

Effect of Plank Exercises on Lumbar Core Stability in Healthy Adults: An Experimental Study

Vijaya Krishnan¹, Aman Minocha²

¹Assistant Professor, MGM College of Physiotherapy, Navi Mumbai.

²MGM College of Physiotherapy, Navi Mumbai.

Corresponding Author: Dr. Vijaya Krishnan (PT)

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ABSTRACT

Background: In the realms of fitness and injury prevention, core musculature training has gained significant attention. The purpose of the study was to compare the effects of planks and conventional stabilization exercises on lumbar core stability in healthy young adults.

Methods: A total of 107 participants were screened out of which, 72 participants were selected for the study and divided into two groups; Group A and Group B. Group A participants received conventional lumbar stabilization exercises and Group B were given plank exercises. Both groups were assessed for core stability before and after completing 6 weeks using Sahrman core stability test and partial curl up test. Each group was given intervention for 3 days every week once a day.

Results: The mean age of group A participants was 28.05 ± 7.83 and that of group B was 27.37 ± 7.21 . There was significant improvement in core stability and core endurance across both groups as p value < 0.05 . But there was significant improvement in group B as compared to group A

Conclusion: Though both the protocols improve core stability and core endurance however planks were found to be more effective than conventional stabilization exercises. This study concludes that planks can be used as an alternative to conventional stabilization exercises in rehabilitation, thereby integrating fitness into rehabilitation.

Keywords: Lumbar core stability, trunk exercise, planks, core fitness, rehabilitation.

INTRODUCTION

The muscular frame that forms the core includes abdominals in the anterior, paraspinals and gluteal muscles posteriorly, diaphragm superiorly and the pelvic floor muscles inferiorly. The 29 pairs of muscles associated with the core stabilize the spine and pelvis thus prepare the kinetic chain of the body for functional movements. These muscles ensure the mechanical stability of the spine ensuring the maintenance of the erect postures and daily activities.^{1,2}

The lumbopelvic rhythm is maintained and the vertebral column stability is strengthened on account of a strong core. This helps to counteract perturbations and maintain erect body position. The feedback & feedforward mechanisms of the motor control strategies applied by a strong core are applied here. In addition to this, global muscles provide additional stability during changes in direction of body movements and also load bearing tasks which increase the spinal movements as proved by Calatayud et al,

2017. Spinal stability is thus enhanced by the lumbar core - superficial & deep muscle co-contraction.³

The isometric plank exercises-lying on the floor with one or both elbows and feet/foot supporting the ground while maintaining an isometric position have been widely used as core stability exercises. Importantly, the isometric plank exercises minimize spine loads and provide muscle tension of longer duration in comparison with dynamic abdominal exercises.

Core muscle activated during a plank are - Transverses abdominis, rectus abdominis, internal oblique and external oblique muscles. Transverses abdominis is the primary muscle to get activated reinforcing the lumbar spine and by this means increases the stability.^{4,5}

Planks make the abdominal muscles rigid and thus creates a stiff position between the rib cage and the pelvis ensuring spinal stability. It also requires muscles between the shoulder blades and the pelvic girdle muscles to fire. If done properly also strengthens the spinal muscles from the neck to the pelvis as well as the hamstrings. The plank can activate core muscles with low compressive forces (1400-1600 N) avoiding high compressive forces on the lumbar vertebrae, which occurs in back extension, trunk curls or lying prone with extended arms and legs^{6,7} There are many variations of plank including; supine plank, unilateral supine plank, modified prone plank, prone plank, extended arm plank, side plank and plank with limb loading.^{4,8}

According to a study by R.Escamila, C.Lewis et.al, the upper and lower rectus abdominis activity was significantly greater in prone plank exercises than side plank exercises. Similarly internal oblique activity was also high in prone plank as compared to side plank exercises. Lumbar paraspinal recruitment is greater in side plank position. The unilateral stable supine plank provides the highest Lumbar erector spinae activity (20% of MVIC), while the bilateral stable supine plank provides lower activity (11% of MVIC)⁸The aim of this study is to compare

the effect of planks versus conventional exercises on lumbar core stability and core endurance.

