A Newly Developed Exercise Program for Treatment of Mechanical Low Back Pain Associated with Accentuated Lumbar Lordosis

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Abstract: The relationship between low back pain and lumbar lordosis has been studied extensively with many contradictory conclusions. The already existing exercise programs to correct the accentuated lumbar lordosis have got many disadvantages. Objectives: Introduce newly developed exercise program to verify the relationship between mechanical low back pain and increased lumbar curve. A new program of exercise has been designed to alleviate the disadvantage of the previous programs. Study design: experimental, one group . Twelve patients with average age 39.3±4.5 years were included in the study, all have chronic low back pain over one year with lordotic angle over 50 degrees. Lateral X ray-films were taken before, after one and two months of treatment .A metal frame was designed to facilitate the use of plumb line, also a wedged pillow with an angle of 115˚ and stretch tool was designed for the execution of the exercise program. The patients did not receive any source of heat or medication throughout the treatment. The results revealed to a significant reduction of pelvic inclination, lumbosacral angle and lumbar curve were 5.4˚, 2.6˚ and 3.00˚ , respectively after the end of the second month of treatment . There is gradual and complete relief of pain without recurrence. It is concluded that this new program alleviated the disadvantages of the previous programs .It confirm the relation between low back pain and accentuated lumbar lordosis.
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1. Introduction:

Mechanical causes are responsible for the greatest percentage of low back pain diagnosis. It does not matter which tissue is involved in the mechanical low back pain but rather the abnormal or excessive forces that converge into the region and result in pain[1].The change in degree of lumbar lordosis have been identified by some investigators as the main cause of low back pain while other found no relationship between the degree of lumbar lordosis and low back pain. From the mechanical point of view the accentuated lumbar lordosis is associated with an increased prevalence of low back pain[2] , an imbalance in trunk muscle strength can influence significantly lordotic curve of lumbar spine and might be one risk factor for potential LBP[3]. No significant difference between normal subject and those with low back pain concerning the degree of lumbar lordosis. High and low value of lumbar lordosis was found in both groups [4,5]**.** No difference in lordosis between those affected with lumbar spine osteoarthritis and those who are disease free[6]**.**

In standing posture, a change in pelvic tilt either anterior or posterior, produces an almost equal angular change in lumbar lordosis, the degree of lumbar lordosis change significantly during the time period of the exercise. No evidence suggests that these exercises will promote a permanent change in posture[7]. Youdas[8] found no relationship between the level of pelvic inclination and the degree of lumbar lordosis in a standing position. There is a weak association between lumbar lordosis and pelvic inclination, but the abdominal muscle force of chronic LBP subject was less than that of the control subject[9]. A strong correlation between pelvic tilt angle and thoracic kyphosis and lordosis found by Legaye and Beapere[10] who assessed the onset of spinal deviation with pelvic inclination. Variations in pelvic morphology may significantly influence measures of pelvic tilt and innominate rotational asymmetry[11].

William's exercise program was developed in 1937 for patient with chronic low back pain for men under 50 and women under 40years who had exaggerated lordosis of lumbosacral part of the spine [12] .No x-ray study was found to proof the reduction of lumbar lordosis after using William's flexion exercise, instead the program faced great criticism. The experimental study don by **Rici, *et al.*[13]** revealed that during the sit up exercise, the pelvis was found to be tilted and put the spine in hyperextension before forward trunk displacement. **Jackson and brown [14]** believed that the exercise to stretch the low back muscle is not necessary as the low back muscles are inter segmental and don't have the mechanical advantage to increase lumbar lordosis.

Kendal and Jenkens[15] mentioned that the isometric exercises using valsalva maneuver were particularly beneficial for patient with prominent lumbar lordosis. This claim was denied by Davise *et al.*[16] .They found no significant alteration of the mean depth of lordosis after 4weaks of treatment using the isometric flexion exercise. The valsalva maneuver did raise intra-abdominal pressure, however it increased rather than decreased spinal load. Press heel sit up increase psoas muscle activity[17].Bent knee sit up may be problematic exercise for people with LBP pathologies because of the relatively high rectus femoris and lumbar paraspinal muscle activity. When these muscles contract, the force generated act to anteriorly rotate the pelvis and increase the lordotic curve of the lumbar spine[18.]

Proper reduction of lumbar lordosis helps to support load on the ligamentous system .This can be accomplished by rotating the pelvis posteriorly and by proper instruction to use abdominal muscles without necessity to bend forward. The thoracolumbar fascia is the only active ligamentous structure capable of balancing the external moment .It is under muscular control through the entire range of spinal motion, whereas the midline ligament is geometry dependant [19]. Contraction of the latissimus dorsi , internal oblique or transverses abdominis can exert active tensile force to the thoracolumbar fascia. Maximizing the effectiveness of the thoracolumbar fascia can be accomplished by training muscles attached to it and utilization of its passive mechanism[1]. Vleeming *et al.*[20] revealed that the fascia attached to the latissimus dorsi is continuous with the fascia of the gluteus maximus in the contra-lateral site. The gluteus maximus and contralateral latissimus dorsi muscle tense the posterior layer of thoracolumbar fascia and provide a force closure perpendicular to sacroiliac joint. The overall trend of latissimus dorsi muscle is to complement erector spine muscle in that when activity of one increased the activity of the other is decreased[21].

