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Myoelectrical study of the effects of vibration stimulation on upper limb muscles' strength training

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ABSTRACT

In this study, the Power-I handheld vibration strength training apparatus is used to do the static and dynamic vibration tests on upper limb muscles of 26 healthy college students, and the Mega8 channel surface myoelectrical measurement instrument is adopted to collect myoelectrical data of related upper limb muscles for analysis. The study shows that the effects of vibration training device on the discharge of upper limb's working muscles are significantly higher than those without applying vibration stimulation. The average discharge of upper limb muscles has very significant differences at the moment of applying vibration stimulation with respect to without applying it. The maximum discharge (except active muscles) has significant differences. And MPF values are significantly enhanced. Myoelectrical levels produced by vibration stimulation on the forearm muscles are significantly better than that of the upper arm muscles. The closer the muscles to the source of the vibration stimulation the more obvious they accept its effect.

KEYWORDS

Vibration stimulation; Upper limb muscles; Strength training; Myoelectrical study.

INTRODUCTION

Vibration strength training is an emerging strength training method. It can effectively improve muscles' maximal strength and explosive power with a relatively small load, which attracts more and more attention of domestic and foreign experts. At present, most studies of the training effects are for the development of athletes' lower limb muscles strength, while myoelectrical studies of the vibration stimulation on upper limb muscles are relatively less. In this study, China's self-developed handheld vibration strength training apparatus is used as experimental equipment in the static and dynamic vibration tests on upper limb muscles of 26 healthy college students. And the study collects myoelectrical data of related upper limb muscles for research. It tries to explore more effective ways and means to improve the effects of muscles' vibration strength training.

RESEARCH METHOD

Literature review method

Through logging China journal mirror network, Baidu, Google and other search engines and some foreign related sites, and through domestic vibration training equipment sales companies, this study accesses to relevant documents about vibration training, within which the articles of English literature are more than 70, domestic literature are more than 20. Through literature review, the required information is obtained.

Experimental method

Experimental instrument

Power-I handheld vibration strength training apparatus (patent number: 201120062910.4) is developed by Beijing Research Institute of Sports Science. The vibrator is biaxial eccentric symmetry mode of vibration, and its vibration frequency is 10~ 40Hz.

The Finland Mega8 channel surface myoelectrical measurement instrument and its supporting software systems conduct spectral analysis, statistical calculations (integral, differential), smooth processing and various signal processing to the obtained myoelectrical signals, then they measure and study muscles' physiological changes during exercising. Set the sampling frequency as 1000Hz.

Experimental scheme

Before the experiment, the subjects do low-intensity warm-up activities. Its focal point is to stretch ligaments and muscle tissue around the joints of shoulder, elbow and wrist of the arms. And each subject does five minutes of practice with the handheld vibration training apparatus to adapt to it. The myoelectrical sampling sites are the anterior bundle and median bundle of deltoid muscles, biceps, long head of triceps of the upper arm, and brachioradialis of the forearm, flexor carpi radialis and forearm extensor group. After the skin of measured muscles is processed, paste electrode chips and do static and dynamic vibration tests on upper limb muscles. The right hand grips vibration strength training apparatus, and the vibration frequency is 40Hz.

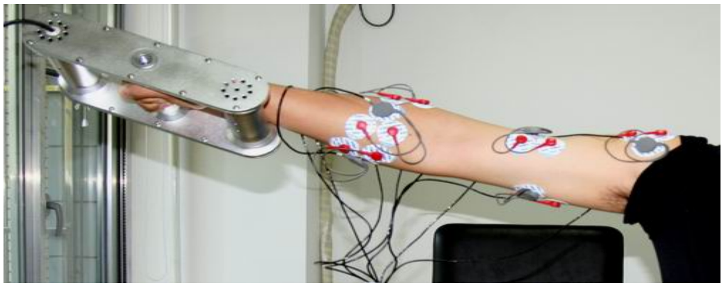

Figure 1 : Experimental test

In the experiment, the subject naturally stands. Two arms do static lateral raise 30s, and each test time is 30s. Both arms' acquisition time of myoelectrical data is the intermediate 10s. After the subject rests 5~6min, he performs upper limb muscles dynamic vibration test. He naturally stands, and the two arms do dynamic lateral raise 10 times. The right hand holds vibration strength training apparatus, and two arms do outreach 10 times within 30s (average 3s outreach once). Record the myoelectrical data of two arms and do a comparative analysis.

