

## The Effect of A Combination of Corrective Exercise and Spinal Taping on Balance in Kyphotic Adolescent

Mirafzal, S.F;<sup>1</sup> Sokhanguue, Y;<sup>2</sup> Sadeghi, H<sup>3</sup>

<sup>1</sup> Department of Exercise Physiology, Central Tehran Branch, Islamic Azad University, Tehran, Iran

<sup>2</sup> Department of Welfare and Rehabilitation, Central Tehran Branch, Islamic Azad University, Tehran, Iran

<sup>3</sup> Department of Sport Biomechanics, Tarbiat Moalem University, Tehran, Iran

### Abstract

Among the deformities of the spine in sagittal plane, kyphosis is one of the most important cases in the study of postural control from the mechanical standpoint. Because the smallest deviation of upper limb, that is almost 60 percent of total body weight in standing position, causes displacement of body center of mass to forward and finally will cause weaker balance performance in kyphotic individuals compared to healthy one. The purpose of this study was to investigate the effect of three non-invasive and active methods on static and dynamic balance of kyphotic adolescents. Thirty five male subjects [age:  $12 \pm 0.31$  years]; height: [ $148.17 \pm 7.31$  cm]; body weight: [ $39.56 \pm 8.05$  kg] and Kyphosis angle: [ $52.85 \pm 4.40$  degree] participate in this study. The subjects divided into three intervention groups (n=27) and a control group (n=8) after pre-test accomplishment. There was no significant difference among four groups in the BMI and kyphosis angle variables ( $p > 0.05$ ). The comparison of balance performance of groups before and after the application of independent

variables for each group using paired t-test showed that the combination of spinal taping and corrective exercise have a significant effect on static and dynamic balance of subjects ( $p=0.004$ ,  $p=0.001$ ) and corrective exercise on dynamic balance of the subjects had a significant effect ( $p=0.001$ ) but no significant effect on their static balance ( $p=0.119$ ). The combination of spinal taping and corrective exercise have a significant effect on the static and dynamic balance in subjects ( $p=0.004$ ,  $p=0.001$ ) and corrective exercise on dynamic balance of the subjects had a significant effect ( $p=0.001$ ) but no significant effect on their static balance ( $p=0.119$ ). Based on results we concluded that taping and corrective exercises have a positive effect on kyphosis correction and this point can be considered in ameliorating programs.

**Key words:** Corrective Exercise, Spinal Taping, Balance

### Introduction

Postural control survey the complex process between sensory input and motor responses required to maintain or change body position and this regarded as one of the basic needs for daily living activities. On the other hand, the ability to maintain

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Mirafzal, S.F (✉)

hadimirafzal@yahoo.com

balance in addressing effective exercise and performance of complex motor skills is important and Determinant (Bryant et al., 2005). Among the deformities of the spine in sagittal plane, kyphosis is one of the most important cases in the study of postural control from the mechanical standpoint Because The smallest deviation of upper limb, that is almost 60 percent of total body weight in standing position, causes Displacement of body center of mass to forward And finally will Causes weaker balance performance in kyphotic individuals compare to healthy one (Anbarian et al., 2008). Active exercise therapy to correct skeletal deformities, has several local and global effects on various aspects of body structure and function, followed with a wide range of cellular level changes to broader systemic levels or even personal and social levels. These changes include flexibility, muscle strength and proprioception improvement, which ultimately will lead to enhancement in posture. Some researchers believe that kinesio tape through increased stimulation of skin receptors and pressure and tension on the skin, stimulate the mechanoreceptors and has to send accurate signals of motion and joint position and finally is able to increase proprioceptive and through the use of more motor unit, improve the muscle function (Murry & Husk., 2001). In order to identify the different aspects and acting to eliminate the disorders related to postural control, so far many studies by researchers in field of motor and behavioral sciences has been done. Some studies have focused on the effect of changes in body position and stature on balance which demonstrated negative effect of poor posture on balance control. For instance, Nalt et al (2002) investigated the relationship between individuals balance performance and body posture parameters in patients with scoliosis, the results showed that the foot pressure center displacement in scoliotic group is higher than control group and they had weaker balance performance

