Original Article

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Efficacy of Vibrapole Abdominal Strengthening Exercises on Strength in Healthy Young Individuals: An Experimental Study

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Abstract:

Objective: To analyze and compare the effects of Vibrapole exercises and elastic band exercises on abdominal strength in young healthy individuals.

Material and Methods: In this experimental study, 80 healthy, young individuals between the age groups of 18–24 were screened and recruited and then allocated into 2 groups. Group A– abdominal strengthening exercise using vibrapole (n=40) and Group B– abdominal strengthening exercise using an elastic band (n=40). The intervention was administered for 3 days/week, for 4 weeks to both groups. Progression was adjusted after 2 weeks, by increasing repetitions of exercises from 10 to 20. Outcome measures, including: surface Electromyography (EMG), pressure biofeedback and 7 stage sit–up test, were assessed pre and post–intervention. The analysis was performed with a 95% confidence interval.

Results: Group A and B showed significant improvement (p–value<0.001) when analyzed individually for surface EMG, pressure biofeedback and 7–stage sit–up test. Group A showed more improvement in abdominal strength than group B in surface EMG (Mean Difference–Group A: 159.27±48.84 and Group B 126.32±39.96) and in 7–stage sit–up test (Mean Difference–Group A: 2.12±0.64 and Group B 1.67±0.57) as p–value<0.01. Pressure Biofeedback showed non–significant differences among the groups (p–value=0.2201).

Conclusion: This study concludes that strengthening exercises using Vibrapole was more effective in increasing abdominal muscle strength than elastic band exercises. Hence Vibrapole can be used by physiotherapists as an effective tool to improve abdominal strength.

Keywords: biofeedback, core, elastic band, EMG, sit–up test, vibrapole

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Introduction

Physical Fitness is a state of health that can be indicated by the ability to execute daily activities and exercise[1]. Hence, to achieve specific fitness goals, for improving performance in daily activities, one must prescribe core strengthening exercises[2]. The core group of muscles work as stabilizers and mobilizers to control the pelvis and spine, and therefore influence the legs and upper body. Global muscles of the abdomen, such as the Rectus Abdominis and the External Oblique, contribute to the overall stabilization of the trunk by generating a wide range of movements and torque of the trunk and pelvis. In contrast, the Transverse Abdominis and the Internal Oblique muscles work for stability and fine movements of the spine and between spinal segments[3-5]. These four major muscles contract first to increase core stability during high-impact exercises and have been shown to help prevent sports-related injuries[6]. Core strength is necessary to maintain the body in specific postures and perform effortless movement, while unloading joints and helping in activities, like sit to stand from the floor or a chair and while sitting without inducing pain.

Core physical fitness training exercises contribute to reducing the risk of musculoskeletal disorders (for examples: Excessive loading on the Lumbar Spine, Paraspinal Muscles Atrophy, and Hip Extensors imbalance), which are the outcomes of defective postures and sedentary lifestyles that may compromise the fitness of a healthy individual[7]. Common core physical fitness exercises are: sit-ups, curl-ups, planks, and resistance exercises have been around for a long time; however new exercises have been developed that add unstable surfaces, such as the Swiss ball, BOSU ball, and wobble balance board, to increase proprioceptive demands of exercise[8].

Vibrapole, also called: Flixibar, which is one of such oscillating instruments used with 1 or 2 hands. The energy required to maintain oscillations has been claimed to be the most efficient tool for core power training. Generally, it is 153 cm long, 710 g, and 9.5 mm flexible foil, having a natural frequency of 4.6 Hz: signifying that it oscillates at 270 vibrations per minute[9]. When the specific muscle groups that are targeted with a significant level of activation, it can be determined by user posture, blade position, orientation and vibration amplitude[10]. To target specific muscle groups, proximal arm movements should be minimal to reciprocate isolated movements of the hand. Still, there is limited research to date on which core exercises should be performed based on muscle activity patterns[9].

Vibrapole exercises have examined changes in muscle activities by providing vibratory stimuli that activate muscle spindles, strengthen the muscles and demonstrate greater muscular activity for the trunk and shoulder, These have been indicated to be effective in increasing trunk muscle thickness[11,12]. Greater trunk muscle activation was proven as significant with vibrapole exercises in the external oblique, the internal oblique, and the erector spinae muscles[9]. The use of vibrapole during various exercise sessions provoked immediate alteration in the arm and leg muscles on EMG parameters, and also on the maximum force-generating capacity. This indicates that it may be used to impose stronger stimulus on the desired muscles during sub-maximal exercises[13]. So, muscle activation with vibrapole, combined with concentric contraction of those muscles, may contribute to an increase in abdominal muscle strength. The purpose of this study was to compare the increase in strength of abdominal muscles through either vibrapole or elastic bands, using surface EMG, pressure biofeedback and the 7-stage sit-up test.

