Effect of Gastrocnemius Muscles in Management of Spondylolisthesis

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ABSTRACT

Background and purpose: *Degenerative spondylolisthesis is a common problem and cause, of Low back pain that cause restriction of daily activities. This study was conducted to show the effect of gastrocnemius muscles in management of spondylolisthetic patients and its relation to lumbosacral angle.* ***Subjects and methods:*** *The study included fourty patients, age ranged from 40 to 50 year, divided into two groups. The first group with mean age 48.2±6.59 years followed a physical therapy program of exercises in the form of isolated stretching of back, hamstrings, gastrocnemius, and iliopsoas muscles; and strengthening exercises for the abdominal muscles, three sessions per week for three months. The second group with mean age 47.95±5.12 years, is submitted to a physical therapy program of exercises in the form of isolated stretching of back muscles, hamstrings, and iliopsoas muscles; and strengthening exercises for the abdominal muscles, three sessions per week for three months. Outcome measures were lateral view of loading x-ray, to detect any change in lordotic curve by measuring lumbo-sacral (LS) angle, tape measurement to detect range of motion (ROM) of trunk flexion, and visual analogue scale to measure the pain.* ***Results:*** *There was a significant improvement in the first group (t of pain = 0.001, t of ROM = 0.005, t of L.S angle = 0.02) than in the second group (t of pain = 0,04, t of ROM = 0,03, t of L.S angle = 0.6).* ***Discussion and Conclusion:*** *This study provides that gastrocnemius stretching exercise is very important to be included in the program of management of spondylolisthetic patients and its effect on the correction of lumbosacral (LS) angle.*
Key words: *Low back pain, Posture, Pathomechanics, Lumbar stability, Lumbar mobility, Lumbosacral angle, Spondylolisthesis, Conservative management.*

INTRODUCTION

One of the prevalent causes of low back pain is spondylolisthesis; which is a bilateral separation in the pars iterarticularis, results in forward displacement of a lumbar vertebral body upon the segment next below. The most common site of this injury is the lumbosacral joint[6,10]. Normal laminae and facets constitute a locking mechanism which prevents each vertebra from moving forwards on the one below. Forward slipping occurs only when this mechanism has failed[1,5,15].

Degenerative spondylolisthesis is a common condition of aging, but the pathomechanisms remain controversial. Most previous studies focused on the role of facet-joint alignment and reported a pronounced sagittal orientation[3,10,11]. In degenerative spondylolisthesis, the displacement is relatively slight. Osteophyte formation in relation to the subluxated and degenerated posterior facet joints may produce compression of the related nerve roots. The predominant symptoms is chronic low back pain due to instability of the abnormal

segment[18]. Leg pain and numbness, and intermittent claudication[21].

Degenerative spondylolisthesis is characterized by degenerative arthritis of the facet joints in association with disc degeneration. Erosion and remodeling of the facet joint complex allow anterolisthesis of the vertebra above on the vertebra below[6,19]. Horizontalization of the lamina and the facets is a pathoanatomic risk factor that can predispose for the development of degenerative spondylolisthesis. If dysfunction of the disc occurs in addition to these conditions, spondylolisthesis may develop[25].

Patients aged over 50 years are usually women with degenerative spondylolisthesis. They always have back ache; some have sciatica and an increased lumbar lordosis with tight hamstrings and gastrocnemius muscles. There is also muscle imbalance in which the lumbar erector spinae and hip flexor musculature are tight; and the abdominal musculature are weak. A 'step' can often be felt at the level of the spondylolisthesis[4,7,15,20]. The degree and progression of slippage are not necessarily associated with the clinical symptoms. Accordingly the degree of slippage is not related to the severity of symptoms and also the decision making for surgery is difficult[20,23].

Patient with spondylolisthesis responds to conservative treatment, using flexion routine (strengthening of the abdominal muscles). Treatment of spondylolisthesis is directed toward controlling and minimizing anterior shear stress in the lower spine by using the following techniques: stretching and strengthening of muscles[4].