Fairweather and Sideway[22] used an adaptive form of idiokinetic imagery that incorporate kinesthetic awareness exercises that improve posture and reduce low back pain. Mental practice may prove to be a useful adjunct to traditional treatment options aimed at increasing muscle strength[23]. Kinesthetic imagery implies somesthetic sensation elicited by action[24]. The purpose of this study is to introduce newly developed exercise program to reduce the pain associated with accentuated lumbar curve, and verify the relationship between mechanical low back pain and increased lumbar curve. It included strengthening and stretching exercises based on biomechanics of the spine and muscle action, the key exercise is posterior pelvic tilt executed through ideokinetic imagery exercise.

2. Methods

Subjects

The study group included 12 patients (8 females and 4 males). Patients were adult with average age 39.3± 4.5 years, weight (81.66± 12.8 kg) and height (161.75±6.9 cm). Total Nineteen patients with chronic low back pain selected consequently from the out patient clinic with age ranging 30- 45 years. They were clinically examined by orthopedist then referred to department of radiology. They were complaining of back pain in spite of previous methods of treatment, including bed rest, pain killer, physiotherapy modalities and acupuncture. They complained of low back pain which was continuous for more than one year. The study included only the twelve patients who had lumbar lordosis greater than 50 degrees measured on x ray. Subjects were excluded if they had nerve root pain, neurologic sign and symptoms, previous spinal surgery or structural deformities such as scoliosis or spondylolisthesis. The study has been don in the Orthopaedic clinic, departments of radiology and physical therapy of Elharm Hospital, Giza Egypt. Informed consent was obtained and the right of subjects were protected.

X ray measurements

Lateral x-ray films were taken from standing position. The plumb line was used to standardize the technique of measurement. A metal frame was used to facilitate the use of plumb line. It is a movable plumb of metal wire. It was selected carefully to be not distorted to help in taking an accurate measurement. The plumb line represents the line of gravity on the external surface of the body. The x-ray was repeated after one and two months of starting treatment. The distance of the x ray tube to the film was fixed by one meter. The x-ray films were taken by the same technician who was aware of necessity for consistency in technique. The x-ray measurements were the degree of lumbar lordosis (L_2-S_1) using standard cob technique, the upper border is a line parallel to the upper surface of the second lumbar vertebrae while the lower border is a line parallel to the upper border of the sacrum .The lumbosacral angle is the angle between the lower border of L_5 and upper border of S_1, pelvic inclination is the angle between the vertical line and the anterior surface of S_1 (Fig. 3). Cases with a lumbar lordosis greater than 50 degrees were only included in the study.

Designed tools

The designed wedged pillow is made of compressed sponge, it has an angle of 115 and nearly square base with dimensions of 65x 50cm, two separate bases of 4cm each were made to modify the height of the pillow according to the height of the patient. The designed pillow helps to keep the knee bent with an angle of 65°; this design was made according to electromyographic finding by **Walter and Partridge**[5] who found that hip flexors are fairly relaxed and participate to a lesser degree when the knee flexion was 65° instead of 90°. (Fig. 1 A). The stretch tool was designed to stretch hip flexors .The main idea of the tool is to design a tool with a changeable angle started from5-30 degrees with 5degrees interval. The general form and solidity were taken in consideration (Fig. 2 F).

Procedures

Pain level was measured with visual analogue scale. The scale of pain has an extreme point representing maximum pain while the other end represents no pain, The scale of pain was then portioned into 10 sections with 0 indicating no pain and 10 indicating maximum pain. Each patient was asked to identify the point appropriate to their level of pain. This identification was recorded at the end of each weak of treatment.

The newly developed exercise program included strengthening and stretching exercises .The strengthening exercises were posterior pelvic tilt exercise implemented through idiokinetic imagery exercise, posterior pelvic tilt with hips abducted and externally rotated ,curl up exercise by raising the head then gradually to elevate the scapula off the plinth, latissimus dorsi exercise to train the transverse and oblique fibers of latissimus dorsi which attached to the thoracolumbar fascia. Shoulder lift trunk rotation, gluteal setting exercise and hip extension exercise.

The mechanical basis of the exercise program is to develop an active tension in the thoracolumbar fascia by training the muscles attached to it. The thoracolumbar fascia will be capable of sub serving antiflexion role complementing that of the back muscles. This mechanism will help to decrease the activity of back muscles (longissimus and iliocostalis of thoracic part of erector spine and multifidus). All the exercises were executed from lying position with upper trunk stabilized to minimize the activity of paraspinal muscles. The stretch tool was used to provide low load prolonged stretch. The exercises preceded stretching because the increase in tissue temperature Produced by muscular exercise allows elongation to occur with less structural damage. The stretching exercise is followed by strengthening exercise for the gluteal muscle. The exercise program is preceded by Relaxation and weight exercises. Figure 2 show most of the exercise program.

