Effect of Therapeutic Exercise Protocol in Asymptomatic Individuals with Hyper-Lordosis of Lumbar Spine – An Interventional Study

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Abstract

Objective- The objective of the study was to study the effect of therapeutic exercise protocol in asymptomatic individuals with hyper-lordosis of lumbar spine.

Methods- Ethical clearance was obtained from institutional ethical committee. Subjects fulfilling the inclusion and exclusion criteria were included. Informed consent form was taken from each of the subject prior to the treatment. The motive and procedure of the study was thoroughly explained to the subjects participating. Instructions were given to the subjects about the exercise protocol. The sessions of these exercise protocol were conducted for 35 minutes/4 days/week. Pre and post test was assessed for lumbar lordotis angle and abdominal muscle strength using flexible ruler and pressure biofeedback respectively and the outcome measures were analysed after 1 month.

Result- Statistical analysis for lumbar lordosis angle (p=<0.0001) and abdominal muscle strength (p=<0.0001) revealed extremely significant difference post intervention. Lumbar lordosis angle in the study population reduced by 2.11 degrees. It also showed that the abdominal muscle strength improved by 5 seconds hold with 40mmHg pressure.

Conclusion- The study results concluded that this exercise protocol was significantly effective in reducing hyper-lordosis of lumbar spine as well as improved abdominal muscle strength.

Keywords- *hyper-lordosis, lumbar lordosis, therapeutic exercises, abdominal muscle strength, flexicurve ruler, pressure biofeedback*

Introduction

Lumbar lordosis is the ventral curvature of the spine formed by wedging of the lumbar vertebrae and intervertebral discs.(1)

Normal lumbar lordosis angle ranges from 30º to 45º (9)

In sagittal plane, lumbar lordosis is a key feature for maintaining balance. (10)

The balance of the muscles around the pelvis is an important factor in maintenance the lumbar lordosis. Because of relationship between the sacrum and the pelvis through the spine, any change in the biomechanics of sacro-pelvic region leads to changes in spinal curvatures, especially the lumbar lordosis.(3)

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Various anomalies are caused in the lumbar and pelvic regions when body balance is affected by any increase or decrease in lumbar curvature.[4]

Figure 1: Lumbar Spine

With normal lumbar lordosis, energy expenditure and stress on the supporting structures is minimised when balance is maintained between the lumbar spine and abdominal musculature.

Normally, the abdominal muscles rotate the pelvis posteriorly and, the erector spinae muscles tilt the pelvis anteriorly. Correct activation of muscle or groups of muscles results in normal compressive and tensile forces occurring at the lumbar spine. There are minimal stresses placed upon the intervertebral disc and the zygapophyseal joints with lumbar spine in neutral position. Hence chances of low back pain are minimal. [5]

Line of gravity lies slightly posterior which causes extension of lumbar spine. Anterior longitudinal ligament and iliolumbar ligaments as well as, the anterior fibres of the annulus fibrosus of the intervertebral disc and zygapophyseal joint capsules provide passive opposing forces which are necessary to counteract extension of lumbar spine. Active opposing forces are also provided by abdominal muscles which is necessary to counteract extension at the lumbar spine. [6]

Lumbar curvature carries the upper body weight and transfers it directly to the pelvis, which is of great significance. The structures in the lumbar region are one of the factors that affect the lumbar-pelvic balance, as well as the performance of lumbar lordosis and pelvic tilt [11]. Also, weakness of abdominal, dorsal, and lumbar muscles has been considered as the most common factors increasing the lumbar curvature. [10]

Types of Lumbar Lordosis:

HYPO-LORDOSIS:

When the lordotic angle of lumbar spine is less than 30º it is termed as hypo-lordosis. [9]

In hypo-lordosis there is over-compression of the intervertebral discs anteriorly with posterior displacement of the nucleus pulposus.

The zygapophyseal joints are in a close-packed position with lumbar spine extension, therefore with a hypolordotic lumbar spine, the zygapophyseal joints are distracted as a result of its anatomical orientation and also due to the decreased load on the zygapophyseal joints posteriorly. [5]

There will be stretching of the lumbar spine extensors and the posterior lumbar spine ligaments whereas shortening of the abdominal muscles and the anterior longitudinal ligament in hypo-lordotic lumbar spine. [6]

Hyper-Lordosis:

When the lordotic angle of lumbar spine is more than 45º it is termed as hyper-lordosis. [9]