Data Processing

The data that are obtained before and after the experiment are all processed mean and standard deviation by using SPSS13.0. Respectively do non-parametric tests to the above experimental data, and use two paired sample Wilcoxon signed rank test to analyze.

RESULTS AND ANALYSIS

Comparative analysis of the test muscles' myoelectrical averages

TABLE 1 : Comparison analysis of the muscles' myoelectrical averages

	Static Lateral Raise		Dynamic Lateral Raise	
	Non-vibration	Vibration	Non-vibration	Vibration
Radial flexor carpi	50.11±14.95	193.89±50.11**	43±13.15	183.78±35.06**
Ulnar flexor carpi	32.78±9.73	168.44±50.01**	39±15.52	173.78±44.94**
Forearm extensor	115.56±47.71	237.44±36.86**	84.78±33.47	213.11±44.38**
Brachioradialis	68.33±20.93	136.11±40.87**	58.22±18.88	129.67±35.75**
Biceps	69.89±25.83	101.11±24.70**	48.33±11.70	85.00±18.00**
Triceps	36.67±14.04	77.33±24.73**	35.78±13.07	78.00±25.60**
Deltoid median bundle	326.44±203.53	348.11±211.07	230.56±12.07	274.78±52.52*
Deltoid anterior bundle	194.33±51.17	227.00±45.65**	160.11±59.5	183.33±73.21

*** means significant difference, * * means very significant difference**

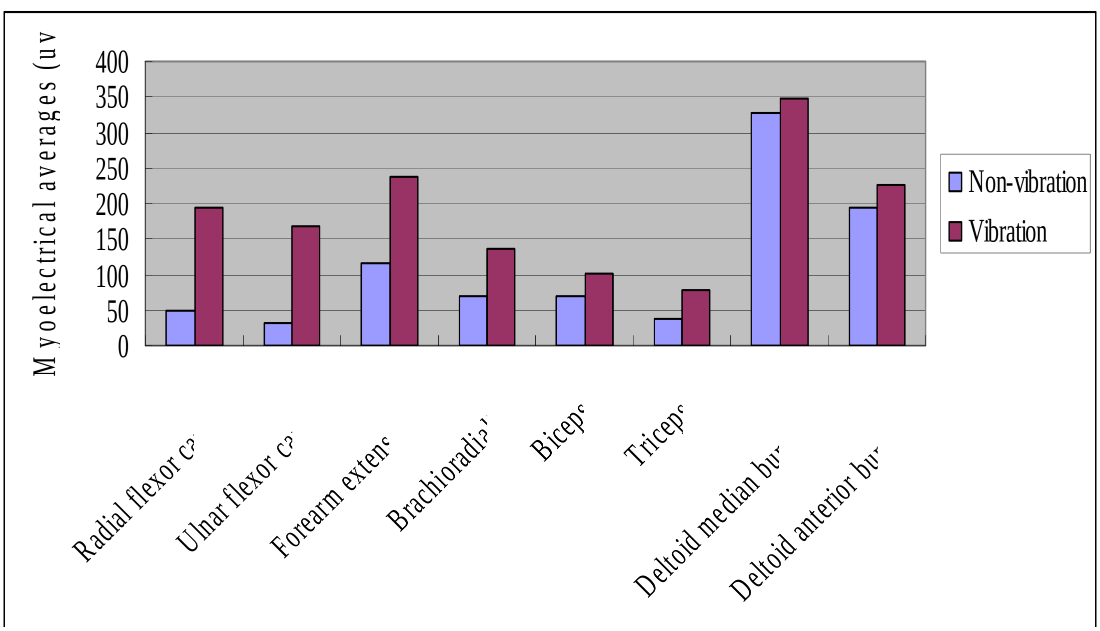

Figure 2 : Comparison of myoelectrical averages of upper limb static lateral raise in conditions of vibration and non-vibration

