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Comparison of Vibration Training and Resistance Training on Quadriceps Muscle Strength in Collegiate Male Athletes

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Abstract: Present study aim towards comparing the effects of five weeks of vibration training and resistance training on quadriceps muscle strength in collegiate male athletes.20 healthy collegiate male athletes were recruited, based on inclusion and exclusion criteria in a pre-post experimental study. Randomization of the subjects was done in two equal groups, group A (n=10) and group B (n=10). Group A received vibration training programme (resistance training and direct vibration), 3 sessions per week for five weeks, while group B received resistance training programme, 3 sessions per week for five weeks. Direct vibration stimulus was given using Beurer™ vibrator of 50 Hz and resistance training was set basis daily adjusted progressive resistive exercise protocol.Muscle strength, as one repetition maximum, of quadriceps muscle was assessed pre and post intervention.Between group analysis showedmean difference of one repetition maximum (1RM) for group A and B, 7.4±1.5kg, and 7.1±1.2kg respectively, with t= 0.479, p=0.63.Within group mean difference of pre and post intervention for group A & B were 18.3±4.37kg, 25.7±3.65kg, and 20.7±2.77kg, 27.8±2.34kg respectively, with t=15.543, p=0.001, t=17.45, p=0.001.Study concludes that five weeks of vibration training and resistance training were equally effective in increasing quadriceps muscle strength in collegiate male athletes.

Keywords: Muscle Strength, Resistance Training, Vibration Training

I. Introduction

Muscular performance plays vital role in performance of athletic activities as well as for the preservation and improvement in functional aspects of daily life. One of the key element of muscle performance is muscle strength, which is defined as the force exerted by a muscle or a group of muscles to overcome a resistance under a specific set of circumstances. Much research supports the notion that greater muscular strength can enhance the ability to perform sports skill and also indicates that stronger athletes produce superior performances during sport specific tasks. Moreover, greater muscular strength not only allows an individual to potentiate earlier and to a greater extent, but also decreases the risk of injury.There are many methods which can be utilized to increase muscle strength, out of which, resistance training still remains the most popular method [1]. Current literature suggest that resistance training when given in combination with vibration, suggested as vibration training or vibration exercise, yields more strength gains[2-4].

Vibration training is given as a mechanical stimulus characterized by oscillatory motion delivered to entire body or specific part of the body along with resistance training. Research studies hypothesize that mechanical vibration stimulus given to the body either through whole body vibration technique or vibration given to the specific part of the body causes postural displacement which produces stretch reflex and stimulates muscle spindles. Muscle spindles send impulses to alpha motor neuron which facilitates the activation of high threshold motor units and ultimately initiates muscle contraction. This process of muscle contraction through vibration stimulus is known as tonic vibration reflex [5,6].Literature advocate two methods of application of vibration stimulus during exercise. In the first method, vibration is applied directly to the muscle belly or tendonof the muscle being trained, by the help of a hand held vibrator [7-10] and in second, the vibration is applied indirectly to the muscle, means the vibration is transmitted from a vibrating source away from the target muscle through vibrating other body part [11].Effects of direct and indirect method of vibration training have been well documented like improvement in muscular strength and power development [11-15], increase kinesthetic awareness [16], prevent bone loss [17], and delay in fatigue [18,19].Toestablish framework for clinical decision making when improving muscle strength thereby enhancing muscular performance, this study aim towards comparing vibration training and resistance training on quadriceps muscle strength in collegiate male athletes.

II. Materials And Methods

20 healthy collegiate male athletes of mean age (23.0±1.82yrs), and (23.4±1.57yrs), height (175.5±3.86cm), and (175.3±3.77cm), and weight (73.1±4.38kg), and (73.4±5.75kg) respectively,participated in a pre-post experimental study. Athletes who suffered any musculoskeletal injury in past 6 months, suffering from any systemic disorder, involved in any other training programme or had any neurological problem were excluded from the study. Subjects were randomly allocatedto two equal groups, group A (n=10) and group B (n=10). Group A received vibration training programme (resistance training and direct vibration), 3 sessions per week for five weeks, while group B received resistance training programme alone, 3 sessions per week for five weeks. Direct vibration stimulus was given using Beurer™ vibrator of 50 Hz and resistance training was set basis daily adjusted progressive resistive exercise protocol.The participants were instructed to avoid any physical activity on the day of assessment, to wear comfortable attire and to take the necessary care with feeding and hydration. Written consent was obtained from all the participants before start of experimental procedure. The ethical clearance was obtained from institutional ethical committee in accordance with the guidelines laid by Helsinki Declaration (Revised 2013).