Weight exercise: patient was made aware of two objects and their respective weight. Two sandbags (1 and 1.25kg) were placed 10 seconds for each with 5 seconds interval on the abdominal area. The purpose of the weight exercise is to increase awareness of the abdominal area and hence facilitate effectiveness of idiokinetic imagery exercises.

The first exercise (posterior pelvic tilt) executed through the idiokinetic imagery exercises. It helps to train the abdominal muscles without including back mscles, so avoid co contraction which caused by pressing back and holding breath. Each exercise was repeated precisely three sets of ten with rest in between .Only a new exercise was added each sitting, however the patient performed each exercise correctly before preceding to a more complex one. The treatment was given three times/week. The time allowed for the exercise program was gradually increased in parallel with the increase of the exercises; it is started with half an hour to reach 1.5 hours for full program.

Exercises in the first month of treatment.

Strengthening exercises

The following exercises were given in order from the hook lying position. The knees were bent at an angle 65° degrees .this position was maintained passively through using the designed wedged pillow.

1-Posterior pelvic tilt

Too often the posterior pelvic tilt is done without any benefit of the abdominal. The subject performs the movement by pushing the feet to help rock the pelvis back into posterior tilt [26] .Caillet[2] mentioned that the movement of posterior pelvic tilt is performed by the combined contraction of the abdominal and gluteal muscles, pressing the low back against the floor. This method may cause valsalva maneuver which increase the activity of the back muscles. In the current study posterior pelvic tilt was implemented through the following idiokinetic exercises (Fig 1 A). Various facilitation techniques were uses throughout the program consisted of multisensory (auditory, tactile, visual, and kinesthetic cuing).

A-Patient imagine his abdomen like a hand pulling the weight on the abdomen downward towards the plinth.

B-Patient imagines his trunk as a flexible curve like the flexible rule and then gradually slid it downward to be straightened on the plinth. The therapist demonstrates this to the patient using a flexible rule.

C-Patient imagine each side of his pelvis as a wheel, both wheels revolving anticlockwise toward the head. After executing each component of posterior tilt correctly, patient then performed the previous exercises as one exercise.

Mechanism of muscle action

Idiokinetic imagery exercises help to perform the exercise under consciousness and to be executed slowly and precisely without co –contraction, they were a modification of that used by fair-weather and sideway[22],they were modified according to the understanding of patients and their ability to imagine.

Posterior pelvic tilt requires moderate activity of internal and external oblique muscles, this helps to generate intra-abdominal pressure [14],it helps to stretch the long fascicles of multifidus , only the long fascicles of multifidus has the capability to increase lumbar lordosis. It also helps to train the longissimus and iliocostalis muscles of the lumbar erector spinae, these muscles has the ability to decrease lumbar curve by inducing posterior shear[27]**.**It Allows the patient to adjust his lordosis to support load through ligamentous tension[28]**.**Posterior pelvic tilt ,not only preceded the other exercises each sitting but it was a component of them. This helps to return to the normal pattern of the abdominal muscles and increase the repetition of the posterior pelvic tilt which is the key exercise for correcting lumbar curve.

2-Posterior pelvic tilt with hip abducted and externally rotated with heels together.

This exercise helps to regain maximus performance of gluteus maximus from the crock lying position.

3-Curl up exercise

The patient performed posterior pelvic tilt then curled the trunk. He raised the head then progressed by raising the shoulders .The patient raised himself enough to elevate the scapula, then return back slowly while maintaining pelvic tilt(Fig. 1 B)

Mechanism of muscle action

This exercise produce minimal amount of lumbar flexion and provided maximum activity of external and rectus abdominis muscle as confirmed by halpern and bleck[29].It provides the advantage of exercising the abdominal muscles without strong hip flexor exercise .In addition there is less intra- discal pressure when doing trunk curl as compared to completing the sit up. The inferior and medial direction of the external abdominal oblique muscles Help to posteriorly rotate the pelvis and check the downward and forward motion of the pelvis.

4-Shoulder lift trunk rotation

The patient tilt the pelvis posteriorly then elevated one shoulder and rotated the shoulder on the pelvis (Fig. 1 C)

Mechanism of muscle action

Trunk rotation performed largely by internal oblique [25].Training the Internal oblique helps to generate intra abdominal pressure reflexly while the deliberate increase in inta-abdominal pressure using valsalva maneuver cause increase in erector spinae activity .This exercise add tension to the thoracolumbar fascia. It increases the force of the extension moment that the fascia can generate. This will help back muscles in overcoming the large flexion moment and consequently decrease the activity of paraspinal muscle.

