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Effect of Core Strengthening Exercise on Maximum Inspiratory Pressure in Asymptomatic Adults

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Abstract

Background: During any movement, the trunk bracing provided by the core muscles keeps all spinal segments in a biomechanically neutral position. The diaphragm, pelvic floor, and abdominal muscles collectively regulate intra-abdominal pressure and function synergistically to facilitate segmental movement. Spinal stability is mostly dependent on the diaphragm, a muscle that helps modulate intra-abdominal pressure. The diaphragmatic inspiratory muscle strength is indirectly measured by maximum inspiratory pressure (MIP). During lifting and during movement, the diaphragm, which is the primary breathing muscle, contributes to core stability.

Objective: To check the effect of core muscle exercise programme on change in maximum inspiratory pressure among healthy individual.

Methodology: An experimental study was done on 34 healthy subjects at a private biomedical institute who aged between 20 to 40 years. They were selected through purposive sampling. Using a capsule detecting pressure gauge for maximum inspiratory pressure (MIP) and a pressure biofeedback unit (PBU) for core muscle strength, subjects who satisfied the inclusion criteria were assessed. A customized exercise regime was given under the supervision of researcher for one month.

Result: The study found the improvement in core strength by reduction in mean value of pressure biofeedback unit from mean of 41.68±2.70 (baseline) value to 40.65±1.07 (after exercise) with p value 0.01 Also there was improvement in Maximum Inspiratory pressure with P value<0.01 which was found highly significant. This could be due to our intervention which included core strength exercise. Additionally, we found with increase in core muscle strength there was improvement of MIP with P value 0.03.

Conclusion: The one month of core exercise program is effective in increasing core muscles strength thereby improving diaphragmatic strength as measured through MIP.

Keywords: Core strength exercise, Pressure biofeedback, Maximum inspiratory pressure.

Introduction

The core must be strong for one to maintain good posture, move limbs properly, and carry out functional tasks. The core is often conceptualized as a muscular box, with the diaphragm forming the roof, pelvic floor and hip girdle musculature forms the base, the paraspinals and gluteals forms the posterior wall, and the abdominals forms the anterior wall. [1] The ability of a loaded structure to retain static equilibrium even with (small) perturbations around the equilibrium position is the well-defined concept of stability in mechanics.[2] The ability of the human body's core stability to maintain stability of the body during movement is linked to the region of the body enclosed by the diaphragm, lower back, pelvis, and abdominal wall. The key muscles involved are the diaphragm, quadrates lumborum, internal and external obliques, and transverse abdominis.[3] Typically, isometric or static strength is linked to stability, and the abdominal muscular groups are linked to the core.[3] As noted by McGill et al. (1995), the trunk muscles are recruitated to stabilize the lumbar spine and may asist in the breathing mechanics. As loading demands progressively increases, the trunk muscles are recruitated to stabilize the spine, while the diaphragm is essential for regulating the ventilation.[4] During quite breathing, diaphragmatic activity is greatest during inspiration and is associated with an increase in intra-abdominal pressure, The activity of the paraspinal and abdominal muscles varies according to the individual and body position.[5] Additionally, the diaphragm, paraspinal, and abdominal muscles, together with the intra-abdominal pressure, are all controlled differently throughout the breathing cycle. One key muscle for maintaining core stability is the diaphragm.[6] The diaphragm is an essential muscle for maintaining spinal stability and controlling intra-abdominal pressure. Sedentary lifestyle can lead to general weakness and a lack of support from the trunk muscles. [7] Respiratory muscle dysfunction impairs breathing, gas exchange, and oxygen supply to tissues.[8] Diaphragmatic inspiratory muscle strength is commonly evaluated using maximum inspiratory pressure. The measurement of MIP reflects inspiratory muscle strength through the total force output of the inspiratory muscles during a brief static effort.[9] Thus, measuring maximal inspiratory pressure (MIP) is a simple test in which subjects are requested to conduct vigorous inspiration against an obstructed mouthpiece.[10] Kennedy (1980) developed the abdominal bracing technique prior to and during any loading workout or functional activity. It stabilizes the lumbar spine by increasing intra-abdominal pressure.[5] The transversus abdominis and lumbar multifidus muscles play a key role in stabilizing this region of the spine. In several investigations, a pressure biofeedback unit—originally developed to evaluate the capacity of abdominal muscles to actively stabilize the lumbar spine—has been employed to assess lumbar stabilization.[11]

Method

This experimental study of pre post design was done on 34 healthy individuals aged between 20 to 40 years of either gender. Subjects were selected from a private biomedical institute involving faculty and students through purposive sampling. Inclusion criteria for the

participants included pressure biofeedback value between 37 mmhg to 44 mmhg which is indicative of poor core muscle strength. MIP was measured in all the participants at baseline and at end of 4 week after completion of whole exercise regime. Subjects who had acute low back ache, history of spinal surgery, any medical problems related to respiratory or cardiac system and any medical and surgical condition influencing the procedure were excluded from the study. The ethical approval and written consent was obtained from the participants. (IES/SBS/132/2016)

Measurement of Core Muscle Strength:

Pressure Bio-Feedback unit (fig 2), a valid and dependable clinical tool for evaluating deep abdominal muscle function, was utilized to measure core muscle strength by monitoring lumbar stabilization.[11] The device comprises an inflatable cushion connected to both an inflation device and a pressure gauge for monitoring.