METHODOLOGY

This study commenced after receiving approval from the Institutional research review committee. Prior to participant recruitment a written informed consent was obtained from every participant. The study was performed in the community set up including young adults within the age group of 18-40 years comprehensive of both genders. Subjects having any musculoskeletal problems, cardiovascular diseases, trauma in the past 6 months, surgery in the past 6 months, neurological disorders and undergoing any other training program were excluded from the protocol.

72 participants were included in the study after initial screening. These participants were then randomly divided into two groups using SNOSE (Sequentially numbered, opaque, sealed envelope) technique, where the name of the group was written on a chit and was kept in an opaque sealed envelope and participants were asked to choose out of the two envelopes. After choosing the envelope they were allocated into respective groups i.e. group A and B and exercise protocol was explained to them. Immediately after allocation week 1 protocol was initiated for the participants.

Group A participants were given conventional lumbar stabilization exercises and Group B were given plank exercises. Both the groups performed warm up exercises for 5 minutes which included general body stretching and mobility such as Lumbar ROM exercises (10 reps and 2 sets) and stretching of the iliopsoas and hamstrings (20 second hold, 3 reps).

Both the groups were assessed for core stability and endurance using Sahrman core stability test and partial curl up test respectively before and after completing 6 weeks. Each group was given intervention for 3 days every week once a day. All the exercises were performed under supervision.

Sahrmann core stability test:^{9,10} is the outcome measure used to evaluate the core muscle capacity to stabilize the lumbar spine. It has a five-level protocol which will assess an individual's core stability. Participants were made to lie in spine position and an aneroid sphygmomanometer was placed under the L4-L5 level. A pressure of 40mm Hg was set and then participants were asked to perform a draw in manoeuvre. 3 trials were given for level 1 for familiarization and after a rest interval final testing was done. A deflection of more than 10 mm Hg was the indicator to stop the test. Level 0 indicates that the subject is unable to maintain a neutral spine against resistance whereas level 5 indicates highest level of core stability.

Partial Curl up test:^{11,12} The partial curl up test measures the muscular endurance of the abdominal muscles. The participant assumes a supine position on a mat with a 90 degree knee angle. The arms are on the side, resting on the floor, with the fingers touching a 10 cm long line made perpendicular to the fingers. A second line was made parallel to the first line at a distance of 12 cm. The participants were instructed to avoid flexing the neck while performing the curl up and were asked to perform as many curl ups as possible in a period of 1 minute. The participants were informed that they have to cross the second line while performing the curl up for that repetition to be valid.

Intervention Protocol: Prior to the beginning of the protocol, warm up exercises in the form of general body stretches were executed

for both the groups for a time period of 10 minutes.

The treatment protocol included were:

Group A: abdominal hollowing in hook lying positions, lower limb loading exercises, quadruped and prone position exercises. Whereas Group B included unilateral & bilateral supine planks, side planks, prone planks, modified planks and planks with leg movements. For both the groups the exercises were progressed over the 6 weeks.

The data obtained was compared, coded, tabulated, and analyzed using Statistical Package for Social Science 25 (SPSS). Normality of the data was analyzed using the Kolmogorov Smirnov test. As the data was not normally distributed (p value< 0.05), non-parametric tests were used for the analysis of data. For comparing distribution free data, Intra group – Wilcoxon test and Inter group – Mann- Whitney U test.

RESULTS

Table 1: Demographic data of participants.

	Group A		Group B	
	Mean	SD	Mean	SD
Age (years)	28.05	7.83	27.37	7.21
Gender				
Male	N=15(42.85%)		N=14(37.83%)	
Female	N=20(57.15%)		N=23(62.17%)	

Inference; The above table indicates Group A has higher percentage of males as compared to group B

Table 2: Intra group analysis for Lumbar core stability and endurance using Wilcoxon test

		Mean±SD	Z value	P value
Group A				
Lumbar core stability	Pre	0.2±0.4	-5.046	0.00
	Post	2.31±0.47		
Lumbar core endurance	Pre	22.29±6.92	-5.193	0.00
	Post	30.26±6.92		
Group B				
Lumbar core stability	Pre	0.16±0.37	-5.493	0.00
	Post	2.57±0.55		
Lumbar core endurance	Pre	21.59±8.04	-5.340	0.00
	Post	31.95±8.32		

Inference; The above table indicates that there is statistically significant improvement in core stability as well as endurance in both the groups as p value<0.05.

