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Full Length Research Paper

The effect of acute vibration practices to upper extremity in handball players on shot velocity and hit accuracy

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ABSTRACT

The aim of this study was to examine the effects of acute vibration on the upper extremity in handball players on shot velocity and hit accuracy. 28 female handball players in the province of Kayseri playing handball under license in different clubs, with a mean age of control group (n = 14) 21.57 ± 1.91 years, and vibration group (n = 14) average age of 21.64 ± 1.91 years, participated voluntarily in the study. SPSS 22 package program was used for statistical analysis of the data. Since the data show normal distribution, paired-samples t-test and independent-samples t-test were used in the analysis of the data. There was no significant difference between the groups in the comparison of the age, sport age, height, BW and BMI variables of the vibration and control groups ($p>0.05$). When the 6 m and 9 m shooting velocity values of both groups were compared both within the group (pre-test/post-test) and between the groups (control-vibration), there was no significant difference in the rate of shot before and after vibration practices ($p > 0.05$). In the comparison of the 6m and 9m hit point values, another parameter of our study, a significant difference was found between the 6m hit point post-test value of the vibration group and the control group post-test value in favor of the vibration group ($p < 0.05$). No significant difference was found in other comparisons of the vibration and control groups ($p > 0.05$). According to the results of this study, it was determined that the 30 Hz frequency acute vibration protocol applied to the upper extremity in handball players produced a clinical increase in shot velocity and hit accuracy, but this increase was not statistically significant. Seeing different results in the literature suggests that more detailed research on vibration studies should be done.

Keywords: Accuracy, handball, hitting, velocity, vibration.

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INTRODUCTION

Vibration is defined as mechanical oscillations that occur as a result of periodic movements that occur regularly or irregularly in relation to the initial position of an object. The amplitude (magnitude of the oscillation) of the vibration is defined in millimetres as the number of completed vibrations in unit time, while the vibration frequency is determined in Hertz (Hz) (Cardinale and Bosco, 2003). Whole body vibration is defined as the practices of mechanical oscillations to the body through a vibration platform (Tomás et al., 2011). The biggest advantage of vibration training is that it stimulates a large number of muscle fibers and increases the number of sarcomeres that contract in the muscle cell due to the increase in the activation of the muscle spindles shortly after the muscle is applied. Therefore, it creates involuntary contractions in the muscle and these contractions increase gradually and continue at a constant level until the practice of vibration ends (Latash, 1998).

In recent years, vibration practices have been used frequently as a training method. Due to the potential of vibration training to increase power generation capacity in the lower and upper extremities and its effects on neuromuscular systems, the use of vibration training for neuromuscular training is becoming increasingly common

(Cardinale and Wakeling, 2005).

Various researches have been done on vibration training. Vibration training provides acute and chronic adaptations and improvements in different groups, and there are studies showing that it has positive effects on strength (Torvinen et al., 2002a; Delecluse et al., 2003; Ronnestad et al., 2004; Turner et al., 2011), on power (Bosco et al., 1999; Delecluse et al., 2003; Kim et al., 2016), on balance (Fort et al., 2012; Despina et al., 2014; Ritzmann et al., 2014; Dallas et al., 2014; Cloak et al., 2016), on flexibility (Van den Tillaar, 2006), on velocity (Mc Bride et al., 2009), on joint motion angle (Cochrane, 2013), on bone mineral density (Cardinale and Rittweger, 2006), and on body composition (Aykora et al., 2017; Demirel et al., 2017).

Handball is a sport in which a variety of skills are mixed, requiring biomotor skills such as muscular strength, velocity and endurance, and these skills interact with each other. In handball, athletes have to use both the lower and upper extremities fairly intensively. For example, running, jumping, deception movements for the lower extremity; holding-pushing, block, shot velocity, such as hitting movements for the upper extremity requires strength and skill. The most important element in handball is scoring goals, which depends on the quick and accurate movement of the ball to the goal (Şimsek, 2019). The effect of vibration practices on neuromuscular performance has been evaluated, and this study is based on the fact that vibration practices can positively affect shot velocity and hitting skills in handball players. The aim of this study was to examine the effects of acute vibration on the upper extremity in handball players on shot velocity and hit accuracy.

