. Furthermore, the researchers studying the impacts of acute vibration practices on neuromuscular performance also reveal separate results. This difference in the results of the research is considered to have originated from variables such as the severity, duration and amplitude of vibration practices (Kin-İşler, 2007).

Neuromuscular, metabolic and hormonal impacts of vibration practices are known (Issurin, 2005). In addition, it has been proven that it is possible to improve the balance, strength, walking stability and some physical and physiological characteristics of individuals through whole body vibration practices (Madou and Cronin, 2008). The results of a study conducted on young skiers suggest that it could be more effective to use whole body vibration training as supplementary to conventional strength training (Mahieu et al., 2006). Indirect acute vibration practices are known to have improved impact on muscle strength, power, flexibility and proprioception.

This impact is considered to be originating from changes in spinal reflexes, also known as tonic vibration stretch reflex, which is associated with muscle contraction (Cochrane, 2011). As a result of vibration training, maximal muscle strength also increases due to motor unit synchronization and increased neuromuscular harmony (Jordan et al., 2005).

Studies on leg strength suggest that vibration training could positively affect leg strength. In a sham operated study conducted by Cormie et al. (2006), Whole-Body Vibration was applied for 30 s in semi-squad position, with 30 Hz., 2.5 mm. amplitude. In the Isometric Squad and Countermovement Jump performance tests conducted soon after Whole-Body Vibration, an increase in jump height was found. Researchers note that this result could have emanated from the heating-supporting impact of vibration and that different Whole-Body Vibration protocols should be tried (Cormie et al., 2006). In the study conducted by Lora et al. (2009), subjects received (60 s, 30 Hz., 2 mm.) Whole-Body Vibration and an insignificant increase were found in the vertical jump value (1.85±3.85 cm.). Researchers suggested that this increase could be attributable to the increasing fatigue preventive impact of vibration and the increase in the rate of signal transmission in the nervous system (Lora et al., 2009). In another study examining the impact of Squad training together with low-density Whole Body Vibration training, it was found that low-density Whole Body Vibration training affected power output and jump height more than those without vibration. Researchers noted that this result could be attributable to the acute harmony of spinal stretch reflex response (Lamont et al., 2009). In another study on the impact of acute whole body vibration practice on vertical jump and flexibility, low-density vibration was found to be more effective than high-density vibration (Cardinale and Lim, 2003). In a study conducted on college athletes, a peak force increase of 6% was found in sprint start performance measured soon after short-term whole body vibration during warm-up (Roberts et al., 2009).

In studies regarding arm strength, both whole body and local vibration training were found to be affecting arm strength. In the study of Cochrane and Stannard (2005), examining the acute effect of Whole-Body Vibration training on arm countermovement vertical jump, grip strength and flexibility, vibration was found to have increased arm countermovement vertical jump and flexibility. The researchers concluded that this change could be due to the neural potential in stretch reflex loop (Cohrane and Stannards, 2005). In a study studying the effect of short-term vibration training on bench press power output, vibration intervention was found to have increased muscle power (Poston et al., 2007). In another study on the impacts of low and high frequency and amplitude vibrations applied to foot on elbow-extensors, the biggest impact was found to be at 50 Hz., 2.51 mm. amplitude. The study concluded that high-frequency vibration practice had a greater neuromuscular facilitation impact than low-frequency vibration practice (Marin et al., 2010).

Some other studies addressed the impacts of vibration training on balance and neuromuscular coordination and concluded that vibration could positively affect neuromuscular coordination.

In a study conducted by Fort et al (2012), 15-week Whole-Body Vibration training was found to have increased postural stability (Fort et al., 2012). In another study analyzing the acute effects of acute vibration practice intermittently applied on legs (100 Hz.) on static and dynamic postural control, vibration was found to be effective on dynamic postural control rather than static control. Researchers noted that this result could be attributable to the disruption of proprioceptive information by vibration intervention (Hosseninimehr and Noresteh, 2010). In a study examining the acute impact of vibration, particularly low-density whole-body vibration was associated with improvement targeting accuracy and precision of hand coordination (Nina and Ewald, 2012).

As evident from the references, there are few studies on the impacts of vibration on coordination. The studies in literature reveal conflicting results. Researchers interpret the results they have reached in differing ways. This study will contribute to the literature as regards the impact of arm vibration loading on hand-eye coordination. Because vibration has perturbative effect, it is considered that the intervention and super-compensation impact originating from the effort of neuromuscular
system to rearrange and compensate this perturbation will improve hand-eye coordination. Accordingly, the hypothesis of this study is that acute vibrations loading on arm will positively affect hand-eye coordination gradually. This study analyzes the acute/short-term impact of acute arm vibration interventions on rotary pursuit performance.

METHODS

Participants

27 subjects, who are active but not exercising regularly, volunteered to participate in the study. Before starting the study, the subjects were informed about the study and were asked to fill out the informed consent form. The ages, heights and weights of participants were 23.75±2.01 years, 173.04±9.65 cm and 65.06±13.89 kg, respectively. The participants reported that they did not have any physical, skeletal or neurological disorder.

Study design

Because learning effect could be possible, randomized controlled crossover study design was used in the study (Figure 1). Before starting the study, 27 subjects were divided into two groups randomly, according to their rotary pursuit performance (P>0.05).

Group 1 (n=14) first took rotary pursuit tests with intermittent vibration interventions, and two weeks later rotary pursuit tests without vibration. Group 2 (n=13) first took rotary pursuit tests without vibrations, and two weeks later tests with vibration interventions.