5-Latissimus dorsi exercise

The patient tilt the pelvis posteriorly then adducting the arm against resistance (Fig. 1 D)

Mechanism of muscle action

The latissimus dorsi muscle has the largest moment arm length; it potentially influences lumbopelvic mechanics with less effort. It has significant effect on lumbopelvic mechanics through its attachment to the thoracolumbar fascia. This exercise was designed to train the part of the latissimus dorsi which attached to the thoracolumbar fascia. It avoid involvement of the direct part of the muscle which constitute the most lateral part (2-3cm).This part is ultimately attached to the iliac crest and its training will cause an increase in the anterior pelvic tilt .It causes bilateral pull on the thoracolumbar fascia by the transverse and oblique fibers of both latissimus dorsi, this help to develop an active tension in the thoracolumbar fascia which ensheaths the back muscles .The tension developed in the fascia helps to brace the erector spinae preventing their dorsal displacement, hence they can work with less effort .The latissimus dorsi muscle complement the erector spinae, therefore increase the activity of latissimus dorsi through training will help to decrease activity of erector spinae and consequently help to reduce lordotic curve. The exercise was preceded by posterior pelvic tilt. The patient maintained this position then adducted against resistance. This exercise allows coupled function of the gluteus maximus and contralateral latissimus dorsi. The gluteus maximus and contralateral latissimus dorsi muscle tense the posterior layer of thoracolumbar fascia. They provide a pathway for uninterrupted mechanical transmission between pelvis and trunk. This coupled function creates a force perpendicular for the sacroiliac joint .The thoracolumbar fascia

exerts compression on the lower lumbar spinae and pelvis, therefore ,it helps to accomplish force closure of SI joint physiologically instead of using pelvic belt.

Stretching exercise

The stretching exercises started on the 4th sitting and preceded by the previous strengthening exercises The starting position for stretch helps to rotate pelvis posteriorly(Fig. 1 E), this implies a decreased risk of hyperextension of lumbar spine .The more posteriorly tilted pelvis in this position means greater extension of the hip[21].The starting position of stretch also helped the stretch to begin when the muscle was in completely relaxed state to minimize the amount in tension developed by the contractile component . A cushion put under the abdomen ,the pelvis was stabilized by designed belt to reduce the magnitude of electrical activity in the sacrospinalis following the study of **Fisher and Houlz [30]** .The starting position was maintained for 5 minutes, then the flexed leg was raised to the bench for one minute .From the starting position the limb was supported on the designed stretch tool(Fig. 1 F) for five minutes elevated 5degrees then lowered for one minute rest in the prone position then elevated another 5 degrees for another five minutes. The stretch was repeated for the other leg. This procedure allows the stretch to be maintained 5 minutes in each new length of hip flexor. The designed stretch tool helps to provide low force long duration stretch technique. The stretching exercise was followed by gluteal setting exercise from prone position.

Gluteal setting exercise

The stretching exercise was followed by gluteal setting exercise. Strong volitional contraction was performed from prone position with cushion under the abdomen.

Mechanism of muscle action.

In the presence of tight hip flexor, an attempt to strength hip extensors might therefore result in overuse of perpetuating tightness of the paraspinalis. Increased erector spinae activity may be seen in the gluteus maximus weakness, the lift is accomplished through a forward pelvic tilt and hyperextension of the lumbar spine resulting in posterior compression and anterior shear in the lumbar region. So initial attention was focused on gluteal setting which elicited a large degree of activity regardless of the position.

The exercises in the second month

All the exercises were performed every sitting, the stretching exercise was modified, In the second month the stretch was maintained with the stretch tool at 10 degrees for 5 minutes repeated three times.

Hip extension with abduction and external rotation

From the starting position of the stretch, strengthening for hip extensor was performed after stretch. The starting position of this exercise was the stretch position but the extended limb was put in abduction and external rotation. The patient was asked to hyperextend the thigh.

Mechanism of muscle action

This exercise elicited the strongest contraction of the gluteus maximus muscle .Hip extension was accompanied with knee extension, so almost all rectus femoris activity disappeared as well as no activity in the hamstring. In this exercise the knee was extended, this help to train quadriceps. Contraction of the quadriceps causes tightness of the iliotibial band, half of the gluteus maximus attached to the iliotibial band. Large portion of the gluteus maximus act with greater leverage when the iliotibial band is tight .The exercise allowed extension beyond the Zero hip extension .It is associated with strong contraction of the gluteus maximus, while extension of the flexed thigh is performed primarily by the action of the hamstring muscle.

Data Analysis

The student t test and correlation coefficient were used to judge statistical significance difference. The level of significance was $p<0.05$. Data were analyzed using SPSS program version 12.0

3. Results

The differences in the three angles, lumbar curve, lumbosacral angle and pelvic inclination after the 1st and 2nd month of treatment were represented in three lateral x-ray films. They were taken for each patient before, after one month and finally after two months of treatment (Fig. 3). The result of the study showed a significant reduction in lumbar curve, lumbosacral angle and pelvic inclination, after the first and second month of treatment Table (1).The differences in lumbar curve were1.25±2.0 and 3.00±2.48 after the 1st and second month of treatment respectively. The differences in lumbosacral angle were 1.08±1.44and 2.66±1.87 after the 1st and 2nd month of treatment, respectively .The significant changes in pelvic inclination were2.08±2.87 and 5.41±1.78, respectively.