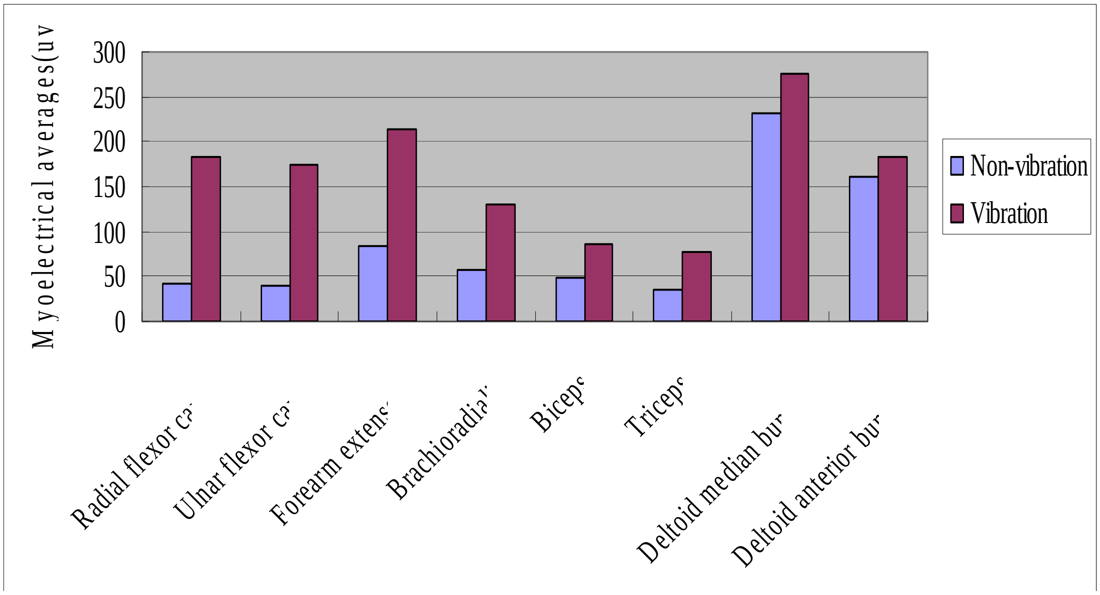

Figure 3 : Comparison of myoelectrical averages of upper limb dynamic lateral raise in conditions of vibration and non-vibration

From TABLE 1, it is known that in the states of applying vibration stimulation or without applying it, the myoelectrical averages of the subject's selected eight muscles are significantly enhanced in both tests of static lateral raise and dynamic lateral raise. After being tested, except deltoid median bundle in the test of static lateral raise and deltoid anterior bundle in the test of 10 times of dynamic lateral raise show no significant differences ($P>0.05$), other muscles all possess highly significant ifferences ($P<0.01$). This shows that applying mechanical vibration stimulation to the upper limb muscles can increase muscle strength. Vibration stimulation can activate more muscle fibers of upper limb muscles to involve in contraction, and can strengthen the stretch stimulation of the series elastic part of muscles. It can produce a good effect of stimulation to the strength and rigidity of the elastic component of muscles, improve the flexibility of the upper limb muscles, and produce greater strength.

Figure 2 and 3 displays that in the two tests, vibration stimulation enhances myoelectrical averages of the selected radial flexor carpi, ulnar flexor carpi, forearm extensor, and brachioradialis of the forearm muscles, which are higher than the myoelectrical averages of biceps, triceps, deltoid anterior bundle, and deltoid median bundle of the upper arm. This shows that the closer the muscles to the source of the vibration stimulation the more obvious they accept its effect.