There was no correlation between the clinical symptoms and progression of slippage. These findings suggest that, the mechanism of the appearance of the symptoms is also complicated, and the degree and progression of slippage are not necessarily associated with clinical symptoms. This makes the choice of treatment and the evaluation of indications of surgery difficult[16].

The goals of exercise are to improve abdominal strength and increase flexibility. Since tight hamstrings and gastrocnemius are almost always part of the clinical picture, appropriate hamstrings and gastrocnemius stretching is important.

Instruction in pelvic tilt exercises may help reduce any postural component causing increased lumbar lordosis[14].

The clinical outcome of lumbar stabilization for degenerative spondylolisthesis remains uncertain. There is no prospective study of differences in clinical outcome between patients who undergo decompression alone and those who undergo decompression and stabilization using the Graf system. Although lumbar Graf stabilization had no effect in preventing the recurrence of leg symptoms, there was a significant effect on reduction of low back pain at the 1- and 3-year follow ups[22,24].

Surgical treatment is indicated when spondylolisthesis is accompanied by a neurologic deficit. Persistent disabling back pain after conservative management may be considered an indication. High-grade slips (greater than 50%) more commonly require surgical intervention. Traumatic spondylolisthesis is rare but almost always requires surgical stabilization[8,9,17].

The aim of the current study is to show the effect of gastrocnemius muscles in management of spondylolisthesis.

MATERIALS AND METHODS

Subjects

All subjects were L4-5, L5-S1 spondylolisthetic volunteer patients. The study included 40 (4 males and 36 females), age ranged from 40 to 50 year, divided into 2 groups. The first group (20 females with mean age 48.2±6.59 years) followed a physical therapy program of exercises in the form of isolated stretching of back muscles, hamstrings, gastrocnemius, and iliopsoas muscles; and strengthening exercises for the abdominal muscles, three sessions per week for three months. The second group (20 patients with mean age 47.95±5.12 years) was submitted to a physical therapy program of exercises in the form of isolated stretching of back muscles, hamstrings, and iliopsoas muscles; and strengthening exercises for the abdominal muscles, three sessions per week for three months. All the patients were listed at out clinic and internal orthopaedic departments at Cairo University hospitals. All of them were suffering from severe or moderate pain, limitation of flexion trunk due to shortening of back muscles, hamstrings, gastrocnemius, and iliopsoas muscles with hyperlordosis of lumbosacral region.

Instrumentations

1. Loading x-ray (siemens Poly phase 50 appartus, siemens).
2. Tape measurement is to detect range of motion (ROM) of trunk flexion by fingertip to floor test.
3. Visual analogue scale (VAS) is to measure the pain severity.

Procedures

The patients signed an informed consent form, and were informed about the whole procedures before testing and training:

Treatment procedures:

The first group was submitted to physical therapy program in the form of strengthening abdominal exercises (from crock lying position and ask the patient try to touch the knees by his hands, 10 repetitions with 3 sets, 6 seconds rest between each repetition, and 1 minute rest between the sets, the resistance is progressed according to repetitions). Isolated stretching was done (5 repetitions,30 seconds in position of stretching, 30 seconds in position of relaxation)for back muscles (from crock lying position and the therapist taking both lower limbs toward the chest), hamstrings (from crock lying position with one limb extended and press on the knee), gastrocnemius (from crock lying position with one limb extended and support the knee with dorsiflexion of the ankle joint), and psoas muscles (from crock lying position at the edge of the table and extend one limb and press on front of the extend limb out side the bed). And postural instructions was discussed for active daily living. The program continued for 3 months, 3 sessions per week performed and supervised by the same physical therapist.

The second group was submitted to physical therapy program in the form of strengthening abdominal exercises (from crock lying position and ask the patient try to touch the knees by his hands, 10 repetitions with 3 sets, 6 seconds rest between each repetition, and 1 minute rest between the sets, the resistance is progressed according to repetitions). Isolated stretching was done (5 repetitions, 30 seconds in position of stretching, 30 seconds in position of

relaxation) for back muscles (from crock lying position and the therapist taking both lower limbs toward the chest), hamstrings (from crock lying position with one limb extended and press on the knee), and psoas muscles (from crock lying position at the edge of the table and extend one limb and press on front of the extend limb out side the bed). And postural instructions was discussed for active daily living. The program continued for 3 months, 3 sessions per week performed and supervised by the same physical therapist.