In hyper-lordosis there is compression of the posterior vertebral bodies and the posterior zygapophyseal joints since they are in a close-packed position, which increases intervertebral disc pressure and narrowing of intervertebral foramina. There is excessive stretching of the anterior longitudinal ligament and abdominal muscles while shortening of lumbar spine extensors, posterior longitudinal ligament, interspinous ligaments and ligamentum flavum.[5]

With a hyper-lordotic lumbar spine posture there is impaction of the zygapophyseal joints. The resultant alteration in the spinal biomechanics results in decreased range of motion of the lumbar spine. The inflammation from the dysfunction phase of the degenerated intervertebral disc along with the decreased range of motion results in the hypersensitivity of proprioceptors and nociceptors in the intervertebral disc, ligaments, joint capsules, zygapophyseal joints and nerves. This hypersensitivity initiates a reflexogenic response thereby inducing muscle spasm.[7]

Following are some causes for hyper-lordosis:

- Bad posture
- Obesity
- Lack of exercises
- Sedentary lifestyle
- Shifting of line of gravity during pregnancy
- Use of footwear with high heels

Hyper-Lordosis Because of Bad Posture:

Lumbar posture in females is thought to compensate for the bipedal obstetric load during pregnancy and is based on a longer series of dorsally wedged vertebrae in the lumbar spine.[8]

Changes in postural patterns have been indicated as a risk factor for developing pain in the lumbar region, since abnormal posture causes tension in the ligaments and muscles, which indirectly affects the lumbar curvature, thus triggering pain.[9]

Hyper-lordosis can be corrected with exercises. Exercises should be such that hip flexors and back extensors will be lengthened and abdominal muscles and hip extensors will be strengthened.

Therapeutic Exercises:

Therapeutic exercise is the systematic, planned performance of bodily movements, postures, or physical activities intended to provide a patient/client with the means to-

- Remediate or prevent impairments.
- Improve, restore, or enhance physical function.
- Prevent or reduce health-related risk factors.
- Optimize overall health status, fitness, or sense of well-being [12]

In treatment of lumbar pain, therapeutic exercises are considered for strengthening lumbar muscles and increasing lumbar flexibility and maintain lumbar lordosis. [13][14]

Therapeutic exercises which specifically include lumbar stabilisation exercises have shown beneficial results in treatment of chronic back pain. [15]

These exercises mainly focus on increasing dynamic stability and lumbar muscle strength.[16][17]

So, this study tried to analyse the changes in lumbar lordosis angle following the implementation of exercise protocol which focused towards correcting its biomechanics.

Materials and Methodolgy

Type of study- Experimental study. Sample size- 46

Study duration- 6 Months Place of study- Karad

Inclusion Criteria-

- Age group 20 to 25 years.
- Lumbar lordotic angle more than 45°(hyper-lordosis) derived using Youdas et al trigonometric method.

Exclusion Criteria-

- Subjects with any congenital spinal deformities.
- Subjects with a history or current status of spinal fracture.
- Subjects who had surgical procedures related to spine.
- Pregnant females.
- Subjects who are physically disabled.

Outcome Measures:

Flexible Ruler:

The measurement of lumbar curvature (lumbar lordosis angle) was done using flexible ruler.

- The method that was used for characterizing the curvature of the low back was referred to by Youdas et al as the trigonometric method.
- Based on the trigonometric method, measurements of curvature was derived by using the

formula, θ = 4arctan(2*h/L),* where d is the depth of the curve at its midpoint and l is the length of the line connecting the end points of the curve.

Pressure Biofeedback Unit:

Measurement of abdominal muscle strength was done by using Chattanooga Pressure Stabilizer™ with subjects in crook lying position and pressure biofeedback unit (PBU) was placed under the lumbar spine at L3 level, right below the umbilicus and it was inflated to 40 mmHg.

The individual was instructed to "Take a breath in and as you exhale, gently draw your navel in towards your spine". Individual was asked to maintain abdominal contraction for as long as they can while maintaining a pressure of 40mmHg on the Pressure gauge. The time duration of the hold was measured.

Procedure-

Subjects fulfilling the inclusion and exclusion criteria were included. Informed consent form were taken from each of the subject prior to the treatment. The motive and procedure of the study were thoroughly explained to the subjects participating. Instructions were given to the subjects about the exercises.

Lumbar lordosis angle and abdominal muscle strength were measured before and after the exercises by using Flexible ruler and pressure biofeedback respectively.

The therapeutic exercises were performed for 40 minutes with proper rest intervals.

The sessions of these exercises were conducted four times in a week for four weeks.

Statistical Analyses

Within the group comparison was done by applying 'Paired t-test' to pre and post training values of same group for all outcome measures.