Fig. 1 The designed wedged pillow made of compressed sponge, with an angle of 115°

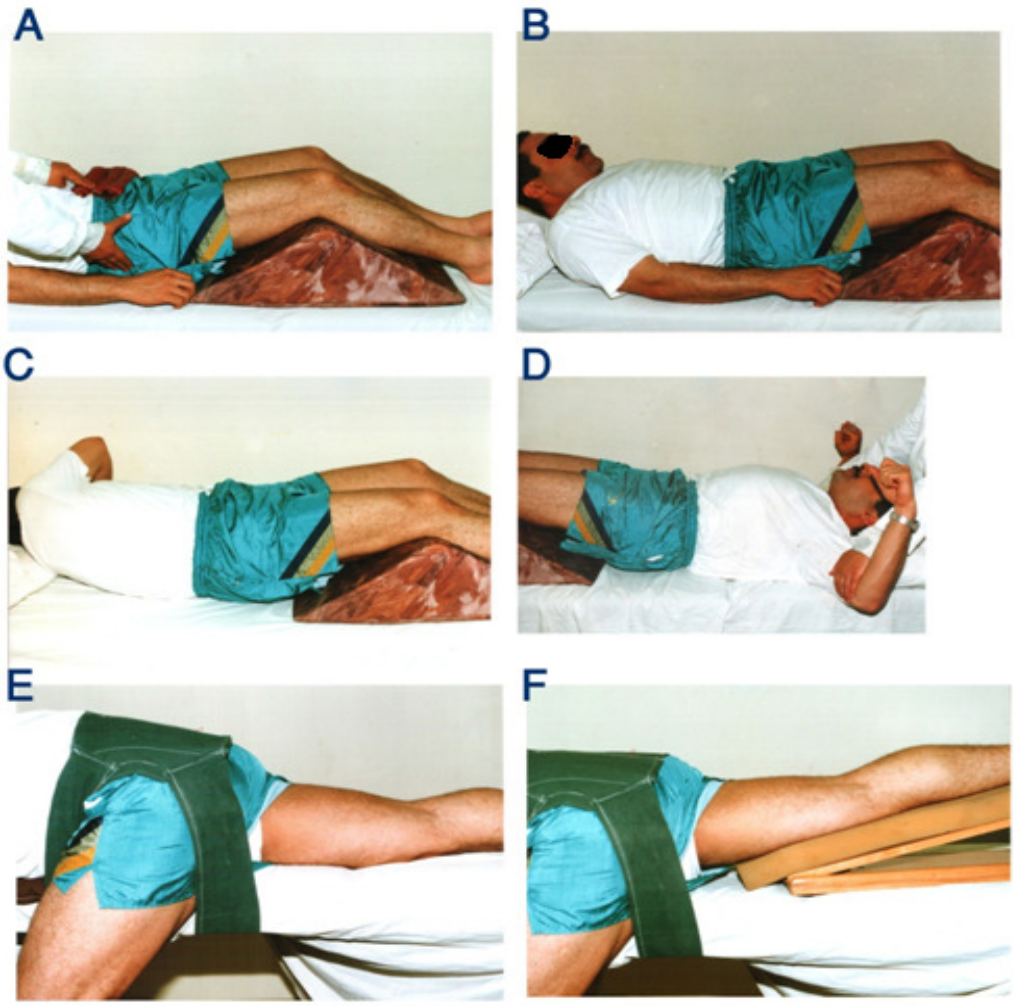
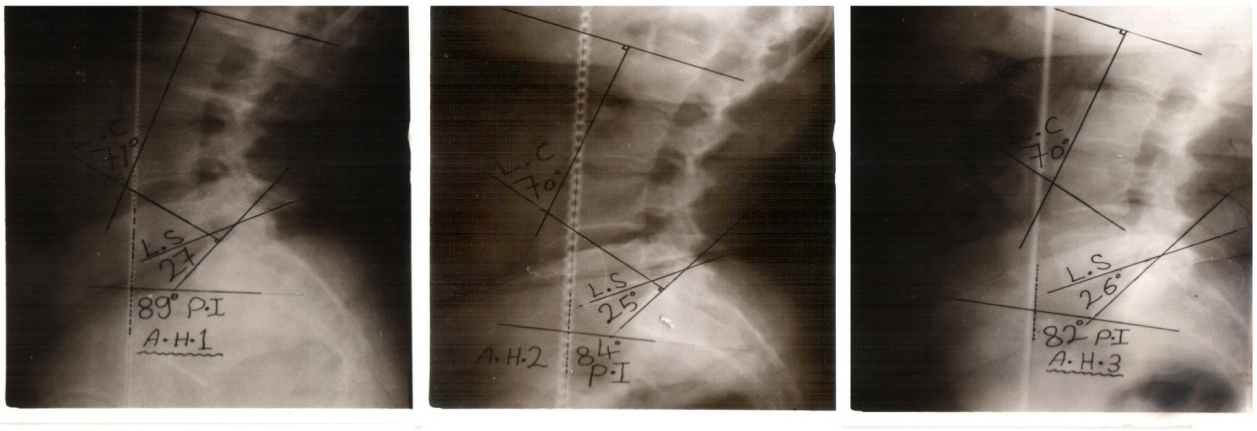