Assessment procedures:

All the patients were assessed before treatment and reassessed after 3 months and followed up after 6 months by:

1. Lateral loading x-ray view is to detect any change in lordotic curve by measuring lumbo-sacral angle (by meeting of two lines, a horizontal line from the superior surface of the first sacral bone and a horizontal line from the superior surface of first lumbar bone).
2. Tape measurement is to detect range of motion (ROM) of trunk flexion (fingertip-floor test) for both groups as following: The patient was instructed to bend his or her trunk as far forward as he could with his knees straight, and to try to touch his or her toes, then the distance from his or her fingertips to the floor was measured, pre and post the program of exercises and surgical approach, to detect if there is a change or not.
3. Visual analogue scale is to measure the pain which is represented from (0) grade to (10) grade. Zero grade means no pain, (10) grade means unbearable pain, from 1 to 10 means graduation intensities of pain. The subjects were asked to indicate the level of pain by placing a dash at the appropriate level on the 10 cm horizontal line.

Data Analysis

The collected data were statistically treated and the following values were found minimum, maximum, mean, S.D., one sample paired t-test to compare between pre and post in the group and two sample unpaired t-test to compare between 2 groups, at a confidence level of (P = 0.05).

RESULTS

The results of the first group:

There was a significant improvement of pain after physical therapy treatment from (7.55±0.51) to (2.05±02.82), ROM of trunk flexion increased from (29.1±6.50) to (6.3±3.059), and lumbo-sacral angle decreased from (45.4±7.05) to (37.5±5.67), tab. (1) fig. (1).

Table (1): Pre and post values of pain, ROM of trunk flexion, and lumbo-sacral angle, in first group.

	Pain		ROM		L/S angle	
	Pre	Post	Pre	Post	Pre	Post
Min	7	1	23	5	30	28
Max	8	6	50	25	55	51
Mean	7.55	2.05	29.1	6.3	45.4	37.5
S.D	0.51	2.82	6.50	3.059	7.05	5.67
t-test	0.001*		0.005*		0.02*	

(*) significant, P ≤ 0.05 (**) no significant, P ≥ 0.05

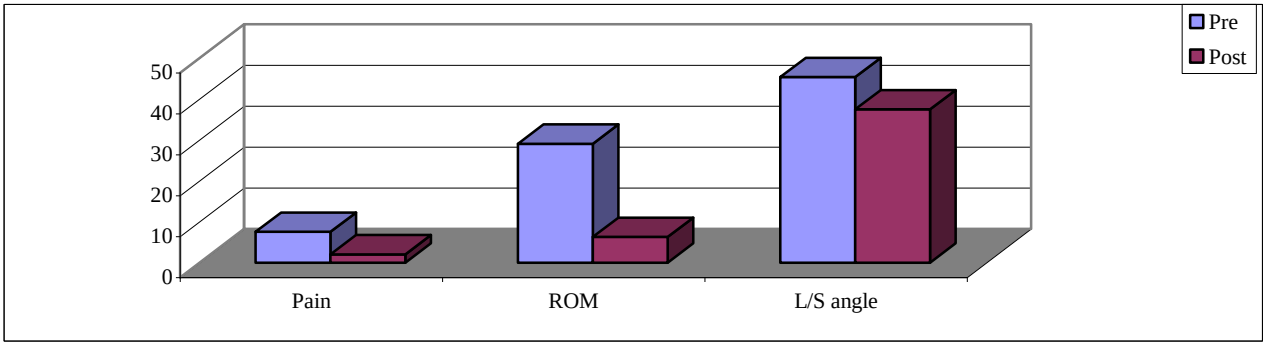

Fig. (1): The mean values of pain, ROM of trunk flexion, and lumbo-sacral angle in first group.