Comparative analysis of the test muscles' myoelectrical maximum values

TABLE 2 : Comparative analysis of the muscles' myoelectrical maximum values

	Static Lateral Raise		Dynamic Lateral Raise	
	Non-vibration	Vibration	Non-vibration	Vibration
Radial flexor carpi	58.33±17.62	233.11±59.65**	55.33±16.16	226.11±48.23**
Ulnar flexor carpi	36.56±10.54	206.33±61.69**	53.56±23.42	218.89±57.93**
Forearm extensor	135.89±56.5	281.00±46.16**	121±46.81	261.56±52.08**
Brachioradialis	79.33±23.82	151.44±42.95**	75.78±17.93	152±38.44**
Biceps	85.44±30.78	120.78±30.5**	73.33±21.64	119.22±30.06**
Triceps	52.67±34.02	88.33±28.08	54.11±22.79	100.56±38.48*
Deltoid median bundle	419.78±24.48	413.56±25.65	469.67±23.91	498.00±52.57
Deltoid anterior bundle	234.22±66.56	266.22±54.86*	296.44±14.86	309.11±32.53

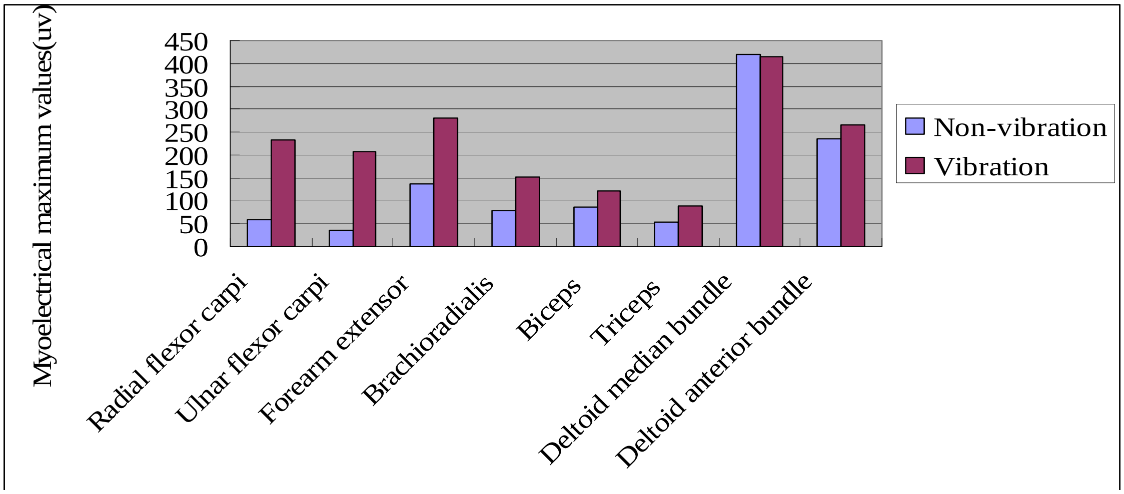

Figure 4 : Comparison of myoelectrical maximum values of upper limb static lateral raise in conditions values of upper limb static lateral raise in conditions