Material and Methods

This was an Experimental study, conducted at Dr. D.Y. Patil College of Physiotherapy, Pimpri, Pune, on 80

healthy, young individuals. Sample size was calculated considering a Confidence Interval=95%; Power=80%; Standard Deviation Group A=6.2, Standard Deviation Group B=3.1[9] using Windpipe Software version 11.65.

Inclusion Criteria included: individuals between the age group of 18 to 24 years, and with a grade level of 1-2 in the 7-stage sit-up test for abdominal strength. Exclusion Criteria consisted of: individuals having a BMI below 18.5, and higher than 28 and above, going to the gym, doing yoga, aerobics, or any exercises for the last 6 months; those having a history of recent upper limb injuries and surgeries (6 months), having low back pain, spine problems, and pathologies; including acute conditions such as fever, respiratory distress, and so forth.

Ethical approval was obtained from the institutional ethical committee: reference number: DYPCPT/IEC/29/2021, dated 18/05/2021. CTRI Trial Registration was performed and approved: registration number CTRI/2021/12/038509. Participants were screened and recruited in addition to written informed consent being obtained and included in this study. Demographic Data were collected from every participant, who were divided using the simple random allocation method (Computer generated) into either grou A or B by the examiner. Potential sources of bias were eliminated by using the simple random allocation method of sampling; age and BMI matching of both groups and blinding was conducted. This was a single-blinded study as outcome measures was assessed by a separate researcher. Abdominal strength was assessed by surface EMG, pressure biofeedback and 7-stage sit-up test. Participants of Group A underwent abdominal strengthening exercises with Vibrapole and Group B underwent abdominal strengthening exercises with an elastic band. The elastic band used was a green band as it gives the same amount of resistance as Vibrapole. The intervention was given 3 times a week for 4 weeks. The trial was commenced from: December 2021 to March 2022.

Intervention

Vibrapole exercises consisted of 9 exercises, while elastic band exercises consisted of 8 exercises. Each exercise was performed for 10 repetitions, for a 10-second hold. Then each exercise progressed to 20 repetitions post 2 weeks of intervention. The exercise duration for both groups was 30-45 minutes, at 3 sessions/week for 4 weeks.

Vibrapole abdominal strengthening exercises were: 2-handed vertical oscillation, 2-handed horizontal oscillation, 2-handed horizontal rotation, 2-handed horizontal standing cross knee lifts, 2-handed horizontal curl up; 2-handed horizontal oblique curl up, 2-handed horizontal bicycle crunch; 2-handed horizontal single leg raise and 2 handed horizontal half roll down.

Elastic band abdominal strengthening exercises were: abdominal crunches in supine, abdominal oblique crunches in supine, abdominal crunch (lower abs); trunk extension in long sitting, trunk 'Chop', trunk 'Lift'; trunk side bend overhead and trunk rotation when sitting.

Outcome measures

Surface EMG: surface EMG signals were collected using a pair of silver chloride surface electrodes placed at a 3 cm spacing between electrodes. Electrodes were attached to each subject on both sides, from the following core muscles and sites: for the rectus abdominis muscle 3 cm outside the umbilicus, approximately 15 cm lateral oblique of the umbilicus; For internal oblique muscles between the anterior superior iliac spine of the pelvis and the median plane, just above the inguinal ligament. The Motor Unit Action Potentials (QMUP) was recorded with the subject in a crook lying position when performing a curl-up[10].

Pressure Biofeedback: muscle strength was measured using a pressure biofeedback unit. The device was placed below the lumbar spine, and consists of three ventricular pressure cells that inflate to a baseline of 40 mmHg. Participants were asked to retract the abdominal

wall without moving the spine or pelvis: the pressure should remain at 40 mmHg. Participants were instructed to hold it for 10 seconds and breathe normally. The actual pressure difference from 40 mmHg was recorded[14].

7-stage sit-up test: the test has participants lie on their back, with their knees at proper (right) angles and feet flat on the floor. The participant then tries to carry out one entire sit-up for every stage within the side, in the prescribed manner beginning with stage 1. Each stage is finished if an accomplished sit-up is straight within the side in the prescribed manner; without the feet coming off the floor. As many tries as vital may be made. Scoring was judged as very poor being zero (0) to elite being seven (7). The highest level of successfully completed abdominal exercises was recorded[15].

