Effect of Upper Body Strength Training in Spatiotemporal Parameters of Gait In Individual with Thoracic Kyphosis

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Abstract

Background: The human spine is an integral part of the human body. Its function includes mobilizing the torso, controlling postural stability, transferring, loads from upper body to lower body, all of which is essential for the activity of daily living. Spine deformity affects spinal mobility and trunk balance, thus altering locomotion pattern during each step. Spinal deformity also alters the center of body mass (com) during gait which leads to gait abnormality. Exaggerated thoracic kyphosis is common in the elderly as there is age related increase in thoracic spine curvature. Generally, patients with thoracic kyphosis mostly have gait impairment with reduced movement in upper limb strength and muscle mass gets altered in upper limb.

Objective: The objective of the study is to study the effect of upper body strength training on spatiotemporal parameters of gait in individuals with thoracic kyphosis and to find out the effect of upper body strength program on gait parameters after thoracic kyphosis.

Material and Method: In this interventional study a total of 25 individuals with in the age group of 20 to 50 years, were selected. Pre-test and post-test assessment was done using the outcome measures of flexi curve ruler to assess kyphosis index and spatiotemporal measurement. Exercises were administered for 6 weeks. Later, post-test assessment and statistical analysis was done to determine its significance.

Results: According to the result, there was a considerable change in the stride length(p-value<0.0001) step length(p-value<0.0001) and cadence (p-value<0.0001). There was also a marked change in the kyphosis index. (p-value<0.0001).

Conclusion: As per the result of this study, we conclude that the effect of upper body strength training on spatiotemporal parameters of gait in individuals with thoracic kyphosis was extremely significant.

***Keywords*:** *Kyphosis, strength, thoracic, spatiotemporal, gait, parameters, upper body, stride length, step length, cadence.*

Introduction

Thoracic kyphosis refers to forward curvature of the thoracic spine. Exaggerated thoracic kyphosis is common in the elderly as there is age related increase in the curvature of the thoracic spine[1].

There are three main types of abnormal kyphosis. Postural kyphosis is more common in girls than in boys and typically appears during adolescence. Poor posture and weakening of the muscles and ligaments in the back causes postural kyphosis[2]. This patient can have symptoms of pain and muscle fatigue. Scheuermann's kyphosis is the result of structural deformity of the vertebrae. It is more common to develop kyphoscoliosis with Scheuermann's kyphosis than with any other type of kyphosis. Congenital kyphosis is the least common

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type of abnormal kyphosis and occurs due to abnormal development of vertebrae.

The most common symptom for patients with abnormal kyphosis are appearance of poor posture with a hump at the back or round back[3]. Symptoms may also include back pain, muscle weakness and stiffness in the back[4]. Physical and social outcomes of spinal kyphosis include in high, protuberant abdomen, downward gaze, digestive problems, impairments of respiratory function and decreased quality of life[1]. Therefore, basic activates of daily living, leisure, and emotional are negatively affected by spinal deformity. The functional consequence of this postural deformity and the overall decline in quality of life often overlook[1]. Generally, patients with thoracic kyphosis have gait impairment with reduced movement in upper limb. Reduction in strength and muscle mass in upper limb also occurs[5].

Gait is the most common human movement involved in daily activity[6]. Gait is the series of alternating movement of the lower extremities in a rhythmic motion that results in forward propagation of body. Gait parameters like cadence, step length and stride length generally tend to be reduced due to thoracic kyphosis. Basically cadence is the number of steps taken per unit time. Step length is the distance between corresponding successive points of heal contact of opposite feet. Stride length is the distance between successive points of heal contact of the same foot.

Normally in patients with altered gait, free movement of upper limb is necessary to improve gait and its parameters. Upper limb strengthening also helps in free motion of upper limb[5].

The human spine is the integral part of the human body. Its function includes mobilizing the torso, controlling postural stability, transferring, loads from upper body to lower body, all of which is essential for the activity of daily living[6,7]. Spine deformity affects spinal mobility and trunk balance, thus altering locomotion pattern during each step[8,9,10]. Spinal deformity changes the center of body mass (com) during gait which leads to gait abnormality[6, 11]

Measurement should be taken on the same population for which the measure is intended. For assessment of severity of kyphosis, normally radiographic method is used. However, it is a relatively expensive method as well as exposes the individual to radiation. Hence, flexi curve ruler is used here. It is a flexible ruler that molds according to the curvature of the spine and thus the angle can be measured. It reliability had a intra class correlation coefficient of 0.906 which is highly reliable.[12]

Therefore, the purpose of this study was to assess the pre-test and post-test reliability of the measurement of thoracic kyphosis using the flexi curve ruler with spatiotemporal parameters measurement[1].