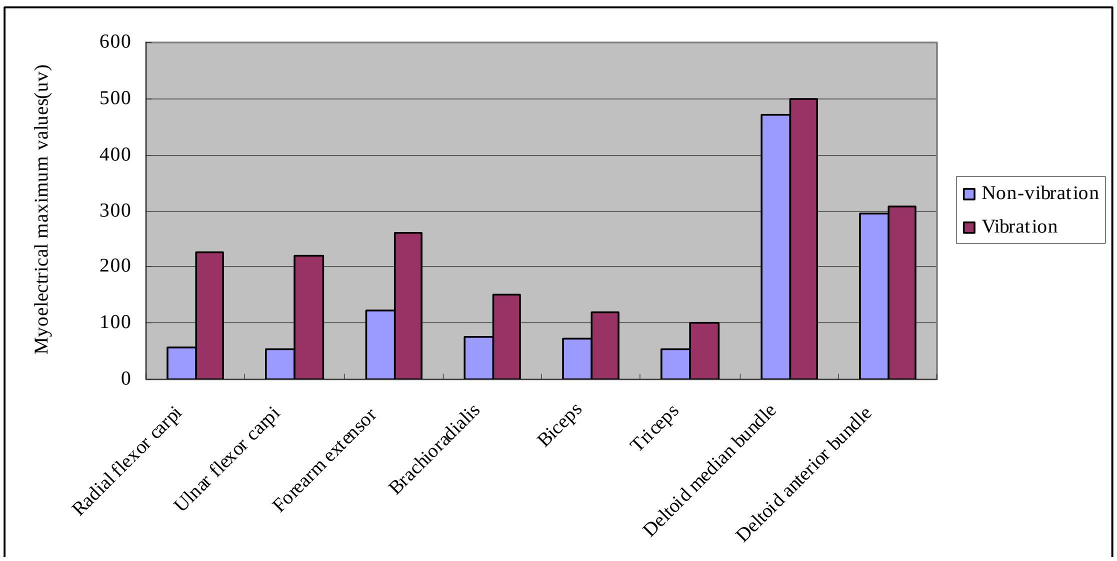

Figure 5 : Comparison of myoelectrical maximum values of upper limb dynamic lateral raise in conditions of vibration and non-vibration

From TABLE 2, it is known that in the states of applying vibration stimulation or without applying it, the myoelectrical maximum values of the subject's selected eight muscles are significantly enhanced in both tests of static lateral raise and dynamic lateral raise. By non-parametric tests, triceps and deltoid median bundle in the test of static lateral raise show no significant differences ($P>0.05$). Deltoid anterior bundle shows significant differences ($P<0.05$). Other muscles all possess highly significant differences ($P<0.01$). Deltoid median bundle and deltoid anterior bundle in the test of 10 times of dynamic lateral raise show differences ($P>0.05$). Triceps show significant differences ($P<0.05$). Other muscles all possess highly significant differences ($P<0.01$). This shows that applying vibration stimulation to the upper limb muscles can further activate and raise more muscle fibers to involve in muscle contraction, that is, applying vibration stimulation to the upper limb muscles and connective tissue can cause the contraction of proprioceptors in muscles to be more powerful.

Figure 4 and 5 displays that in the two tests, the maximum myoelectrical level of the forearm muscles produced by vibration stimulation is significantly better than that of the upper arm muscles. This means that during the conduction process in the upper limb, vibration stimulation appears attenuation phenomenon because of the influence of the viscoelasticity of muscles and connective tissue.

Comparative analysis of the test muscles' myoelectrical MPF values

MPF is an indicator that is commonly used in frequency domain analysis, which is mean power frequency, MPF.

TABLE 3 : Comparative analysis of the muscles' myoelectrical MPF values

	Static Lateral Raise		Dynamic Lateral Raise	
	Non-vibration	Vibration	Non-vibration	Vibration
Radial flexor carpi	78.22±13.13	184.78±20.89**	78.33±14.69	186.89±17.94**
Ulnar flexor carpi	82.33±17.93	190.22±20.56**	77.22±14.80	183.00±31.51**
Forearm extensor	104.89±26.34	173.22±19.11**	97.78±23.00	178.44±15.05**
Brachioradialis	66.11±6.70	120.67±28.64**	66.22±11.14	119.33±25.83**
Biceps	63.00±8.86	75.11±23.69	62.22±8.50	80.11±31.07
Triceps	77.11±10.83	133.78±41.35**	74.78±10.57	124.67±50.48*
Deltoid median bundle	85.00±13.15	93.67±16.32**	77.89±9.35	92.00±17.11**
Deltoid anterior bundle	69.44±7.6	84±11.62**	65.89±5.23	85.44±14.41**