2.1 Procedure

2.1.1 Pre intervention measurement of one repetition maximum (1RM)

To start with subjects were asked to do warm-up (static cycling) for 3 to 5 minutes, followed by self-stretching of right quadriceps for 5 to 8 times. After that subjects were asked to sit on a quadriceps chair comfortably with back straight, and hip and knee in 90-90 degree position with towel underneath right thigh. Subject's right thigh was than strapped along the quadriceps chair with the help of a stabilizing belt to avoid any compensation while performing isolated knee extension for one repetition maximum measurement. Subjects were then instructed to perform 4 to 5 repetitions with weights on the chair to get familiarize with the process. At last, subjects were asked to lift the leg from 90 degree knee flexion to 0 degree knee extension and bring back to 90 degree knee flexion (as measured through goniometer attached to the quadriceps chair) one single time with maximum possible weight in an increasing order until no possible lift to get estimate of one repetition maximum[20-23]. Rest period of 2-5 minutes was given after 2-3 lifts in order to avoid fatigue [24,25].

2.1.2 Intervention

Similar protocol for warm up and stabilization was utilized before initiating vibration training programme for group A and resistance training programme for group B. Both the programmes were given for three sessions per week for five weeks. Resistance training programme was set basis daily adjusted progressive resistive exercise (DAPRE) [26]. Subjects of group A also received direct vibration stimulus on the anterior aspect of upper one third of right thigh, as calculated by measuring the length from anterior superior iliac spine (ASIS) to superior pole of patella with the help of a measuring tape and dividing it by three, by means of hand held Beurer™ vibrator atpreset frequency of 50 Hz. (Fig. 1) Rest of 2-3 minutes was given in between the sets in order to avoid fatigue [24,25]. To ensure consistency with the previous repetition, subjects were instructed to complete one repetition in approximately 2 seconds [27].

Figure 1: Site of direct vibration stimulus

2.1.3 Post intervention measurement of one repetition maximum (1RM)

After completion of five weeks of training programme, one repetition maximum (1RM) of quadriceps muscle was measured again utilizing the same procedure as in pre-test measurement.

2.1.4 Statistical analysis

The data was analyzed using SPSS 18.0. Independent t- test was utilized to find the differences between demographic and baseline data of subjects including age, height, weight, and pre-test readings of one repetition maximum of group A and group B. Between group comparison was done utilizing independent t-test while within group differences was explored using paired t-test. Level of significance was set at $p<0.05$.

III. Results

3.1 Analysis of demographic data &baselinereadings of one repetition maximum

Statistically insignificant differences in demographic data and base line measurement of one repetition maximum of right quadriceps muscle of group A as well as group B was observed. (Table 1)

Table1: Demographic Description of Subjects

	Group A Mean ±SD	Group B Mean ±SD	t value	p value
Age (year)	23±1.82	23.4±1.57	0.524	0.607
Height (cms)	175.5±3.86	175.3±3.77	0.117	0.908
Weight (kgs)	73.1±4.38	73.4±5.75	0.131	0.897

3.2 Between group analysis

The outcome variable i.e. difference of muscle strength was analyzed using independent t-test. The mean difference of 1RM for group A and B were (7.4±1.5kg), and (7.1±1.2kg) respectively. No significant difference was found between the muscle strength gain of group A and B with (t= 0.479, p=0.638). (Table 2) (Fig. 2)

Table 2: Between group comparison of 1RM

	Group A Mean ±SD	Group B Mean ±SD	't' value	'P' value
Diff 1 RM (Kgs)	7.4±1.5	7.1±1.28	0.479	0.638

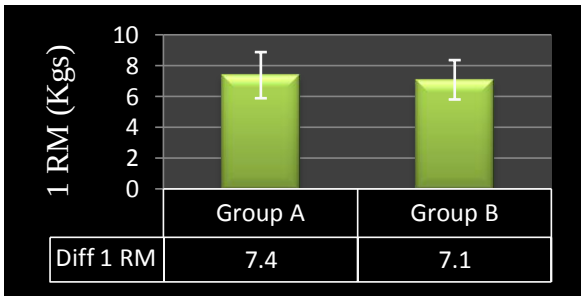

Figure 2: Between group comparison of 1RM

3. 3 Within group analysis

To analyze the difference within group A & B paired t test was used.The mean of 1RM pre and post intervention within group A and B were (18.3±4.37kg), (25.7±3.65kg), (20.7±2.77kg), and (27.8±2.34kg) respectively.Results revealed significant differences between pre and post intervention readings of muscle strength gain with (t=15.543, p=0.001) (t=17.45, p=0.001) in group A and B respectively. (Table 3 &Fig. 3) (Table 4 &Fig. 4)