Methodology

The ethical clearance was taken from ethical committee of Krishna institute of medical sciences, Karad. There were 25 participants in the study. The study took place in the Physiotherapy department, Krishna institute of medical sciences. The study was effect of upper body strength training in spatiotemporal parameters of gait in individual with thoracic kyphosis. The treatment protocol was of 8 weeks. The subjects were assessed for severity of kyphosis and spatiotemporal parameters as well. The type of study was experimental study. The study design was pre and post. The samples were chosen using the simple random sampling method. Participants were included as per inclusion criteria, i.e. age group of 20-50 years, individuals with acquired thoracic kyphosis and with Secondary kyphosis

Procedure

All the subjects were selected for the study according to the selection criteria. Demographic data and consent form was provided. Pre and post assessment were taken before the treatment began and after completion of treatment i.e. at 6 weeks respectively with the help of outcome measures.

In 1st and 2nd week, mirror image thoracic extension exercises for a hold time of 30sec and for a total of 5 repetitions was given. Along with this, head retraction for a hold time of 15sec and for a total of 5 repetitions was given as well as superman exercise for a hold time of 3sec and for a total of 10 repetitions was given.

In 3rd and 4th week, mirror image thoracic extension exercises for a hold time of 30sec and for a total of 7 repetitions was given. Along with this, head retraction for a hold time of 15sec and for a total of 7 repetitions was given as well as superman exercise for a hold time of 3sec and for a total of 15 repetitions was given. Raise up thoracic extension for a hold time of 15sec and for a total of 10 repetitions was given.

In 5th and 6th week, mirror image thoracic extension exercises for a hold time of 30sec and for a total of 10 repetitions was given. Along with this, head retraction for a hold time of 15sec and for a total of 10 repetitions was given as well as superman exercise for a hold time of 3sec and for a total of 15 repetitions was given. Raise up thoracic extension for a hold time of 15sec and for a total of 15 repetitions was given along with thoracic spine foam rolling for a hold time of 30sec and for a total of 10 repetitions was given.

Results and Dicussion

1) Age wise distribution

Table 1: Distribution of kyphotic individuals according to age

Age Group	No. of Individuals	Percentage	Mean ± SD
21-30	13	52.0%	23.93±2.72
31-40	8	32.0%	36.37±3.34
41-50	4	16.0%	45.5±2.65
Total	25	100.0%	31.36± 8.92

Interpretation: According table no. 1, 13 (52%) individuals belong to the age group (21-30) years with a mean age of 23.93 years, 8 (32%) individuals belong to the age group (31-40) years with a mean age of 36.37 years, 4 (16%) individuals belong to the age group (41-50) years with a mean age of 31.36 years.

2) Distribution according to gender

Table 2: Distribution according to gender

Gender	No. of Individuals	Percentage
Male	16	64.0%
Female	9	36.0%
Total	25	100.0%

Interpretation: According to table no.2, 16 (64%) individuals were male and 9 (36%) individuals were female.

3) Distribution of kyphosis index scores

Table 3: Distribution of kyphosis index scores pre and post intervention respectively.

Kyphosis index	Mean±SD
Pre	35.92± 4.99
Post	33.44±5.51

Interpretation: According to table no.3, the mean score for kyphosis index prior to intervention was 35.92 and post intervention was 33.44.

4) **Association between kyphosis index pre and post intervention**

Table 4: Association between kyphosis index scores pre and post intervention respectively.