METHODOLOGY

Study group

A total of 28 female handball players who played licensed handball in different clubs and actively trained in Kayseri, control group (n = 14) with an average age of 21.57 ± 1.91 years and vibration Group (n = 14) with an average age of 21.64 ± 1.91 years, participated in this study as volunteers. The groups were determined by randomized method. The study included handball players who verbally stated that they did not have any health problems (orthopaedic injury or other injury) that would prevent them from participating in vibration practices and shooting. Participants were informed about the measurements to be made prior to the study. Study measurements were made between 14:00 and 16:00.

Measurement of height, length, body weight and body mass index

The length measurement of the athletes participating in the study was measured with a precision of 0.1 cm barefoot, while the body weight (BW) measurement was measured with a precision of 0.1 kg barefoot and with shorts and T-shirts on it. The body mass index (BMI) values of the athletes were calculated with the formula BW/ Lenght^2 and recorded in kg/m^2.

Shot velocity

The Stalker Solo II (Plano, USA) brand gun radar device was used to determine the velocity of the handball players ' shots. In measurements, the radar device is fixed to the target point 1 m ahead of the shot line so that it is not affected by limb movements or other movements and does not disrupt the handball player's shot (Figure 1). A total of 5 shots were shot as fast and accurate as possible and the arithmetic average of the shots were noted. The shot rate is set to be the highest velocity reached by the ball and is recorded in m/sec (Şimşek, 2019).

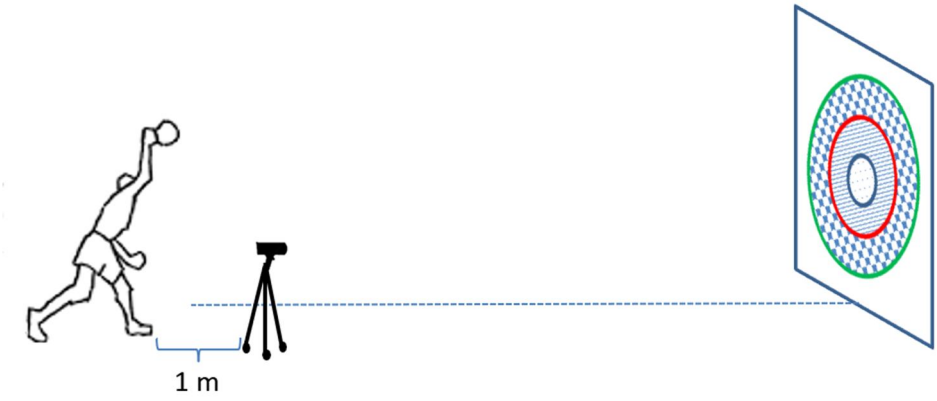

Figure 1. Shoot velocity scheme (Şimşek, 2019).

Hit accuracy

The athletes were shot at a distance of 6 and 9 m from the target. The diameter of the target circle on the wall, the center point of which is 150 cm above the ground, has been determined as 3 zones from inside to outside, with the 1st zone = 40 cm, 2nd zone = 80 cm and 3rd zone = 120 cm (Figure 2). 5 shots were made as fast and accurate as possible without violating the line, and the arithmetic mean of the scores obtained was recorded. Athletes scored 3 points from the 1st zone for each hit, 2 points from the 2nd zone and 1 point from the 3rd zone. Athletes could not score points from their shots outside the third zone (Şimşek, 2019).

Vibration practices

In the study, DKN XG10 vibration device was used for vibration practices. Vibration was applied to the athletes for 30 seconds at 30 Hz. All exercises were introduced visually to the athletes and the application criteria were explained before the practice started. In the study, 4 different exercises applied to the upper limbs were done with 30-second rest intervals. These exercises are; Shoulder Press, Advanced Triceps, Biceps Curl and Advanced Push-Up movements (Figure 3).

Study protocol

A standard handball ball specified by the International Handball Federation guidelines were used (diameter = 54 to 56 cm, weight = 325 to 375 g). Shots were performed from standing with one limb in front of the body (Figure 1). The study protocol was applied in the order shown in Figure 4.

Statistical analysis

The data obtained in the study were evaluated in SPSS 22 package program. The normal distribution indicators of the data were examined with the shapiro-wilk test, skewness-kurtosis values and histogram graphs. Since the data fit the normal distribution, paired-samples t test was used for intra-group comparisons, and independent-samples t-test was used for inter-group comparisons.