Results

Statistical analysis was performed using MedCalc Software version 18.2.1. Mean and standard deviation were calculated. Shapiro Wilk test was used to assess the normality of data distribution. The p-value for both age and BMI was non-significant, so age and BMI in both groups matched. Within-group analysis for normally distributed data was performed via paired T-test; whereas, data which was not normally distributed was analyzed via Wilcoxon signed rank-sum test. Between-group analysis for normally distributed data was analyzed via T-test; whereas, not normally distributed data was analyzed ia Mann Whitney U test. Group A and group B showed significant improvement (p-value≤0.0001) when analyzed individually in Surface Electromyography, Pressure Biofeedback and 7-stage sit-up test. This showed both interventions were effective in improving the strength of abdominal muscles. When inter-group analysis was perfromed, pre-parameters showed a non-significant difference, indicating both the groups were comparable. Post analysis showed significant improvement in Surface Electromyography and 7-stage sit-up test (p-value<0.01). However, non-significant improvement was observed in pressure biofeedback; as p-value=0.2201. This shows that Vibrapole is more effective in improving strength of abdominal muscles as compared to the elastic band.

Table 1 Demographic details of groups A & B

Demographic Data	Group A	Group B	p-value
Age (years)	22.05±1.37	22.57±1.35	0.1264
BMI	23.53±2.66	23.05±2.62	0.4222
Gender Male	8	6	
Female	32	34	

BMI=body mass index

Table 2 Mean, standard deviation and p-value of surface electromyography, pressure biofeedback and 7-stage sit-up test

Mean±S.D.	Pre		Post	
	Group A	Group B	Group A	Group B
Surface electromyography	416.75±57.18	401.65±58.52	576.02+77.11	527.97+63.59
P-value	0.2404		0.0032*	
Pressure biofeedback	0.0032*	49.07±6.72	60.70±6.91	58.85±6.46
P-value	0.1830		0.2201	
7-stage sit-up test	1.50±0.50	1.32±0.47	3.62±0.95	3.00±0.90
P-value	0.1188		0.0054*	

*shows the significance of p-value

Table 3 Mean difference in pre and post values and S.D. and p-value of surface electromyography, pressure biofeedback and 7-stage sit-up test

Mean±S.D.	Mean difference in pre and post values and S.D.	
	Group A	Group B
Surface electromyography	159.27±48.84	126.32±39.96
P-value	0.0015*	
Pressure biofeedback	9.55±3.69	9.77±3.63
P-value	0.7843	
7-stage sit-up test	2.12±0.64	1.67±0.57
P-value	0.0015*	

*shows the significance of p-value S.D.=standard deviation

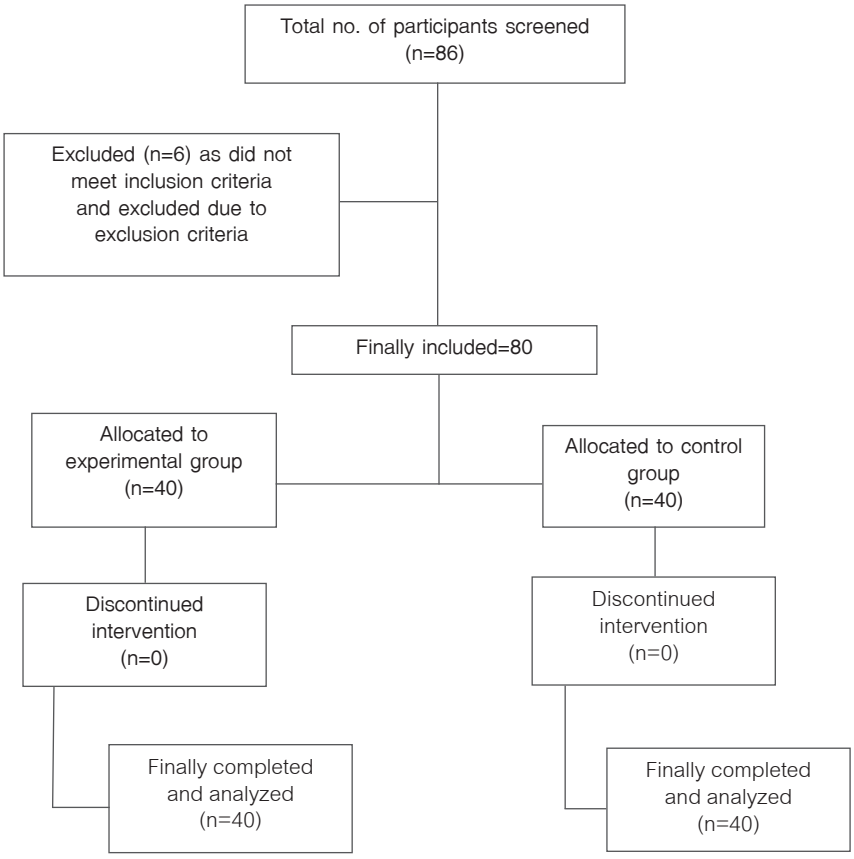

Figure 1 Consort chart

Discussion

This study aimed to determine the effectiveness in increasing abdominal muscle strength with either Vibrapole or an elastic band in healthy, young individuals. To achieve this an exercise program was selected. Participants in different groups had to perform exercises for abdominal strengthening, with vibrapole in one group and an elastic band in another group. The abdominal muscle group is the muscles for postural control, and should be strengthened to prevent low back pain in later life. A study on abdominal exercises stated that: "stability of the trunk is essential for daily life, and regular abdominal muscle strengthening should be done with adequate exercise prescription"[16].