	Paired t-test	
Kyphosis index	**t- value**	**p- value**
	8.667	<0.0001(ES)

Interpretation: According to table no. 4, the association between pre and post intervention scores of kyphosis index was compared using paired t-test with a p-value of <0.0001(ES)

5) **Distribution of spatiotemporal parameters pre and post intervention**

Table 5: Distribution of spatiotemporal parameters pre and post intervention

Spatiotemporal Parameters	**Mean±SD**		
	Stride Length	**Step Length**	**Cadence**
Pre	68.48±6.96	34.32±3.36	76.32±9.53
Post	75.56±9.48	37.76±4.74	80.88±10.91

Interpretation: According to table no. 5, the mean score for stride length pre and post intervention was 68.48 and 75.56 respectively, for step length pre and post intervention was 34.32 and 37.36 respectively, and for cadence pre and post intervention was 76.32 and 80.88 respectively,

6) **Association between spatiotemporal parameters pre and post intervention**

Table 6: Association between spatiotemporal parameters pre and post intervention

Spatiotemporal Parameters	**Paired t-test**	
	t- value	**p- value**
Stride Length	8.752	<0.0001(ES)
Step Length	7.502	<0.0001(ES)
Cadence	6.979	<0.0001(ES)

Interpretation: According to table no.6, association between spatiotemporal parameters was done using paired t-test. Stride length had a p-value of <0.0001(ES), step length had a p-value of <0.0001(ES) and cadence had a p-value of <0.0001(ES),

Discussion

The human spine is the integral part of the human body. Its function includes mobilizing the torso, controlling postural stability, transferring, loads from upper body to lower body, all of which is essential for the activity of daily living. Spine deformity affects spinal mobility and trunk balance, thus altering locomotion pattern during each step. Spinal deformity changes the center of body mass (com) during gait which leads to gait abnormality. Exaggerated thoracic kyphosis is common in the elderly this age related increase in thoracic spine. Generally patient with thoracic kyphosis mostly have gait impairment with reduced movement in upper limb strength and muscle mass gets altered in upper limb. Thus kyphotic individuals need appropriate treatment and awareness of such therapeutic techniques

like upper body strengthening necessary for preventing further complications as well as improving the quality of life of the individual.

In this study, 25 individuals who had kyphosis were taken. Individuals in the age group of 21-50 years were included in this study, out of which 13 (52.0%) individuals were in the (21-30) age group, 8 (32.0%) individuals were in the (31-40) age group, 4 (16.0%) individuals were in the (41-50) age group.

Also, out of the total 25 individuals participating in this study, 16 (64%) were male and 9 were female (36%).

Score according to Kyphosis index (KI) and spatiotemporal parameters of subjects were taken before the treatment/intervention was given. The mean Kyphosis Index score prior to the intervention was 35.92 and post intervention was 33.44.

Statistical analysis of Kyphosis index score of pre and post intervention was done to confirm that the difference between the pre and post measurements is significant. The comparison for pre and post Kyphosis index scores was found to have a p-value of (<0.0001) which was extremely significant.

To analyze the impact of kyphosis on gait in terms of spatiotemporal parameters like stride length, step length and cadence was done. Same as Kyphosis index score, measures of stride length, step length and cadence were taken before and after the treatment. The mean scores of stride length pre and post intervention was 68.48 and 75.56 respectively, for step length the pre and post intervention score was 34.32 and 37.76 respectively and for cadence the pre and post intervention score was 76.32 and 80.88 respectively. Here, stride length was altered the most among all the parameters.

Statistical analysis was done to compare the mean pre and post intervention scores of spatiotemporal parameters to confirm whether they were significant or not and it was found that stride length had a p-value of (<0.0001) which was extremely significant, step length had a p-value of (<0.0001) which was extremely significant and cadence also had a p-value of (<0.0001) which was extremely significant. Thus there was a significant improvement in the spatiotemporal parameters post intervention.

The reason behind this may be due to the fact that the exercises administered by us also utilized the lower limb muscles in some instances. Moreover, these exercises are known to strengthen the scapular muscles as well as the back muscles that link the trunk to the lower extremities.[8] The trunk is the central key point of the body, and the control of movement proceeds from proximal to distal body regions. Motor control literature also suggests that an improvement in the levels of proximal trunk control might lead to a better distal limb control. Hence, strengthening the trunk plays a significant role in improving gait.

Thus the results obtained by studying both the pre and post intervention scores in this study suggest that in treatment of kyphosis, upper body strengthening is extremely effective.

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Conclusion

On the basis of the result of the study it is concluded that in treatment of kyphosis, upper body strengthening is extremely effective.

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Conflict of Interest: There were no conflicts of interest in my study.

Ethical Clearance: The Institutional Ethical Committee has hereby given permission to initiate the research project titled, "Effect of upper body strength training in spatiotemporal parameters of gait in individual with thoracic kyphosis."

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