The results of the second group:

There was a significant improvement of pain after physical therapy treatment from (7.65±0.48) to (4.35±1.64), ROM of trunk flexion increased from (29.8±7.43) to (25.6±5.85), but no significant improvement in lumbosacral angle where changed from (44.9±8.06) to (44.6±7.78), tab. (2) fig. (2).

Table (2): Pre and post values of pain, ROM of trunk flexion, and lumbo-sacral angle, in second group.

	Pain		ROM		L/S angle	
	Pre	Post	Pre	Post	Pre	Post
Min	7	1	25	15	28	27.5
Max	8	8	51	35	55	54
Mean	7.65	4.35	29.8	25.6	44.9	44.6
S.D	0.48	1.64	7.43	5.85	8.06	7.78
t-test	0.04*		0.03*		0.6**	

(*) significant, $P \leq 0.05$ (**) no significant, $P \geq 0.05$

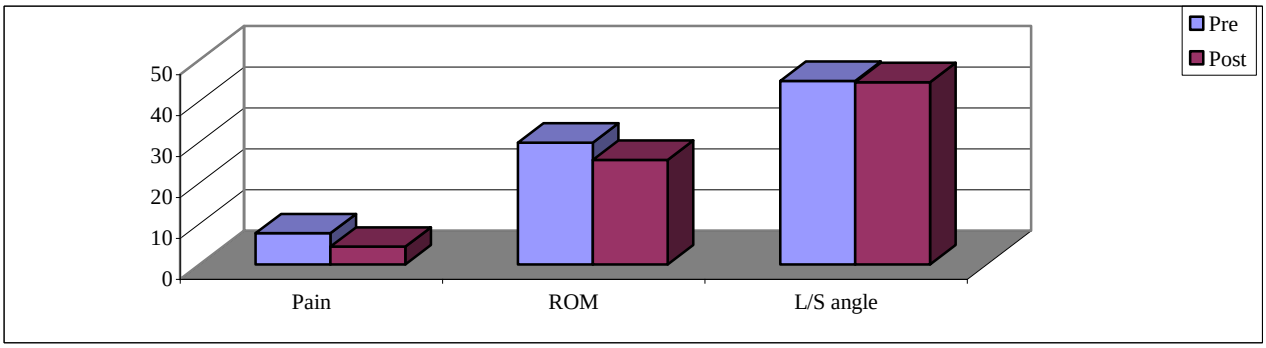

Fig. (2): The mean values of pain, ROM of trunk flexion, and lumbo-sacral angle in second group.

Comparison between both group:

1. There is no significant difference between pre measures of the first group and pre measures of the second group of pain, ROM of trunk flexion, and lumbosacral angle, where t-value of pain 0.8, t-value of ROM of trunk flexion 0.7, and t-value of lumbosacral angle 0.9 tab.(3) fig.(3).

Table (3): The mean values of pre test of pain, ROM of trunk flexion, and lumbosacral angle, in both groups.

	Pain		ROM		L/S angle	
	1st gr.	2nd gr.	1st gr.	2nd gr.	1st gr.	2nd gr.
Min	7	7	23	25	30	28
Max	8	8	50	51	55	55
Mean	7.55	7.65	29.1	29.8	45.4	44.9
S.D	0.51	0.48	6.50	7.43	7.05	8.06
t-test	0.8**		0.7**		0.9**	