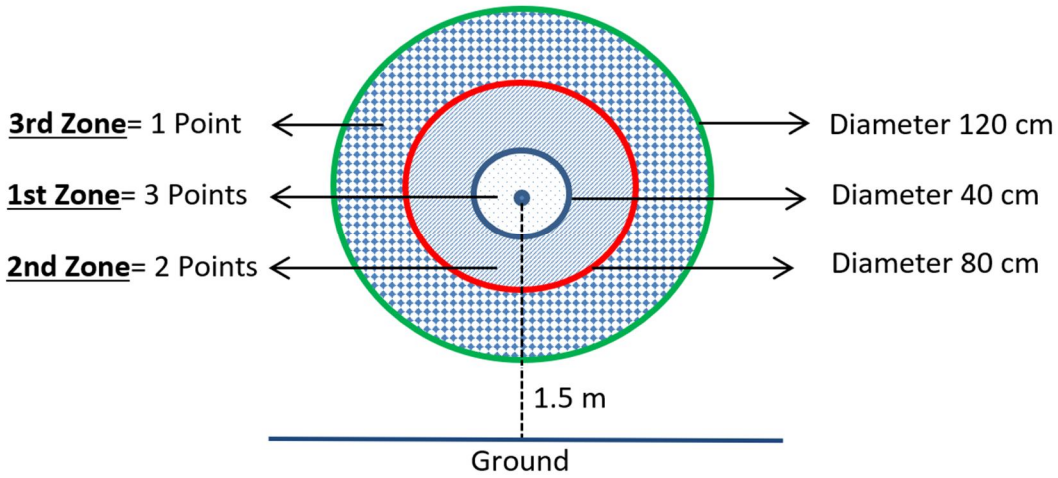

Figure 2. The target circles on the wall (Şimşek, 2019).

Figure 3. Vibration exercises.

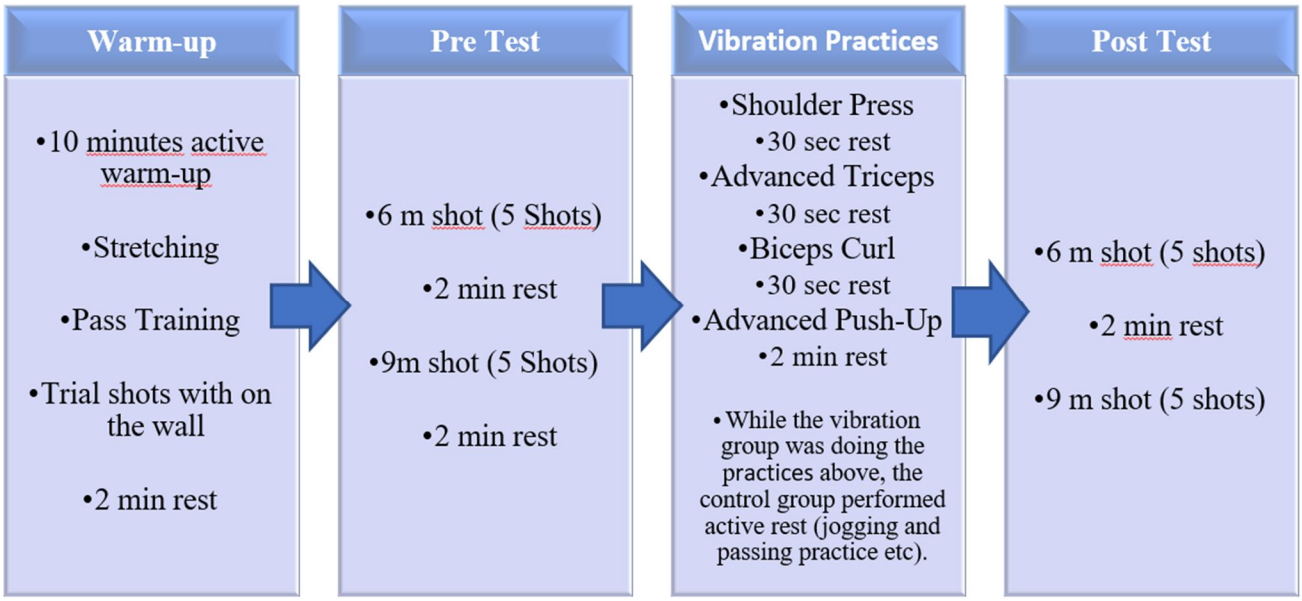

Figure 4. Study protocol scheme.