Fig. 2: Part of Newly developed exercise program .A .show posterior pelvic tilt through idiokinetic imagery exercise. B. Curl up exercise preceded by posterior pelvic tilt. C trunk rotation preceded by posterior pelvic tilt. D. Latissimus dorsi exercise for the transverse and oblique fibers preceded by posterior pelvic tilt. E, starting position of low load stretch where the pelvis stabilized by belt. F, low load prolonged stretch using designed stretch tool.



"FIGURE 3" X ray measurements pre treatment, after one month and 2 month of treatment, from left to right respectively.
PI: The angle of pelvic inclination **LS: lumbosacral angle**
LC: Angle of lumbar curve **A.H: The abreviation of patient's name**

There was a gradual decline of pain after treatment without recurrence. The pain was reduced by about50% at the end of the 3rd week and completely relieved by the end of the 8th week(Fig. 4)There was a correlation of the change in pelvic inclination with that of lumbar curve after the first month and second month equal to .8 and .513, respectively. The correlation is highly significant only after the first month of treatment where P=.002.

Table 1: Measurements of lumbar curve , lumbosacral angle and pelvic inclination before, one and two months after treatment.

X-ray measurements		Mean	T	Sig	Difference
Lumber curve	lumber curve before treatment	61.±5.79			
	lumber curve after 1 month	60.25±6.39	2.159	0.054	1.250
	lumber curve after 2 month	58.5±7.166	4.180	0.002	3.00
Lumbosacral angle	Lumbo-sacral angle before treatment	15.75±6.63			
	Lumbo-sacral angle after 1 month	14.6667±6.4	2.600	0.025	1.08
	Lumbo-sacral angle after 2 month	13.08±6.639	4.927	0.000	2.66
Pelvic inclination	Pelvic inclination before treatment	73.667±7.389			
	Pelvic inclination after 1 month	71.58±6.4	2.510	0.029	2.08
	Pelvic inclination after 2 month	68.25±6.689	10.532	0.000	5.416

Table 2: Correlation of the change of pelvic inclination with change in lumbosacral angle and lumbar curve.

Variables	Correlation after one-month	Correlation after two-month
Lumbar curve & Pelvic inclination	r =0.8 P.002**	r= 0.513 P.088

**Correlation is significant at the 0.01 level (2- tailed)

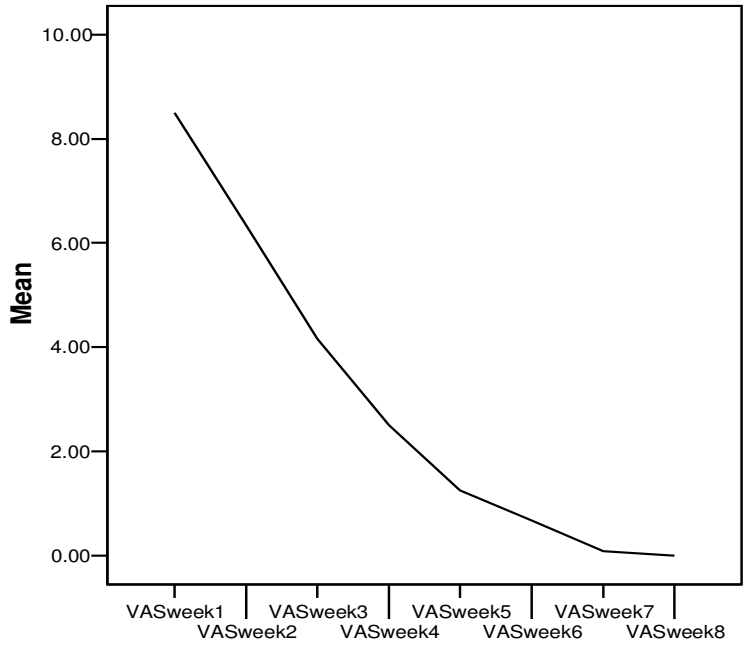


Fig. 4: Visual analogue scale of pain show complete relief of pain without recurrence by the end of treatment.

