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Effect of Spinal Mobility Exercises on Functional Mobility Using AI Powered Software on Lumbothorax of Young Adults with Sway Back Posture

S. JESVIN BOSE [1], N. SENTHIL KUMAR[2], DR.JESLIN G N[3*]
[1, 2 & 3] Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, Thandalam, Chennai - 602105, Tamil Nadu, India

Abstract
BACKGROUND AND AIM: Sway-Back Posture (SBP) is the most common deviation or faulty posture of sagittal alignment, characterized by anterior translation of the pelvis and hip joints, beyond the center of gravity line, a flatted curve in the lumbar region and overextended hip and knee joints. It can cause a variety of symptoms and may be caused by several factors including poor posture, muscle imbalance, congenital conditions, and obesity and so on. The goal of the study is to ascertain the efficacy of spinal mobility exercises and bal asana in subjects with sway back posture. **METHODS:** Sixty subjects aged from 18 to 25 of both genders with deviation of at least the pelvis tipped forward for 10 degree or took part in the study that was conducted. The subjects were randomly segregated into two groups; Spinal mobility exercise group were given spinal mobility exercise whereas the control group were given Bal asana, the intervention period was of 8 weeks. The postural analysis of the subjects was evaluated pre and post-training using APECS (AI Posture Evaluation and Correction System). **RESULT:** Spinal mobilization along with lumbar spine mobility exercise was found to be effective compared to Bal asana in improving posture and performance of individuals with sway back posture. **CONCLUSION:** Spinal mobility group had better functional movement and muscular balance and seen to have reduced degree of anterior pelvic tilt compared to Bal Asana group. It is concluded that Spinal mobility group provides more functional movement and is seen as the effective treatment in sway back posture.

Keyword: technology, spine, posture, lumbosacral region, good health and well-being.

Introduction

Posture, which is the relative disposition of the body at any one moment, is composite of the different positions of the joints at that time (1). Good posture relies on muscular strength, emphasizing the significance of maintaining a well-balanced strength throughout the body. Enhancing muscular power in particular regions, without strength training the opposite muscles, tends to misalign rather than encourage proper posture. Flexibility relies on unrestricted joint movement and muscle length. Children typically exhibit high flexibility, but as they grow and develop greater strength, it is natural for them to experience a reduction in flexibility. Sway back posture is frequently linked to muscle imbalances, with some muscles becoming tight and others weak characterized by an excessive inward curve of the lumbar spine, which is frequently accompanied by an anterior tilt of the pelvis which can put additional strain on the spine's joints, potentially causing back discomfort or pain Sway-Back Posture (SBP) is thus the most prevalent deviation of sagittal alignment, identified by anterior translation of the pelvis and hip joints, extending the center of gravity line (2). The consequence of habitual poor posture is the adaptive lengthening or shortening of muscles which can be addressed through targeted exercises and the cultivation of proper posture (3). In such an example; The body exhibits less efficient balance over its support base. Therefore, any restrictions, imbalance, or deviations in alignment of musculoskeletal structures will have a significant outcome on the efficiency of movements (4). The core strength and stability pertain to the central part of the body, encompassing the spine, hips, pelvis, proximal lower limbs, and abdominal tissues., provide an appropriate foundation for distal limb performance (5).

Exercises aimed at improving lumbar spine stability have recently gained popularity (6). It entails gently moving and manipulating the spinal joints to promote range of motion, relieves discomfort, and improve general function. The lumbar spine gains stability when the diaphragm contracts and intra-abdominal pressure increases. Ventilatory requirements on the body may produce more diaphragm dysfunction and lead to increased compressive stresses on the lumbar spine (7).

Fear-avoidance behavior causes some people with back injuries to fail to activate their core muscles (8). People with hip as well as back disorders are commonly guided to practice the pelvic bridge exercise (BE). This exercise is specifically effective in aiding pelvic motions and Enhancing muscles in the lower back and hip extensors. It also improves movement regulation of the lumbo-pelvic area (9).

Individuals with low back discomfort can benefit from a variety of exercises to progressively improve gluteus muscle strength, tailored to their personal needs and limits. This method emphasizes the need of individualized rehabilitation treatments that target the gluteus muscles in order to develop strength and improve overall function (10). Considerably during various ranges of motion, and some of the muscles even switch functions depending on their posture (11).

The Bird Dog activity is a versatile and effective action that offers numerous benefits for anyone wishing to increase their core strength, stability, and general fitness. The Bird Dog primarily targets the core muscles, such as the rectus abdominis, obliques, and erector spinae. This helps to strengthen and stabilize the central region of the body (12, 13). In contrast to exercises performed on the ground, the dynamic bird dog practiced on a wobble board was seen to have a greater muscle activation (14,15).