Age Distribution :

Table No. 1: LUMBAR LORDOSIS ANGLE-

Minimum	Maximum	Mean	Standard deviation
20	24	22.2	0.66

Table no. 2 : ABDOMINAL MUSCLE STRENGTH:

	Pre-test		Post-test		p value	t value
Lumbar Lordosis Angle	Mean	SD	Mean	SD		
	46.71	1.29	44.6	1.08	<0.0001	15.91

Table no. 3

	Pre-test		Post-test		p value	t value
Abdominal Muscle Strength	Mean	SD	Mean	SD		
	8.58	1.22	12.3	2.09	<0.0001	9.84

Result

Statistical analysis for lumbar lordosis angle (p=<0.0001) and abdominal muscle strength (p=<0.0001) revealed extremely significant difference post intervention. Lumbar lordosis angle in the study population reduced by 2.11 degrees. It also showed that the abdominal muscle strength improved by 5 seconds hold with 40mmHg pressure.

Discussion

This study "Effect of therapeutic exercise protocol in asymptomatic individuals with hyper-lordosis of lumbar spine." was conducted to analyse the effect of therapeutic exercise protocol which focused on normalising lumbar lordosis in asymptomatic hyper-lordotic individuals. Hyper-lordosis is considered as a predisposing factor for low back pain. Weakness of abdominal muscles and hip extensors leads to increase in lumbar lordosis angle as well excessive anterior pelvis tilt. Bad posture, obesity, use of footwear with high heels and sedentary lifestyle cause alterations in lumbar curvature and surrounding musculature. So it is necessary to maintain normal biomechanics of lumbar spine so as to reduce the chances of low back pain.

So this study was conducted to find out best therapeutic exercise protocol which focus mainly on normalising lumbar lordosis angle and strengthening of abdominals muscles.

The objective of this study was to analyse the effect of therapeutic exercise protocol which included posterior tilting of the pelvis along with strengthening of abdominal muscles on hyper-lordosis of lumbar spine. This study was conducted with 46 subjects. Subjects included were within the age group of 20 to 25 years and lumbar lordosis angle measuring more than 45^0 with flexicurve ruler derived using Youdas et al trigonometric method. Subjects with any congenital spinal deformities, any history or current status of spinal fracture, subjects who had surgical procedures related to spine, pregnant females and physically disabled were excluded from this study.

Prior informed consent was taken. They were explained with the necessary information before handing them with the forms. The forms used consisted 2 sections firstly demographic data and information about the subject and outcome measure, secondly the consent form. Subjects with lumbar lordosis angle greater than 45 degrees were taken for this study. The outcome measures used in the study were flexicurve ruler and pressure biofeedback apparatus. Pre assessment was done with flexicurve ruler and pressure biofeedback apparatus and values were taken. Subjects were informed about the therapeutic exercises to be performed. A session of 35 to 45 minutes was conducted four times a week for four weeks. Post assessment was done and values were noted. Values were measured to study the effect of therapeutic exercises.

The age group included in this study was 20-25 years. The mean of the age group was 22 years and standard deviation was 0.66.

Pre-test mean of lumbar lordosis angle was 46.71 and standard deviation was 1.29. Whereas, post-test mean was 44.6 and standard deviation was 1.08. p value was <0.0001 and t value was 15.91. Inference was extremely significant.

Pre-test mean of abdominal muscle strength was 8.58 and standard deviation was 1.22. Whereas, post-test mean was 12.30 and standard deviation was 2.09. p value was <0.0001 and t value was 9.84. Inference was extremely significant.

This study showed that lumbar lordosis angle in the study population reduced by 2.11 degrees. It also showed that the abdominal muscle strength improved by 5 seconds hold with 40mmHg pressure. This study showed that the therapeutic exercise protocol which focused on normalising lordosis of lumbar spine as well as strengthening of abdominal muscles are equally effective.

Conclusion

It was found that therapeutic exercise protocol focusing on posterior pelvic tilt was effective in normalising lumbar lordosis angle and improving abdominal muscle strength. Hence it is concluded that this exercise protocol shows effectiveness in reducing hyper-lordosis of lumbar spine in asymptomatic individuals.

Lumbar lordosis angle in the study population reduced by 2.11 degrees. It also showed that the

abdominal muscle strength improved by 5 seconds hold with 40mmHg pressure.

Therefore, it is concluded that this exercise protocol with posterior pelvic tilt is effective in reducing hyper-lordosis of lumbar spine as well as improving abdominal muscle strength in asymptomatic individuals.

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