RESEARCH FINDINGS

In Table 1, the age, sport age, height, BW and BMI variables of the volunteers participating in the study are given as mean / standard deviation values and comparisons between these variables between vibration and control groups. According to the results obtained, there was no significant difference between the variables showing the demographic information of the vibration and control groups ($p > 0.05$).

Table 2 shows both the intra-group (pre-test-post-test) and inter-group (control-vibration) comparisons of the 6 and 9 m shooting velocity parameters of the vibration and control groups. According to the results obtained, no significant difference was detected in 6 and 9 m shot velocity after the vibration practices ($p > 0.05$).

Table 3 shows the comparison of the 6 and 9 m hit point parameters of the vibration and control groups both within the group (pre-test/-post-test) and between groups (control-vibration). According to the results obtained, a significant difference was detected between the 6m hit point post-test value of the vibration group and the post-test value of the control group in favor of the vibration group ($p < 0.05$). When looking at other comparisons of the vibration and control groups, no significant difference was detected ($p > 0.05$).

Table 1. Descriptive information.

	Group	n	Mean	Standard deviation	t	p
Sports age (years)	Vibration	14	4.93	4.48	-.355	0.725
	Control	14	5.50	4.01		
Age (years)	Vibration	14	21.64	1.91	.099	0.922
	Control	14	21.57	1.91		
Height (cm)	Vibration	14	165.42	6.53	-.206	0.838
	Control	14	165.87	4.89		
BW (kg)	Vibration	14	58.43	5.85	-.976	0.338
	Control	14	61.78	11.43		
BMI (kg/m^2)	Vibration	14	21.33	1.35	-1.105	0.279
	Control	14	22.35	3.20		

Table 2. Comparison of volunteers' shot velocity parameters within and between groups.

		Vibration (n = 14)	Control (n = 14)	t	p
6 m shot velocity (m/s)	Pre-test	14.29 ± 1.39	14.55 ± 1.18	- .540	0.594
	Post-test	14.35 ± 1.37	14.96 ± 1.33	- 1.273	0.214
	t	- .315	- 1.673		
	p	0.758	0.118		
9 m shot velocity (m/s)	Pre-test	14.56 ± 1.40	14.75 ± 1.22	- .377	0.709
	Post-test	14.58 ± 1.57	15.19 ± 1.43	- 1.080	0.290
	t	- .094	- 1.673		
	p	0.927	0.118		

Table 3. Comparison of the volunteers' hit point parameters within and between groups.

		Vibration (n = 14)	Control (n = 14)	t	p
6 m hit point	Pre-test	1.61 ± .60	1.53 ± .54	.395	0.696
	Post-test	1.86 ± .45	1.39 ± .67	2.185	**0.038***
	t	- 1.635	.842		
	p	0.126	0.415		
9 m hit point	Pre-test	1.13 ± .38	.97 ± .44	1.016	0.319
	Post-test	1.07 ± .45	1.06 ± .60	0.071	0.944
	t	.414	- .633		
	p	0.686	0.538		

*p < 0.05.

DISCUSSION

This study was conducted to investigate the effects of acute vibration practices on upper extremities on rate and accuracy of female handball players. In the study, no significant difference was detected in handball players' 6 and 9 m shooting velocity and accuracy after acute vibration practices. In the results obtained, only a significant difference was found between the vibration group's 6 m hit point post-test value and the control group's post-test value in favor of the vibration group.

Body vibration practices result in acute improvements in lower limb performance, such as countermovement jump, velocity, agility, flexibility and penalty kick in football (Cochrane and Stannard, 2005; Cormie et al., 2006; Pojskic et al., 2015; Şengür et al., 2018; Gelen et al., 2008) other studies have not reported beneficial acute effects of vibration (De Ruiter et al., 2003; Torvinen et al., 2002b).

Upper body vibration (UBV) has been used in only a few studies. Nepocatych et al. (2010) reported that the use of acute upper body vibration in warming has no positive effect on swimming performance. Cochrane and Hawke (2007) did not detect a significant effect of UBV on medicine ball shot and hand grip strength. Bosco et al. (1999) found a significant increase in average electromyographic (EMG) activity during 5 min of UBV and a significant increase in mechanical power during maximum dynamic elbow flexion. Therefore, it is quite difficult to determine whether UBV affects performance based on these findings (Nepocatych et al., 2010).