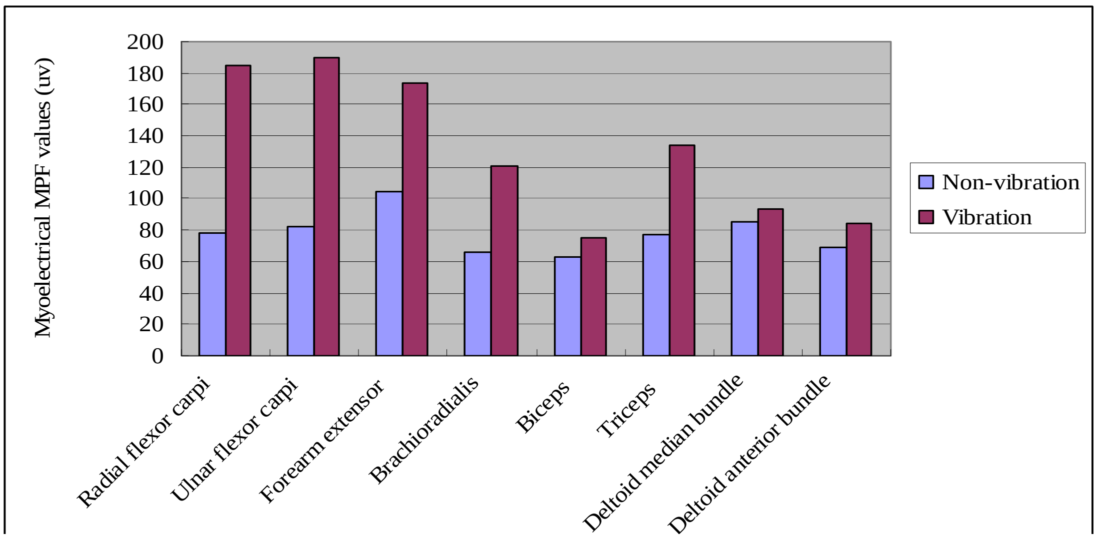

Figure 6 : Comparison of myoelectrical MPF values of upper limb static lateral raise in conditions of vibration and non-vibration

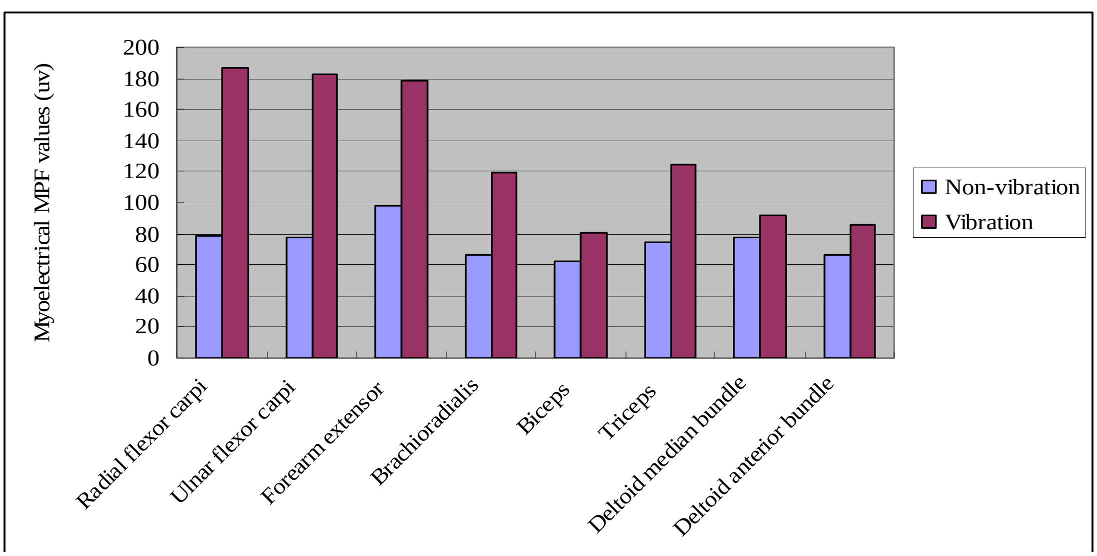

Figure 7 : Comparison of myoelectrical MPF values of upper limb dynamic lateral raise in conditions of vibration and non-vibration

From TABLE 3, it is known that in the states of applying vibration stimulation or without applying it, the myoelectrical MPF values of the subject's selected eight muscles are significantly enhanced in both tests of static lateral raise and dynamic lateral raise. By non-parametric tests, biceps in the test of static lateral raise show no significant differences ($P>0.05$). Other muscles all possess highly significant differences ($P<0.01$). Biceps in the test of 10 times of dynamic lateral raise show no differences ($P>0.05$). Triceps show significant differences ($P<0.05$). Other muscles all possess highly significant differences ($P<0.01$). This shows that applying vibration stimulation to the upper limb muscles can improve the motor neuron function of neuromuscular system when it organizing, coordinating, and controlling muscles during the process of muscle contraction. At the beginning of muscle contraction, vibration stimulation can make the nerve system quickly activate and raise muscle fibers to involve in and to increase upper limb muscle strength. It is because that mechanical vibration generates stimulation to the sensory organs of the upper limb muscles and makes their activation rate increase.