consequently (Nault et al., 2002). Guo et al (2006), in comparison of Balance performance in healthy adolescents with idiopathic scoliosis one Concluded that during the manipulation of balance control sensory systems, people with scoliosis were weaker than control group in proprioceptive activation (Guo et al., 2006). Sinaki et al (2005) in a study on elderly women with osteoarthritis – kyphosis, compared the characteristics of postural control and balance performance of 12 women with osteoarthritis - kyphosis (mean age 76.5 years) with 13 healthy subjects (mean age 71 years) using the force plate, the results showed that postural control in people with osteoarthritis - kyphosis was weaker in comparison with controls ( $p=0.002$ ) and the risk of falls and injuries was higher also (Sinaki et al., 2005). Murray et al (2000) compared the postural oscillations in people with ankylosing spondylitis (a type of fixed kyphosis) and controls one. The results showed that people with ankylosing spondylitis, in comparison with controls, have greater postural oscillations (Murray et al., 2000), but Aydog et al (2006) study on dynamic balance in people with ankylosing spondylitis, showed no significant difference between two groups in postural fluctuations and center of foot pressure (Aydog et al., 2006). Generally, previous studies in relation to postural control in patients with kyphosis deformity, not only are few but also these studies results are conflicting. Considering the fact that the kyphosis through restricting chest expansion resulting in breathing and cardiovascular disorders and gradually provides physical problems for affected person, corrective exercise trainings and use of assistive devices and inspection of their effects on biomechanical parameters, Can be important in rehabilitation services quality improvement. With regard to this point that in the field of corrective exercise, correct posture generally is considered and studies that probe biomechanical

indicators following corrective exercise are trivial, it seems pay attention to components such as balance, can increase performance of corrective exercise field and help to the therapists in providing the best and the most appropriate treatment. The investigation of spinal deformities effects such as kyphosis, reveal useful and detailed information about the balance of kyphotic people, to adopt effective procedure and reduce the complications of this deformity on their balance and to improve their quality of life. Therefore the aim of this study was to investigate the effect of three non-invasive and active methods on static and dynamic balance of kyphotic adolescents.

### **Methods**

Thirty five male subjects [age:  $12 \pm 0.31$  years]; height: [ $148.17 \pm 7.31$  cm]; body weight: [ $39.56 \pm 8.05$  kg] and Kyphosis angle: [ $52.85 \pm 4.40$  degree] participate in this study. The subjects divided into three intervention groups (n=27) and a control group (n=8) after pre-test accomplishment. All subjects, completed consent form for participation in this research. There was only one deformity in the spinal column of subjects that was increased kyphosis, also the subjects hadn't any visual impairment, hearing and neuromuscular disease and a history of surgery. The samples were randomly selected from available population. After the pre-test accomplishment, the subjects divided into four groups, namely, 1- corrective exercise, 2- taping, 3- combined corrective exercise and taping and 4- control. Group 1 subjects participated in 12 sessions corrective exercise program for a month, group 2 subjects taped with kinesio tape (without any activity) once a week so that the elastic bands were continuously adhered to spinal column, the corrective exercise program and kinesio tape were applied for group 3 and group 4 considered as control group without any intervention. One month later the subjects were tested again. For static balance measuring,