Few studies investigating the effect of acute vibration practices on shot rate or accuracy have been found in the literature. Galazoulas et al. (2019) examined the effect of acute vibration practices on upper extremity at the amplitudes of 2-4 mm and 40 Hz in elite male adolescent handball players. As a result of the acute vibration practices (2 and 4 mm), they found that handball players had a significant increase in the rate of shot (Galazoulas et al., 2019). Similarly, Ebrem et al. (2008) examined the acute effects of vibration on shot performance in handball and obtained positive results (Soylu et al., 2012). However, in our study, contrary to these studies, it has been determined that the vibration practices applied to the upper body have no positive effect on the rate and accuracy of the shot. In fact, it creates the tonic vibration reflex in the muscle due to the increase in the activations of the primary terminations of the muscle spindles of the applied vibration workouts, thereby creating an increase in contraction power (Cardinale and Bosco, 2003). Therefore, it can be said that the muscles will perform stronger contractions and cause an increase in power

output. In parallel with this situation, an increase in the rate of shot was expected after the handball players' vibration practices. However, the results show that the vibration practices do not affect the handball players' velocity of 6 and 9 m. This situation is thought to result from different vibration protocols applied. While Galazoulas et al. (2019) performed vibration practices at the 40 Hz level and in the shot position, we performed the 30 Hz level in our study and the exercises that used 4 different muscle groups in the upper extremity. Therefore, it seems that the preferred exercise protocol, frequency and amplitude are very important factors.

On the other hand, the most important factor in handball is to score a goal. Çetin and Balcı (2015) stated that the ability to score goals depends on the ball velocity and accuracy (hit) of the shot. There are studies in the literature that examine the hit accuracy, but each has different protocols. Since it is unlikely that the results obtained can be compared with those in the literature, percentage comparisons have been made by calculating the percentage of the maximum score that can be obtained from each protocol. It was thought that it would be appropriate to discuss the findings of the study in this context. In our study, it was determined that the maximum score that the vibration group can get from the shots from 6 m can get 54% before the vibration protocol, 62% after it, 38% before the 9 m protocol and 36% after it. In a similar protocol, it is observed that Şimşek (2019) achieved 58% of the maximum score that female handball players can get in a 6 m shot, and 37% in 9 m. Akyüz et al. (2019), on the other hand, determined that the elite male handball players received 33% of the maximum score that can be obtained in shots shot at a distance of 7 m before the fatigue protocol, and 37% after the protocol. In our study, the hit rates obtained after vibration practices seem to be higher than those in the literature. According to the results obtained, there was an 8% increase in the hit points of 6 m shots in the vibration group after the vibration practices. Contrary to this situation, there was a 5% decrease in the values of the control group. Therefore, there was a 16% difference between the two groups in favor of the vibration group and this difference was found to be significant. These results partially support previous findings showing that applied vibration exercises may increase performance and neuromuscular response in the upper limb muscles (Galazoulas et al., 2019; Mischi and Cardinale, 2009). In addition, antagonistic muscle relaxation (Ritzmann et al., 2018) occurring during vibration is likely to have resulted in improved motor coordination (Eklund and Hagbarth, 1966). As a result of the improvement of motor coordination, it can be said that the athletes may have contributed to shooting more accurately.

As a result, the main goal to win in handball is to score a goal, which depends on a quality shot (Şimşek, 2019). Considering that the shot rate and the hit score have a high level relationship (Şimşek, 2019), it is seen that both the shot hit and the shot velocity should be improved for a quality shot. Improving the rate of shot (Galazoulas et al., 2019) and hit rates is one of the main goals of handball players, coaches and scientists interested in this field. According to the results of this study, it was determined that the 30 Hz frequency acute vibration protocol applied to the upper limb in handball players created a clinically increase on the rate and accuracy of the shot, but this increase was not statistically significant. The fact that different results are seen in the literature indicates the need for more detailed researches about vibration studies. In subsequent studies, it is suggested that conducting studies on the rate and accuracy of shot, especially at different Hz and amplitudes, simulating protocols for hit measurement, and in the studies both the number of elite athletes and the group should be higher.

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