Figure 6 and 7 displays that in the two tests, the myoelectrical EMP level of the forearm muscles produced by vibration stimulation is significantly better than that of the upper arm muscles. This shows that the closer limbs to the source of the vibration stimulation the more obvious they accept its effect. From the perspective of upper limb muscles' strength training, when doing shoulder abduction strength training vibration stimulation can significantly improve the strength of the forearm muscles. Adding vibration stimulation also can enhance the strength training of upper arm muscles, which can improve the effectiveness of training.

CONCLUSION AND SUGGESTIONS

The effects of upper limb vibration training device on the discharge of upper limb working muscles are significantly higher than those without applying vibration stimulation. The average discharge of upper limb muscles has very significant differences at the moment of applying vibration stimulation with respect to without applying it. The maximum discharge (except active muscles) has significant differences. And MPF values are significantly enhanced. This shows that applying vibration stimulation to the upper limb muscles can further activate and raise more muscle fibers to involve in muscle contraction, that is, applying vibration stimulation to the upper limb muscles and connective tissue can cause the contraction of proprioceptors in muscles to be more powerful. And it can generate greater strength.

Vibration stimulation enhances myoelectrical averages of the selected radial flexor carpi, ulnar flexor carpi, forearm extensor, and brachioradialis of the forearm muscles, which are higher than the myoelectrical averages of biceps, triceps, deltoid anterior bundle, and deltoid median bundle of the upper arm. This shows that the closer the muscles to the source of the vibration stimulation the more obvious they accept its effect.

The maximum myoelectrical level of the forearm muscles produced by vibration stimulation is significantly better than that of the upper arm muscles. During the conduction process in the upper limb, vibration stimulation appears attenuation phenomenon because of the influence of the viscoelasticity of muscles and connective tissue.

The myoelectrical EMP level of forearm muscles produced by vibration stimulation is significantly better than that of upper arm muscles. From the perspective of upper limb muscles' strength training, when doing shoulder abduction strength training vibration stimulation can significantly improve the strength of the forearm muscles. Adding vibration stimulation also can enhance the strength of upper arm muscles, which can improve the effectiveness of training.

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REFERENCE

[1] Ren Manying, Yan Qi, Liu Ying; Comparative study of the effects of different frequencies of whole-body vibration stimulation of lower limb muscles' strength training [J], Sports Science, **(12,2008)**.

[2] J.Luo, B.Mcnamara, K.Moran; The use of vibration training to enhance muscle strength and power, Sports Medicine, **(2005)**.

[3] K.Peter; The ABC of EMG-A practical introduction to kinesiological electromyography [EB/OL], **(2005)**.

[4] C.Bosco, M.Cardinale, O.Coll, et al; The influence of whole body vibration on jumping performance [J], Biology of Sport, **(1998)**.

[5] C.Bosco, M.Cardinale, R.Colli, et al; The influence of whole body vibration on the mechanical behavior of skeletal muscle [J], **(1999)**.

[6] Carmelo Bosco, M.Iacovelli, O.Tsarpela, M.Cardinale, M.Bonifazi, J.Tihanyi, M.Viru, A.De Lorenzo, A.Viru; Hormonal responses to whole-body vibration in men [J], **(2000)**.

[7] Carmelo Bosco, Marco Cardinale, Olga Tsarpela; Influence of vibration on mechanical power and electromyogram activity in human arm flexor muscles [J], **(1999)**.

[8] L.Steven Wolf, L.Richard Segal, D.Nancy Heter, A.Pamela Catlin; Contralateral and long latency effects of human biceps brachii stretch reflex conditioning [J], **(1995)**.