Spinal manipulative treatments can be generally categorized into manipulation-based or mobilization-based techniques. Manipulation-based techniques involve applying a high-velocity, low-amplitude force to the spine, often resulting in an audible sound from one or more joints (16). Pelvic tilt exercises can have various positive impacts on the body, notably in terms of strengthening core strength and flexibility, as well as treating posture difficulties. Pelvic tilt is the angle between the horizontal and a plane traveling through the superior iliac spines, both posterior and anterior. Pelvic tilts increase pelvic awareness and control, which can assist correct and maintain good posture. They are frequently prescribed for those who have anterior pelvic tilt or other postural problems. Excessive anterior pelvic tilt and lumbar lordosis are commonly corrected with abdominal muscle training (17).

The thoracic spine is the upper and mid-back part of the spine, located between the cervical (neck) and lumbar spines. Flexion and extension movements of the thoracic spine are necessary for a variety of functions and improve overall spinal health. Incorporating thoracic spine flexion exercises can help counteract the consequences of extended sitting or bad posture, which frequently result in a rounded upper back. Strengthening the flexors and increasing thoracic spine flexibility can help improve posture. Mechanical pain problems in the thoracic spine often lead to reduced mobility (18).

Individuals with mobility disability often experience limited thoracic spine movement in both axial and sagittal planes, especially in extension (19). Normative motion along the sagittal plane of the spine ranges have seen to be documented for the lumbar region, but not for thoracic. This could contemplate the belief "extension mobility of the thoracic region is limited and usually not measured" (20). In clinical settings and extensive research studies, the use of photographic analysis can provide precise measurements of spinal posture and movement (21). Incorporating flexion and extension into your training program can assist to overall spinal health and function.

The human posture is of interest due to potential associations between alterations in axial alignment and various patient complaints, with pain being a prevalent issue. The optimal human posture is expected to enhance biomechanical efficiency while minimizing energy expenditure (22). Various structural stresses, congenital disorders, and age-related changes, such as decreased muscle strength and limited range of motion, can lead many individuals to experience alterations in body alignment, potentially resulting in significant postural deviations (23, 24).

In recent times, attention has shifted towards exercises designed to sustain and enhance stability in the lumbar and thoracic spine. While there is no official definition for lumbar stabilization exercises, the objective is to enhance posture in the spinal and trunk regions.

Materials and Methods

In this study, the sample was collected at a couple of universities in Chennai. Sixty participants were randomly selected according to inclusion and exclusion criteria. Informed consent was obtained after a brief explanation of the study's safety and simplicity. The participants were of both genders and within the age range of 18 to 25 years with sway back posture and anterior pelvic tilt $>10^0$ were contained in the study and subjects with major past or current musculoskeletal injuries, Recent fracture of spine, surgeries of spine, scoliosis and spinal arthritis were excluded from the study. Pre-test values for posture analysis on functional movement and muscular balance were recorded using APECS (AI Posture Evaluation and

Correction System). The subjects were randomly put into 2 groups; The spinal mobility exercise group underwent an 8-week program consisting of spinal mobility exercises combined with strength training, while the control group engaged in Bal asana along with strength training. After the training period, post-test values were once again recorded using the same outcome measure and any significant differences were analyzed.

Exercise program

Spinal mobility exercise group (Intervention group)

1. Cat-Cow Pose: Participants were instructed to get down on all fours, arching the back upward, and dropping the head down. Then they were asked to drop their belly towards the mat, lift the head and tailbone upwards, creating a concave shape in the back. This is done for 10-15 repetitions for 2-3 sets. (Figure 1) "See Supplementary file"
2. Pelvic Tilt: Subjects are asked to sit upright, feet flat on the ground, and engage their core. With an exhale, they were guided to tilt their pelvis forward, feeling a gentle rounding in the lower back. After a brief hold, the patient released the tilt, returning to a neutral seated position, and repeated the movement. This is done for 10-15 repetitions for 2-3 sets. (Figure 2) "See Supplementary file"
3. Standing Hip Hinge: The individuals were instructed to stand with their feet hip-width apart. Then they were then guided to hinge at their hips, keeping their back straight throughout the exercise. After this they were asked to return to an upright position. This is done for 10-15 repetitions for 2-3 sets. (Figure 3) "See Supplementary file"