Table 3: Intergroup analysis between differences in Lumbar core stability and endurance using Mann Whitney U test

	Group	Mean rank	Z value	P value
Lumbar core stability	A	31.54	-2.46	0.014
	B	41.19		
Lumbar core endurance	A	27.40	-3.64	0.00
	B	45.11		

Inference; The above table indicates that there is statistically significant improvement in core stability as well as endurance in group B as compared to group A.

DISCUSSION

This study compared the effect of planks and conventional lumbar core stabilization exercises on healthy individuals of the age group 18-40 years. Parameters assessed were core stability and core endurance. Important observations made during the study procedures were that Group B participants could easily be taught to perform planks whereas in Group A, more time was spent in explaining the exercises and training the correct way of drawing in maneuver and maintaining it during the exercise. Table 1 describes the demographic details of the participants.

Core stability; Core stability is described in terms of three subsystems; passive (inert structures), active (muscles) and neural control. Both global as well as deep segmental muscles play critical roles in providing stability and maintaining the upright posture. In the lumbar spine, the global muscles, being more superficial of the two groups, are the large guy wires that respond to external loads imposed on the trunk that shift the center of mass. The functional unit of the spine is better protected by the deep core muscles having attachments closer to the functional unit. They maintain the stability so as to avoid undue stress on the other soft tissues and ligaments of that region. The end range of motion is controlled by the contributions from both these segments to achieve stability during mobility. On comparison within the two groups, Table 2, clearly indicates that there is

improvement in core stability across both the groups (Group A & Group B) as both conventional and plank exercises involve activation of the global as well deep segmental muscles and helps in developing neuromuscular control of deep and global stabilizing muscles to support the spine against external loading.

According to Lee and McGill (2015), the long-term isometric training increased passive stiffness/torso stiffness and is superior to dynamic training in enhancing core stability^{13,14}. McGill SM, states that muscularly stiffening the spinal column enhances its load bearing capacity thus, preventing buckling¹²

From the Table 3. when compared between two groups, it was observed that Group B shows significant improvement in core stability as compared to Group A. During the plank exercise the aim is to maintain a neutral spine against the forces acting on it. The deep segmental and global muscles are expected to provide reactive forces to neutralize the downward pull of the gravity. It also performs the role of anti-gravity spinal stabilization.¹² L.Bliss, et.al, stated that the bridge tests are more functional tests to assess core stability as they assess strength, endurance and how well the athlete is able to control the trunk via synchronous activation of all trunk muscles¹⁵ and hence when used as in a strengthening protocol with progressive overload leads to improvement in core stability and also core endurance.

Core endurance; The muscles of the trunk are activated and controlled by the central nervous system, which is influenced by peripheral and central mechanisms in response to fluctuating forces and activities. Transversus abdominis is active during both isometric trunk flexion and extension and has a major role in lumbar stabilization. The multi-fasciculated multifidus muscle group has a high distribution of type 1 fibers, emphasizing its role as a tonic stabilizer.² On comparison within the two groups as seen in Table 2, there is significant improvement in core muscle endurance in both the groups, as core stabilization exercises involves isometric contraction of the core muscles and holding it for a particular time period, it helps in developing endurance. Lee and McGill, in their study described that a 6-week isometric core training program, stimulates neural changes and increases residual stiffness^{13,14}

From the table 2., when compared between the two groups, Group B shows statistically significant improvement in core endurance than Group A. Bohannon M. Steffl et.al suggested that planks is a reliable and valid measure for evaluating abdominal muscle performance in younger (20-35 years) as well as older (60-79 years) adults¹¹ Tong, et.al, in their study found sport specific endurance plank test is a valid and practical method for assessing the endurance capacity of the global core muscles of athletes in a functional manner¹⁶ As planks have to held for a predetermined time, it challenges the slow twitch muscle fibers of the core muscles and thereby help in improving core endurance. These mechanisms help improve both – lumbar core stability as well as lumbar core endurance while performing various plank exercises.^{17,18}

CONCLUSION

Both the protocols (conventional & plank exercises) improve lumbar core stability and core endurance but planks were found to be more effective than conventional stabilization exercises in improving core stability and endurance. Planks can be used

as an alternative to conventional stabilization exercises in rehabilitation, thereby integrating fitness into rehabilitation.

Conflict of Interest: The authors declare that there is no conflict of interest.

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