Performance test

Rotary pursuit test procedure

Rotary Pursuit test apparatus, which is preferred in some learning and control researches relating to hand-eye coordination, is used to measure sensory-motor coordination. There is a rotating disc with pre-configurable speed on the apparatus. The luminous point revolving around a center on the upper edge of the disc is in contact with a stylus that is held manually. The task of the subject is to follow the revolving luminous point as long as possible and keep it in contact. Rotary pursuit apparatus separately records the time during which the stylus is in contact with the light and the time during which contact is lost.

In this study, on-target time of stylus has been taken into account. While applying the test protocol, test time was adjusted as 20 s, test cycles as 2 sets (2x20 s-total test time 40 s), rest time as 5 s, stimulus sensitivity as 5, direction as “clockwise”, and revolution speed as 20 rpm (Revolution per minute). After explaining the test protocol to the subject, Rotary Pursuit apparatus was placed on a desk at the hip level of the subject, and the subject was asked to try the protocol once before the first test.

Intervention

Acute vibration practices

In the acute vibration intervention section of the study, the subjects took 4 rotary pursuit tests and 3 vibration interventions between them. During acute arm vibration intervention, subjects were asked to stand in push-up position, with their hands on the vibration platform and elbows slightly bent (150°-170°) for 30 s. Vibration intervention was applied with 50 Hz., 4 mm amplitude. The rotary pursuit test applied soon after vibration was performed within 10 s after vibration. Subjects said that vibration intervention stimulated their arm muscles.

In the study section without acute vibration intervention (2 weeks later), the same procedure was applied but the subjects were asked to rest for 30 s, instead of arm vibration practice, between the rotary pursuit interventions and tests.

Data analysis

First, a descriptive analysis of data was conducted. Because the number of subjects was less than 50, the distribution of data used was verified through Shapiro-Wilk normality test.

To compare differences, two way ANOVAs with repeated measures on the “protocol: vibration and non-vibration” and “time: 1st, 2nd, 3rd and 4th measurement” factors followed by Tukey’s post-hoc test was conducted.

RESULTS AND DISCUSSION

Test results obtained from the study are shown in Table 1...
Table 1. Interaction between protocol (Vibration and Non-vibration) and time (1st, 2nd, 3rd and 4th) performance of rotary pursuit on-target measurement.

<table>
<thead>
<tr>
<th>Protocols</th>
<th>Vibration</th>
<th>Non-vibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotary pursuit Trails (sec.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st</td>
<td>28.28±5.21</td>
<td>27.42±4.80</td>
</tr>
<tr>
<td>2nd</td>
<td>29.59±4.61</td>
<td>28.54±4.45</td>
</tr>
<tr>
<td>3rd</td>
<td>30.51±5.31</td>
<td>29.03±3.58</td>
</tr>
<tr>
<td>4th*</td>
<td>31.42±4.29</td>
<td>28.60±4.21</td>
</tr>
<tr>
<td>Protocol</td>
<td>F=4.92 P=0.04</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>F=10.68 P=0.00</td>
<td></td>
</tr>
<tr>
<td>Protocol*time</td>
<td>F=2.02 P=0.12</td>
<td></td>
</tr>
</tbody>
</table>

* Significant difference (P<0.05) between protocols at the time point. Note: There are not significant differences among time measurements according to Tukey’s post hoc test results for two protocols.

and Figure 2. The table shows the ANOVA results in repeated measurements applied to determine the time-bound changes in protocols with and without vibration, as well as the differences among time measurements. Furthermore, the results in each of the interventions with and without vibration (protocols) were compared. In the table, 4 rotary pursuit tests performed consecutively are named “Time”.

According to the results of variance analysis in repeated measure of ANOVA during vibration and non-vibration coordination practices; while a time-bound, regular and cumulative increase is observed in protocols (P<0.05). In addition, there is significant interaction of protocols by time with respect to 4th measurement (P<0.05). As revealed by the table, there is not any significant interaction (P>0.05) between protocols (vibration vs. non-vibration) and times (1st, 2nd, 3rd and 4th measurement).

This study, designed to identify the effect of acute isometric arm vibration intervention in push-up position with bent elbow, on rotary pursuit performance, used the hypothesis that vibration with bent elbow could have a cumulative positive effect on rotary pursuit performance.

The hypothesis has been confirmed by research results, and it was concluded that acute vibration intervention between tests could have positively affected rotary pursuit performance that requires hand-eye coordination.

Neuromuscular control exercises are used to develop joint position sense. However, it is difficult to standardize these exercises and their validations are limited. Tripp et al. (2009) suggest that neuromuscular control exercises with vibration on hand improved Joint Position Sense (Tripp et al., 2009).

In a study examining the change in hand-eye pointing after acute vibration intervention, researches emphasize that visual control is necessary for hand-eye coordination, but suitable conditions have to be created for this. Researches also suggest that pointing performance is affected less by high-frequency vibration (Martin et al., 1998).

Furthermore, researchers note that local vibration could have an enhancing effect on neuromuscular system and sensory structure (Cardinale and Bosco, 2003).

According to the study results, vibration interventions were found to have a positive effect on rotary pursuit
coordination. This effect is considered to be attributable to the ameliorated and sensitized joint position sense of subjects due to acute vibration intervention. It is believed that the results of this research might inform physical education teachers working on hand-eye coordination.

Conflict of Interests

The author(s) have not declared any conflict of interests.

REFERENCES