Control group

1. Bal Asana: The subjects were asked to kneel on the mat, while sitting back on their heels and then they were asked to extend the arms forward with their forehead resting on the ground. A steady breathing pattern were asked to be maintained during the yoga pose. This position is held for 30 seconds to 1 minute and 10 repetition is done for 2-3 sets.(Figure 4)

Common strengthening exercises for both groups

1. Pelvic Bridging: Subjects were asked to lie on their back with knees bent and feet flat with their arms on the side. Then they are asked to lift their hips towards the ceiling, engaging the core and squeezing the glutes at the top to form a straight line extending from the shoulders to the knees. This is done for 10-15 repetitions for 2-3 sets. (Figure 5) "See Supplementary file"
2. Plank: Subjects were asked to Begin in a forearm push-up position, ensuring the body is aligned in a straight line from head to heels. They were guided to engage their core muscles, hold the position, and focus on steady breathing. This is done for 10-15 repetitions for 2 sets (Figure 6) "See Supplementary file"
3. Bird Dog: Subjects were asked to balance on their hands and knees, extending one arm and the opposite leg simultaneously. This was asked to perform to up to 2 to 3 sets per session. This is done for 10-15 repetitions for 2-3 sets (Figure 7) "See Supplementary file"

Result and Discussion

No changes were made to the protocol during the intervention period. As needed descriptive statistics was used to determine the mean and SD. All p values <0.0001 were considered as statistically significant using paired t-test. The statistical analysis compares the post-test mean values of APECS (AI POSTURE EVALUATION AND CORRECTION SYSTEM). for Spinal Mobility Exercise Group and Control Group. As a result of statistical analysis as shown in Graph 1 -3 "See Supplementary file", the p value shows that both Spinal Mobility Exercise Group and Control Group are effective, however the values of Spinal Mobility Exercise Group were found to be slightly higher and showed significant effect in terms or alignment of the spine as well as posture and functional outcome in subjects with Sway Back Posture.

This study also shows light on the potential uses of both interventions, guiding on the development of each strategies for the management of posture in young adults. The sway-back posture stands out as one of the prevalent deviations in the sagittal plane (25). It is a passively obtained posture as it depends on structures like the ligaments, capsule and other structures which aid in maintaining an erect position which is against the gravity (26). Individuals with sway-back posture

are vulnerable to structural changes in the lumbar erector spinae and lumbar mulfidus muscles, due to the habitual adoption of posture and pain (27). Dariusz Czaprowski et al, showed that there are majorly four types of body postural mal alignments in the sagittal plane; which are the lordotic, kyphotic, flat-back and sway-back posture. Every single one of these mal alignments has its possibilities to disturb the physiological loading of the musculoskeletal system which may lead to any functional disorder (28).

Studies showed that Backpacks weighing 4kgs or more changes and slight deviations in gait, posture and stability in individuals. The center of mass shifts backward and stability is compromised. In normal gait, there is seen to be an increase in anterior pelvic tilt as well as a trunk tilt is seen with increased flexion of the hip which may have a long-term negative effect on day to day living (29). Syeda Toprak Celenay et al, showed that spinal stabilization exercise program reduces pain caused due to postural misalignments, reduces the occurrence of excessive curvature of the spine. He also showed that this intervention has a greater efficacy in postural pain and various mal alignments of spinal issues related to core weakness and balance disorders (30).

Studies show that spinal mobility exercises play an immense role in enhancing various factors like spinal flexibility, range of motion and muscle strength in the lumbar and thoracic regions. Incorporating this intervention targets the muscles that are weakened due to some reason and thereby aid in promoting optimal posture in individuals with sway back posture re-establishing muscle balance and relieve any associated discomfort.

Spinal mobility exercise regimen involves various controlled movements that target the various planes of the spine, promoting a better articular system working between the vertebrae and thereby seen to reduce associated stiffness. Studies have also suggested the use of technologies into the whole process of functional mobility training and postural correction which was used in this study.

Furthermore, studies show that both spinal mobility exercises stimulate neuromuscular activation. They involve conscious muscular engagement, coordination and an enhanced association between targeted muscle group and nervous system is to be seen. Mobility exercise focuses on postural position or awareness, allowing individuals to maintain an optimal posture and a neutral spine during various movements of day to day life. The use of the APECS (AI Posture Evaluation and Correction System) software added more accuracy to the results thus making the results more valid for use as part of the treatment.

Conclusion

It is concluded in this study that Spinal mobility along with strengthening exercises provides functional movement and is seen as the effective treatment in sway back posture. Thus, Spinal mobility exercises are recommended to be added as part of the treatment protocol for individuals with Sway back posture and it is also recommended to conduct more researches with more participants.

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