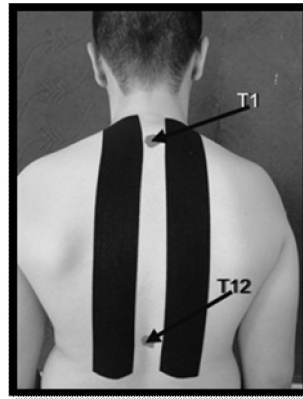
modified stroke test was used. For this purpose the subject laid hands on his thighs, while he must place his non-dominant leg at medial side of dominant leg's knee. Whenever that the subject removed hands from his thighs or removed the non-dominant leg from knee, trial was finished. During the test fulfillment, the subjects looking at a mark that located 4 meters far from subjects. Each subjects accomplished three trials and the best time was recorded as subjects point (McCurdy & Langford., 2006). This test is reliable with eyes closed and open and has good inter-rater reliability ( $r=0.87-0.99$ ), also an appropriate reliability have been reported for children and adult static balance measuring when standing on one leg (Atwater et al., 1990). To measuring the dynamic balance the star excursion balance test (SEBT) was used. This test is used to measure the dynamic postural control and has eight directions (like a star on Earth) so that the lines are drawn to each other with 45 degree angle. To perform the test, the true length of leg was considered as a distance between greater trochanter and medial malleolus. After explaining the required test by the examiner, each subject trained to learn the test completely. After warm up section the subjects stood in the center of star with open eyes then they touched the farthest point with non-dominant leg on all of lines without losing their balance. The farthest point was marked and recorded and then the subjects regain the primary position. This action was repeated three times in each direction and the value was recorded for each repetition. For data normalization, we divided the value that obtained from eight directions to leg length multiplied by 100 in order to obtain a unique score of dynamic balance. Hertel and his colleagues reported inter-rater reliability of star test between (0.78-0.96) (Hertel et al., 2000). Also Kinzey determined that this test has medium reliability and correlation coefficient of 0.86 to 0.98 for dynamic balance evaluation (Kinzey SJ &

Armstrong., 1998). For spine taping we used two equal pieces of kinesio tape. These two pieces adhered to erector spine muscles in a parallel line with spinous processes of T<sub>1</sub> and T<sub>12</sub> (5 cm from the origin and insertion of each piece at above and below of T<sub>1</sub> and T<sub>12</sub> installed without stretching). The order of corrective exercises implementation in each session was five minute warm up, Static and dynamic stretching exercises and light isotonic exercises ( 20 minutes, with 30 to 50 repetitions in order to stretch the anterior muscle and strengthening the shoulder girdle and scapular retractor muscles) respectively. Then isometric exercises to strengthen of the spinal column extensor muscles according to overload and variety principle was performed for 25 minutes, after that abdominal muscle strengthening exercises were carried out for 5 minutes. Finally, during the 5 minutes the subjects performed exercises for return to the initial state. Exercises that prescribed to strengthen the extensor muscles of the spine were based on evidence of Moffroid and his colleagues (Moffroid et al., 1993). Also for spinal alignment restoration according to McKenzie (McKenzie., 2006) and Murray (Moore., 2004) recommendations we used the retraction neck exercises. Stretching exercises that used for scapular and pectoral muscles are validated by Wang and colleagues (Wang., 1999). After data collection and confirmation of normal distribution using kolmogorov smirnov (K-S) test, results analyses were performed within groups using paired t-test and compared between groups using 4 in 2 design of multivariate analysis of variance test (MANOVA).

### Results:

There was no significant difference among four groups in the BMI and kyphosis angle variables ( $p > 0.05$ ). The comparison of balance performance of groups before and

after the application of independent variables for each group using paired t-test showed that the combination of spinal taping and corrective exercise have a significant effect on static and dynamic balance of subjects ( $p = 0.004$ ,  $p = 0.001$ ) and corrective exercise on dynamic balance of the subjects had a significant effect ( $p = 0.001$ ) but no significant effect on their static balance ( $p = 0.119$ ). There was also no significant difference between static and dynamic balance of the spinal taping group in pre-test and post-test ( $p = 0.440$ ,  $p = 0.128$ ) (table 1). Also comparing the influence of each experimental approach compared with control group showed that there were no significant differences among groups in effect on the static balance ( $p = 0.031$ ) and a significant difference in effect on the dynamic balance ( $p = 0.001$ ,  $p \leq 0.025$ ) (table 2). In this regard the results of post hoc test (bonferroni alpha adjustment) in comparing the effect of three methods based on static balance showed that there is a significant difference between combination of taping and corrective exercise group and control group ( $p = 0.030$ ) and no significant difference between corrective exercise and spinal taping groups and control group ( $p > 0.05$ ). Also the results of post hoc test in comparing the effect of three methods on dynamic balance showed that there is a significant difference between the combination of taping and corrective exercise group with spinal taping and control group ( $p = 0.001$ ) and no significant difference between the combination of taping and corrective exercise group with corrective exercise group ( $p = 0.481$ ). As well There was significant difference between corrective exercise and spinal taping groups in their effects on the dynamic balance ( $p = 0.014$ ) but no difference between taping and control groups was found ( $p = 1.00$ ).