4. Discussion

This study concerned with applying a newly developed exercise program. It helped to correct the accentuated lumbar lordosis and decrease low back pain. The traditional exercise program of **Williams**[12] and isometric exercises[15] were believed to decrease lumbar lordosis however the biomechanical analysis[14],the experimental study by **Ricci *et al.*** [13] and electromyographic study by **Black Burn and Porteny**[31] revealed their disadvantages and the result of the few researches using such programs did not show any improvement in the lumbar curve[16,22].This study confirmed the relation between low back pain and accentuated lumbar lordosis , in contrast with **Youdas** [9] who mentioned that patients with CLBP had no more standing lumbar lordosis or pelvic inclination than their counterparts with healthy backs. **Nourbakhsh, *et al.*** [5] found no significant relationship between LBP occurrence and the degree of lumbar lordosis and concluded that the degree of lumbar lordosis did not differ between normal subjects and those with low back pain. This can be explained by the wide variation of the degree of lumbar lordosis among normal subjects [4,6] and any changes that might occur sooner or later may still within this normal range [6] and that large variation of pelvic morphology masks any difference in pelvic tilt between normal subject and a group of LBP[11]

In the present study the difference in the change of pelvic inclination is greater compared to the mean differences in the lumbosacral angle and lumbar curve, they were 5.41, 2.66 and 3.0, respectively after the second month of treatment. The results in the current study verified the suggestion of fair-weather and sideway [22] that the change in subject's lordotic angle was the result of reduction in anterior pelvic tilt and realignment of the spine as a whole. This in agreement with Day, etal[32] who mentioned that the lumbar curve can be altered by pelvic tilt. Anterior tilt increased the depth of lumbar curve and posterior tilt decreased the depth of lumbar curve, however his result was only at the time of exercise. A highly significant correlation in the current study was found in the change of pelvic inclination with that of lumbar lordosis after the first month of treatment. There was a significant reduction in pain in low back accompanied reduction in lumbar curve. In contrast to the study done by **Davis, *et al.*** [16] where the pain was reduced without change in lumbar curve. Our results goes with fair-weather and sideway[22] regarding the complete

disappearance of pain by the end of 8th week of treatment , however they mentioned that the cessation of pain had been preceded by initial sharp increase in pain level during the first week. In the present study, there is gradual decrease in pain without recurrence.

The hip flexor activity is less in the crunch than the knee bent set up[33] as the relative high rectus femoris muscle activity obtained with bent knee set up may be problematic for some people with LBP problem[18] .However, the curl up exercise executed in the current program is better than the crunch) .The designed billow allow the knee bent of 65 instead 90, this allow the rectus femoris to be fairly relaxed, also it avoid support foot on the plinth. In the current study the patient raised him self only enough to elevate the scapula. Following the study of **Halpern and** Bleck[29], this exercise produced minimal amount of lumbar flexion and provide maximum activity of external oblique and rectus abdominal muscles. In the current study Curl up exercise is preceded by maintaining pull in abdomen similar to Crunch exercise which show high EMG activity from the internal oblique which may offer more effective stabilization to the spine and pelvis[18] . Activation of the deep lateral abdominal muscles could be enhanced with proper instruction during the abdominal crunch, such as performing the abdominal crunch while holding the abdominal drawing in maneuver[34] .

In subject with normal abdominal muscles, as trunk flexion is slowly initiated by raising the head and shoulders from a supine position, the pelvis tilts posteriorly simultaneously[26] ; hence in this study every strengthening exercise was preceded by posterior pelvic tilt to return to the normal pattern of the abdominal muscles. In addition posterior pelvic tilt from hook lying position requires moderate activity of internal and external oblique muscles with minimal rectus abdominis activity, this help to develop intra abdominal pressure[14] . The increased lumbar lordosis increases the activity of the multifidus[28] , only the long fascicles has the capability to increase lumbar lordosis ,a reduction of the activity of the multifidus can be accomplished by posterior tilt exercise. It helps to stretch the long fascicles of multifidus. Posterior tilt exercise also helps to train the longisimus and iliocostalis muscles of the lumbar erector spinae, these muscles have the ability to decrease lumbar curve by inducing posterior shear[27]. Posterior pelvic tilt has been advocated to cause co-contraction of the local stabilization musculature and that for the posterior tilt to be performed the individual contract the lower abdominal muscles to rotate the pelvis posteriorly, so that the lumbar spines flatten out[35]. The contraction of the abdominal muscles accompanied the posterior tilt in the current study was implemented through ideokinetic imagery exercises. It is a method used to facilitate positive change in the spinal column of the subject through subcortical stimulation[22]. Slow eccentric curl-back phase and multisensory kinesthetic cuing without foot stabilization helped to increase voluntary recruitment of the internal oblique and transverses abdominis muscles, teaches abdominal muscle awareness and voluntary control to break the patterns of dependence on the iliopsoas muscles in exercise and functional trunk movement[36].

Some Commercial abdominal exercise devises have come to the market and have come popular with the public .A comparative electromyographic activity analysis between commercial abdominal exercise devices and conventional crunch start curl up revealed that the conventional curl up exercise is safer with less hip flexor activity[37] . Therefore, the technique used to execute Curl up ex in the current study is better than Some commercial abdominal ex (AbDoer'Ab twister,A b Roker and SAM) which recorded the lowest amount of abdominal activity and exhibit the greatest rectus femoris activity. Purchasing these abdominal devices does not appear to offer any advantage in recruiting abdominal musculature over performing traditional exercises that require no additional equipment[33] .The relative high rectus femoris muscle activity obtained with power wheel exercise may be problematic for some people with LBP problem[18] .While the makers of the Bodyblade claim that it is "the most efficient core power training tool ever designed". Use of the Bodyblade may either enhance or compromise spine stability. Associated lumbar compressive forces may be inappropriate for some people with compressive intolerant lumbar spine pathology[38].