Table 3: Within group A comparison of 1RM

	Pretest 1 RM Mean ±SD	Posttest 1 RM Mean ±SD	't' value	'P' value
Group A	18.3±4.3	25.7±3.65	15.543	0.001

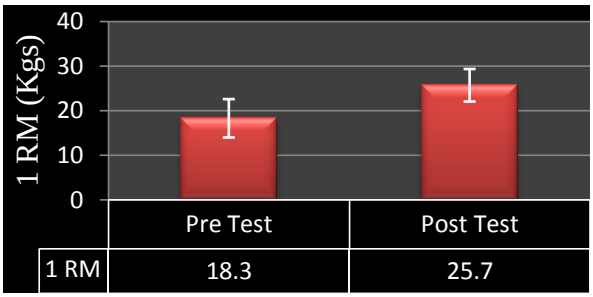

Figure 3: Within group A comparison of 1RM

Table 4: Within group B comparison of 1RM

	Pretest 1 RM Mean ±SD	Posttest 1 RM Mean ±SD	't' value	'P' value
Group B	20.7±2.6	27.8±2.34	17.45	0.001

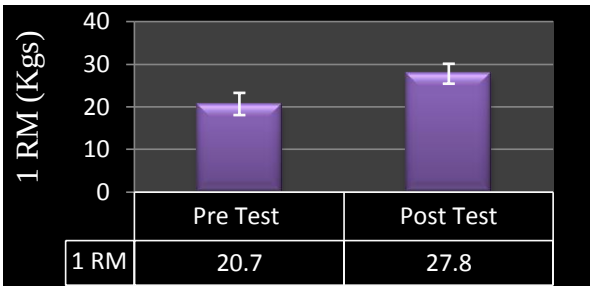

Figure 4: Within group B comparison of 1RM

IV. Discussion

Present study findings revealed that both the training programmes lead to improvements in muscle strength over five weeks of training.Similar findings were reported by a research which examine the effect of a superimposed muscle/tendon vibration at 50.42±1.16 Hz (acceleration 13.24 ± 0.18ms^{-2}: displacement ≈5mm) on muscular activation and maximal isometric contraction. Sixteen participants with a mean age, body mass, and height of 22 ± 4.4 years, 73.2 ± 11.7 kg and 173.1 ± 9.7 cms, respectively, were recruited for this study. Electromyography and accelerometry from the rectus femoris, and maximal isometric force data characteristics were collected from the dominant limb under conditions of vibration, and no-vibration. A superimposed 50 Hz vibration was used during the contraction phase for the maximal isometric leg extension for the condition of vibration. A one-way ANOVA revealed no significant ($p > 0.05$) differences between the vibration and no-vibration conditions for peak normalized EMG_{RMS} (84.74% Vs 88.1%) values. An ANOVA revealed significant ($p > 0.05$) differences between the peak fundamental frequencies of the FFT between the conditions vibration (27.1 ± 12.2 Hz) and no-vibration (9.8 ± 3.5 Hz). Peak isometric force, peak rate of force development, rate of force development at times 0.05, 0.01, 0.1, 0.5 seconds, and rate of force development at 50, 75, and 90% of peak force were not significantly different. The results suggested that the application of vibration stimulation at 50 Hz during the contraction does not contribute to muscle activation, or enhance force production for maximal isometric contractions [9].

An explanation of present study findings could be given basis previous research which explored the effect of vibration training on isometric force production. Researcher reported that there was no significant increase in the isometric force after vibration training. They reported that the muscles attached via long thin tendon displaying a better response to stimulation, while muscles having short tendon were the least responsive. Investigators further referred that the elastic and viscous properties of the muscle also played a role in force response to vibration training [14]. Another study which investigated the response of human muscle to vibration stimulation concluded that vibration given on tendon elicits better response in muscle activation when compared with vibration delivered on muscle belly, as could be the added explanation of present study findings [28].

Justification for the present study findings could also be made on the basis of time period for which the athletes were exposed to vibration stimulation in a single session. Previous studies have shown that increase in muscle strength following vibration training program was seen in the subjects who were exposed to vibration stimulation for longer period in a single session. In the present study the vibration exposure to the subjects was delivered only for 1 to 2 minutes in a single session. Literature suggest that prolonged exposure of vibration stimulation causes increase motor unit activation which could possibly encourage strength gain [29].

V. Conclusion

Present study concludes that five weeks of vibration as well as resistance training programme were found to be equally effective in enhancing quadriceps muscle strength in collegiate male athletes.Findingsof this study could be utilized further to make clinical decision for selection of appropriate intervention in order to enhance muscular strength. Future researchwith larger sample size and increased durationof vibration stimuli is recommended to explore this topic.

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