There are various methods of abdominal strengthening that work for everyone. Resistance exercises are the most common exercises used to improve strength, such as resistance/elastic band exercises and others being Pilates or Yoga[9]. A study stated that in patients with Non-Specific Low Back Pain elastic band exercises gave more pain relief, and increased both muscle strength and functional ability compared to core stabilization exercises[17]. Vibrapole improves health-related fitness and physical fitness in overweight adults, and is useful in the activation of trunk muscles[9,16]. In contrast, a study stated that horizontal use of Vibrapole tends to be easiest to perform and abdominal curls elicit 31% of maximal voluntary isometric contraction of the rectus abdominis, and can be considered as an exercise for rectus abdominis strengthening[10]. So, Vibrapole has now been used to assess its effect on abdominal muscle strengthening and was compared with an elastic band.

The results of this study are supported by a study that has shown that 2-handed use of Vibrapole had the highest activation levels of internal oblique and external oblique, with 35% to 52% maximal voluntary isometric contraction. Additionally, horizontal use of Vibrapole showed the highest activation levels in rectus abdominis, with 16% maximal voluntary isometric contraction bilaterally. Hence, the study says that the horizontal use of Vibrapole tends to be the easiest to perform and that abdominal curls elicit 31% of maximal voluntary isometric contraction of the rectus abdominis. Therefore, it can be considered as an exercise for rectus abdominis strengthening[10]. A study contradicting this study's results has shown a significant difference in muscle activity between the external oblique and internal oblique muscles while standing, and a non-significant difference between erector spinae and rectus abdominis[9]. Therefore, significant improvement in group A was more than in group B, because the following may be due to the vibration characteristic of Vibrapole, This creates a strong, proprioceptive stimulation; leading to muscle spindle activation and strong external loads. This further has an effect on the movement perception and strengthening exercises, increasing core muscle activities during exercise combinations; leading to a more positive effect on the strength of abdominal muscles.

There was a significant difference noted with pressure biofeedback when both groups were analysed individually. A study showed improvement in core muscle strength on pressure biofeedback in the elastic resistance band group and Yoga groups[14]. As shown there are significant effects of Vibrapole and elastic band exercises in abdominal muscle activation and strength. Pressure Biofeedback is a tool to measure core strength, and a dependent variable of increase in strength has significantly been noted in both groups.

There was a significant difference between both interventions; however, group A showed more difference compared to group B. The 7-stage sit-up test is used as a tool by athletes as well as healthy individuals to assess core strength and endurance. As strength increases the level in test grades increases. As demonstrated there was a significant increase in abdominal strength in both groups. However, group A showed more improvement than group B, due to the effects of Vibrapole on muscle length and

activation of muscles. An increase in strength leads to an increase in grade level of the test; thus, demonstrating significant improvement.

This study also determined the effect of Vibrapole exercises on trunk muscle thickness and balance in students in their twenties. It showed an increase in muscle thickness of transversus abdominis and multifidus post 6 weeks of intervention; whereas, when Vibrapole was compared with the control group it indicated that Vibrapole was an effective tool to increase trunk muscle thickness and improving balance[18].

A systematic review study related to elastic band shows effects of Elastic Resistance Exercises has been advanced, whilst in comparison with passive manage on practical overall performance and muscle strength. However, whilst in comparison with lively controls, the impact of Elastic Resistance Exercise became inferior on characteristic overall performance, and without any comparable impact on muscle strength. So, Elastic Resistance Exercise is a powerful tool to enhance practical, overall performance as well as muscle strength in comparison to no intervention, in healthy adults it is not advanced enough of combines different strategies of resistance education to enhance practical, overall performance and muscle strength in said adults[19].

The limitations of this study were that the ratio of males and females did not match in both groups; additionally, ultrasonography could have been considered to assess abdominal muscle thickness as an outcome measure for muscle strength assessment. Further studies should be conducted on Vibrapole training effects on different age groups, which only including male or female subjects, and in different conditions like Low Back Pain and in Post-partum women. Furthermore the 'carryover effect' of the strength training could also be further studied. The results of this study conclude that abdominal strengthening exercises using Vibrapole are useful in increasing trunk muscle strength compared to elastic band abdominal strengthening exercises.

Conclusion

This study concludes that abdominal strengthening exercises using Vibrapole are more effective in increasing abdominal muscle strength than elastic band exercises, and can be used clinically as an efficient tool to improve abdominal strength in healthy, young adults.

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Conflict of interest

There are no conflicts of interest to be declared.

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