When the inclination of the pelvis was voluntary increased, there was an increase in the erector spinae muscle activity and when decreased there was a decrease in the muscle activity[39] . The increased activity of the erector spinae occurs in the longissimus and iliocostalis of the thoracic part and in the multifidus. The increased activity of these muscles can be reduced through latissimus dorsi exercise, as the latissimus dorsi complement the erector spinae[21].commercial exercises (torso track and AB slide) generate tension in the latissimus dorsi in addition to the internal oblique which all tense the thoracolumbar fascia and enhance trunk stabilization but maintain the spine and pelvis in neutral or extended position[33] which are not suitable to this subgroup in the current study. Latissimus dorai muscle EMG was high using some commercial device (power wheel pike , power wheel knee up and hanging knee up with strap) ,however they show highest lumbar paraspinal EMG and that rectus femoris was highest for the power wheel Knee up. In addition that the subjects

participated in that study were all relatively young, active people. Older, less active or people with trunk pathology may not be able to perform the more difficult exercises used in that study[18]. These commercial exercises did not concentrate on the transverse fiber of the latissimus dorsi compared with that in the current study, hence in this study through strengthening of the latissimus dorsi specially the part attached transversely to the thoracolumbar fascia, active tension is developed in the fascia which ensheaths the back muscles, preventing their dorsal displacement, hence its action can be done with less effort.

One of the most common clinical challenges is to stretch the hip joint capsule and anterior thigh musculature without creating an extension force to the lumbar spine [1].The method used for stretching hip flexor in this study has several advantages. The starting position for stretch posteriorly rotates the pelvis, this implies a decreased risk of hyperextension, the more posterior tilt pelvis in this position means greater extension of the hip[40].The pelvis is stabilized by a designed belt to reduce the magnitude of electrical activity in the sacrospinalis ,following the study of **Fisher and Houtz[30]** the designed stretch tool allowed low load prolonged stretch technique .Permanent lengthening is most favored by low force longer duration stretch[41].

Abdominal drawing in maneuver during prone hip extension exercises is recommended as an effective method for preventing excessive anterior pelvic tilt and increase the contribution of the hip extensors while reducing the activation of the lumbar erector spinae .While the drawing in maneuver decrease anterior tilt from 10 to 3degrees, the starting position in the current study was the starting position of stretch, which may eliminate any degree of anterior pelvic. In addition that Drawing in maneuver may preclude hip extension in the prone position hip flexion contracture and significant weakness of the gluteus maximus[42].So in the current study, in the first month of treatment initial attention is focused on gluteal setting exercises which elicited a large degree of activity regardless of the position and low load stretch of hip flexor preceded isotonic hip extension .In the second month of treatment hip extension is performed while the hip is abducted and externally rotated. This exercise exhibit the strongest contraction of the gluteus maximus[30] .In the current study hip extension is accompanied with knee extension, So almost all rectus femoris activity disappears as well as no activity in the hamstring[43]. Hip extension in combination with lateral rotation might be effective choices to optimize gluteus maximus function[44].

Specific exercise treatment approach was more effective than general conservative treatment [45,46] .The current program found a significant reduction in pelvic tilt and lumbar curve in contrast with **Lindgren *et al.*** [47]. Who did not find any radiographic improvement in 9 subjects with segmental dysfunction, following a treatment regimen focusing on strengthen of the abdominals and multifidi. The use of subgrouping classification methods for the physical therapist management of subjects with LBP may result in better outcomes than physical therapist management that is not classification based. Using specific inclusion criteria to identify more homogenous subgroups of subjects and attempting to match treatment to the subgroup has the potential to enhance treatment effects [48,18,49]. The findings of **Browder *et al.*[50]** support the hypothesis of improved outcomes when interventions are matched to more specific subgroups of patients, hence this program focused on subgroup of adults complaining of chronic low back pain associated with increased lumbar curve.

Conclusion

The current study introduced newly developed exercise program succeed to decrease pelvic tilt and consequently accentuated lumbar lordosis and support the relation between low back pain and accentuated lumbar lordosis.

The design as well as effect of the designed stretch tool on the hip rang of motion will be discussed in a separate article.

Key points

- The study introduced newly developed exercise program to decrease pain associated with the accentuated lumbar curve.
- Find a correlation between the change of pelvic tilt and lumbar lordosis.
- Studies comparing X ray measurements pre and post treatment to detect the role of accentuated lumbar curve in LBP should be done, rather than studies comparing patients with low back pain with normal subjects. There is wide a rang of normal lordosis which mask any difference between both group studies.
- The study only limited to those patients who had Cobb angle measurements more than 50,therefore all patients had lumbar lordosis below this angle were excluded from the study.

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