**Figure 1: Taping method**

Table 1. the effect of experimental methods on static and dynamic balance

<i>Group</i>	<i>No</i>	<i>Test</i>	<i>Difference between pre-test and post-test (SD)</i>	<i>t value</i>	<i>sig</i>
<b>Corrective exercise</b>	9	Static balance	67.63 (116.35)	-1.74	0.119
		Dynamic balance	113.91 (57.92)	-5.90	0.001*
<b>Spinal taping</b>	9	Static balance	38.67 (68.36)	-1.69	0.128
		Dynamic balance	16.70 (61.73)	-0.812	0.440
<b>Combination</b>	9	Static balance	98.42 (74.22)	-3.97	0.004*
		Dynamic balance	167.07 (87.28)	5.74	0.001*
<b>Control</b>	8	Static balance	2.63 (12.01)	-0.005	0.996
		Dynamic balance	-0.03 (17.56)	0.620	0.555

Table 2. the comparison of three methods effects with control group

<i>Dependent variable</i>	<i>Df</i>	<i>F value</i>	<i>sig</i>
<b>Static balance</b>	3	3.356	0.031
<b>Dynamic balance</b>	3	14.196	0.001*

### Discussion and conclusion

The bonferroni post hoc test results of comparing of three methods on static balance indicated no significant difference among the three intervention groups with control group. Also except a significant difference between the combination group with control group, no significant difference in any of the groups was seen in relation to static balance. There are so many researches that reported balance declining following deformities (Anbarian et al., 2008; Sinaki et al., 2005; Murray et al., 2000; Durmus et al., 2010). Anbarian et al (2008) compared the features of postural control in patients with kyphosis and control groups and founded that Static

balance can be disturbed with change in line with normal spinal alignment, but this clearly and firmly, affected with the ability to make dorsal spinal deformity reduces the dynamic balance control (Anbarian et al., 2008). Related to this point it can be noted that a kyphotic individual have a more instability as a result of tribulation in base of support and they turn to compensatory mechanisms for balance maintaining. These compensatory mechanisms are created by visual and vestibular systems and they can be found with higher rate in the anterior - posterior direction. This can be explained with this point that following a deformity in the spine in sagittal plane, body's center of gravity changes its location to forward and

downward and consequently the whole body center of mass moved forward and downward and main outcome of this process is balance instability. Finally to returning the body center of mass to normal position, the person forced to adopt a compensatory mechanism with hip extension, knee flexion and ankle plantar flexion (Bot et al., 1999) and this manner, postural deviations are controlled in the anterior – posterior Directions. Absence of non-significant differences between experimental groups and control group in static balance can be attributed to use of compensatory mechanism in them. With regarded to after-mentioned issues we recommend both open and closed eyes situation for accurate measuring of static balance. Also the results indicate non-significant difference between the effect of combined spinal taping and corrective exercise method and corrective exercise method on dynamic balance of subjects. Due to the after-mentioned issues in static balance, this increase in dynamic balance can be followed from the increase in subject's postural control that itself results from reduction in the kyphosis angle. The effect of combined spinal taping and corrective exercise on static and dynamic balance can be attributed to performing the Strengthening and stretching exercises associated with proprioceptive training. Since the activities of daily living required to the simultaneous contraction of prime mover, assistant and stabilizer muscles and the proprioceptive impulses that arising from receptors in muscles, connective tissues and joint capsules have a major role in executing correct motions, according to the (specific adaptation of imposed demands (SAID)), Specific proprioception, motor control and functional exercises should be used simultaneously to improve deformities so that the improvement has a high durability (Christensen., 2000). It seems increased improvement in combined taping and corrective exercise group, compared with other groups resulting from improved mental imagination of body in

daily life using the accomplished properties of the spinal taping and also increased muscular strength and endurance due to nervous system response to over load, that is with increased muscle activity in this period by increased recruitment of motor units and increased frequency and coordination of neural messages followed by corrective exercise program. Also muscle contraction facilitation caused by applicable kinesio tape can't be ignored.

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