Once the pressure biofeedback device is inflated, the subject must maintain the predetermined pressure whlie ensuring the lumbar spine remains in correct position.

Subjects were positioned on the couch in a crook-lying posture the pressure bio-feedback inflatable cushion was placed beneath the lumbar spine, and the pressure was increased to a baseline of 40mmhg. Subjects were instructed to perform abdomen drawing in maneuver holding each contraction for 10 seconds, completing 10 repetitions. During the maneuver, the individual must maintain this pressure on the pressure gauge and ensuring the correct lumbar spine in position.

If pressure is kept constant, the transverse abdominus and multifidus muscles contract positively, indicating adequate core strength, and are thus eliminated from the study. If pressure is not maintained at the target level, it indicates inadequate isometric contraction of the abdominal muscles, potentially leading to loss of control and decreased stability of the lumbar region, Therefore, these individuals were included in the study and were advised to follow an exercise regimen to strengthen the core muscles of the lumbar spine.

MIP (cm H2O) was assessed following the criteria established by the American Thoracic Society (ATS) and European Respiratory Society (ERS). Following familiarization, individuals breathing through a flanged mouthpiece were instructed to forcibly inspire from the maximum expiratory level against an occluded valve (V-max Series 330; Sensor Medics). A recorded MIP values were the maximum pressure sustained for one second as reflected on the MIP dial. The average of three manoeuvres was recorded.

The intra-rater reliability ICC = 0.962 and the inter-rater reliability ICC =0.922.

Exercise Regime/Intervention

Following exercise were given to subjects who were included in the study

Crook-lying position (fig 4a &4b)

Abdominal bracing, Bracing with heel slides.

Supine position (Fig 4c)

Abdominal Bracing with leg lifts at the 30 degree of angle.

Quadruped position (fig 4d &4e)

Quadruped arm lifts with abdominal bracing, Quadruped knee slides with abdominal bracing without dropping down the pelvis level.

Subjects were asked to do it for 10 repetitions (5 sec hold) of 2 set for 3 days per week for one-month duration.

Data Analysis

Statistical analysis was performed using SPSS version 16 software. Descriptive statistics were employed to summarize the study variables, and paired t-tests were conducted to evaluate changes in core strength and maximum inspiratory pressure following the exercise intervention.

Result: A total of 34 subjects with a mean age of 28.29±7.09 and a gender distribution of 71% female and 29% male participated in the study.

In this investigation, we discovered a change in variable scores, as shown in Table 1.

Participants' core strength improved, as evidenced by a decrease in mean pressure biofeedback sensor values from 41.68±2.70 to 40.65±1.07 following the training program, with a statistically significant P value of 0.01.With the improvement in core muscle strength there was increase in maximum Inspiratory pressure value from median value of 74.9(44,95) to 83.3(65,1.10) Pvalue <0.01. This was found highly significant. Improvement in MIP score could be due to our intervention which included core strength exercise.

Table 1: Showing the mean and S.D in total no. of subjects

	Pre	Post	P value
Core Strength (mmhg) Mean±S.D	41.68±2.70	40.65±1.07	0.1*
MIP (cmH_2O) Median (IQR)	74.9(44,95)	83.3(65,1.10)	<0.01**

*Significant, ** highly significant

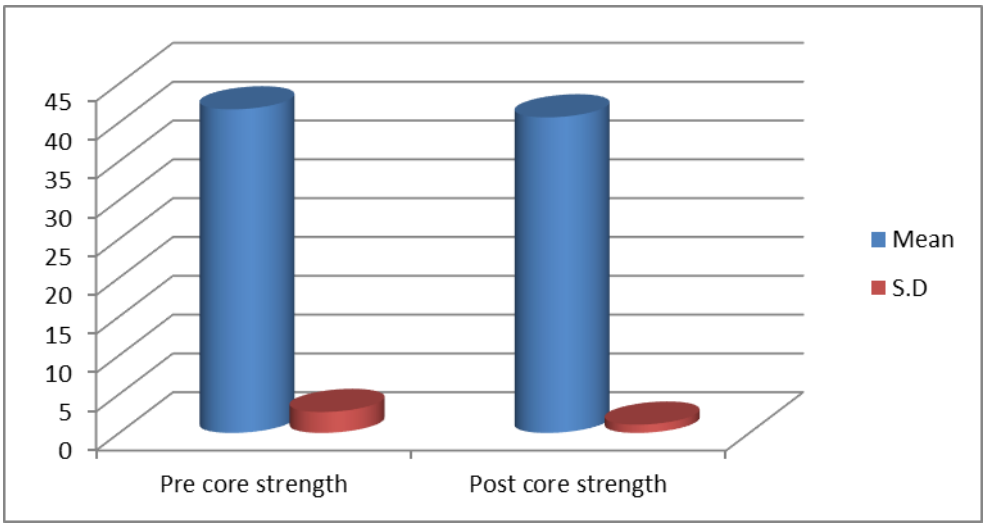

Fig 1: Showing change in core strength following exercise program

Instruments Used:

Fig 2: Capsule Sensing Pressure

Fig 3: Pressure Biofeedback Unit

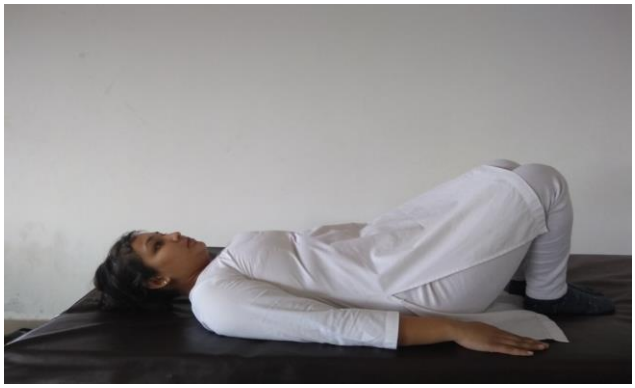

Fig 4a: abdominal drawing maneuver

Fig 4b: Abdominal bracing with heel slides

Fig 4c: Abdominal bracing with straight leg raise (30*)

Fig 4d: Arm lift with abdominal bracing (on quadruped)

Fig 4: Exercises

Discussion

This study was designed to assess the effects of core strengthening exercises on maximum inspiratory pressure in asymptomatic subjects. We looked for indirect method of measuring core muscle strength using pressure biofeedback unit. The mean core strength value recorded was 41.68±2.70. The pressure biofeedback unit (PBU) assessed the strength of the core muscles. The device was positioned beneath the lumbar spine in the crook lying position and inflated to 40 mmHg. The analogue pressure measurement range was 0-200 mmHg, with a dependable accuracy of ±3 mmHg. The subjects were advised to follow a core exercise regimen if the pressure was not kept constant.

In their study, Crasto et al. demonstrated that the pressure biofeedback unit is a valuable instrument for assessing deep abdominal muscle activation. It is also used as feedback during lumbar stabilization exercise in management of chronic LBA.[13]In the present study, baseline core strength among subjects was not very poor. We gave strengthening exercise of core muscle for one month which included abdominal bracing exercises, bracing with heel slides, Abdominal Bracing with leg lifts at the 30 degree of angle, Quadruped arm lifts with abdominal bracing, Quadruped knee slides with abdominal bracing without dropping down the pelvis level in various position. After one month of exercise program the pressure biofeedback value was decreased to mean 40.65±1.07 which shows there was improvement in core strength with p value of 0.01.[14] This finding was similar to findings of Noh et al and Kumar et al, where improvement in core muscle strength was noted following exercise program however the duration of exercise program was longer i.e. 6 weeks as compare to our study where we gave only one month of exercise program.[15, 16] This could have occurred because we have included abdominal drawing in manoeuvre with each exercise which would have improved core muscle strength in short duration.[17]

A decreased MIP may suggest insufficient overall muscle strength, making it a potential indicator of generalized health status. We measured MIP using capsule sensing pressure gauge. The baseline MIP (median value) of the participants in our study was 74.9(44,95).

The core muscles work together to maintain maximum stability in the abdominal and lumbar as well as also refer to the IAP during breathing and exercise. Respiration primarily depends on the diaphragm as its key muscle and a crucial muscle for postural stabilization, and because it is voluntary controlled, it can execute both respiratory and postural functions at the same time.[18] Abdominal bracing is the main technique used during core exercise training in which there is contraction of the abdominal the multifidus and the transversus abdominis muscle.[19] In our study after one month of core muscle strength the MIP median value was 83.3(65,1.10). A capsule pressure-sensing gauge was employed to measure maximum inspiratory pressure with average value of 3 repetition on pretest reading and posttest reading. We found that there was significant change in MIP value as a result of exercise where p value was <0.01. This is similar to study conducted by Mustafa Ozdal et.al found change in MIP value after 10 week of core training program with mean value 157.08±15.85 to 168±19.36. this shows that after core muscle strength program there was improvement in MIP.[20]

Our study provides an insight of core muscle training in addition to respiratory muscle program to improve the efficacy of respiratory muscle. [21] However, our study had some limitations, such as a small sample size and the use of an indirect method to confirm MIP, making it difficult to apply the current findings to a wider population.

Conclusion

One month of core exercise program was effective in increasing core muscles strength thereby improving diaphragmatic strength as measured through MIP.

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