(*) significant, P ≤ 0.05 (**) no significant, P ≥ 0.05

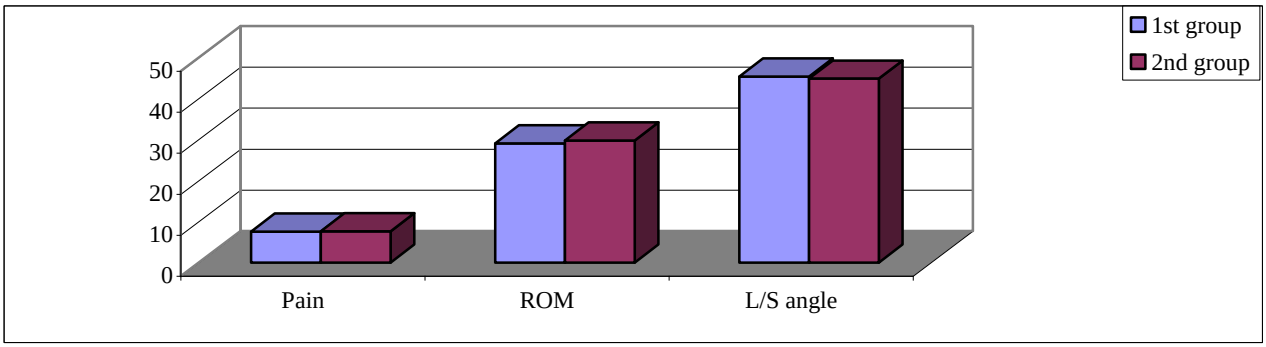

Fig. (3): The mean values of pre test of pain, ROM of trunk flexion, and lumbo-sacral angle , in both groups.

2. There is a significant difference between post measures of the first group and post measures of the second group of pain, ROM of trunk flexion, and lumbosacral angle, where t-value of pain 0.04, t-value of ROM of trunk flexion 0.028, and t-value of lumbosacral angle 0.045 tab. (4) fig. (4).

Table (4): The mean values of post test of pain, ROM of trunk flexion, and lumbosacral angle, in both groups.

	Pain		ROM		L/S angle	
	1st gr.	2nd gr.	1st gr.	2nd gr.	1st gr.	2nd gr.
Min	1	1	5	15	28	28
Max	6	8	25	35	51	55
Mean	2.05	4.35	6.3	25.6	37.5	44.6
S.D	2.82	1.64	3.05	5.85	5.67	7.78
t-test	0.04*		0.028*		0.045*	

(*) significant, P ≤ 0.05 (**) no significant, P ≥ 0.05

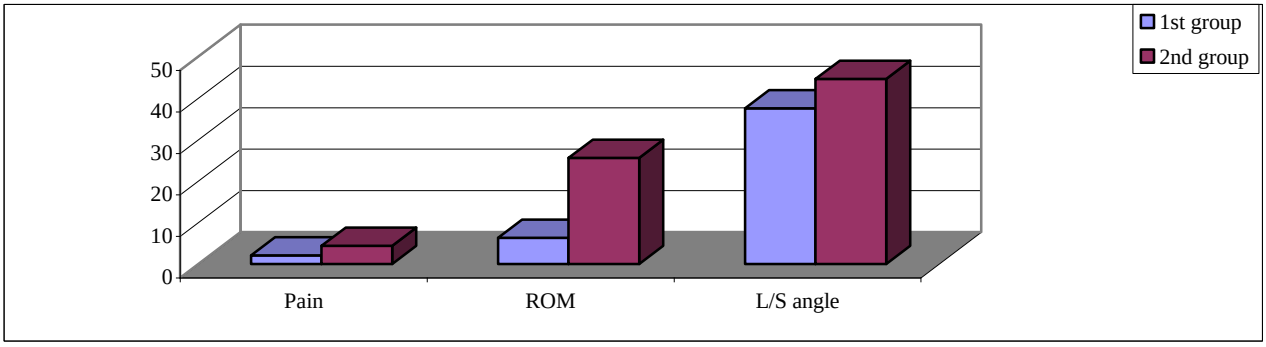

Fig. (4): The mean values of post test of pain, ROM of trunk flexion, and lumbo-sacral angle, in both group.

DISCUSSION

The results of this study showed that, there was a significant results of the first group for pain, ROM of trunk flexion, and lumbo-sacral angle due to using of exercises program which include:

Stretching exercise of back muscles which is decreasing spasm of the muscles and improving the circulation which is decreasing the concentration of metabolites, decreasing the hypertonicity and hyperactivity of the lumbar erector spinae, and also increasing ROM due to increasing elasticity of the back muscles[13,14].

Stretching exercise of hamstrings muscles was decreasing spasm and tightness of the muscles, where forward bending is a complex movement of combined lumbar and hip motion and is considered an important activity and can be restricted due to Shortening of back and hamstring muscles with low back pain. Short hamstring muscles, because of their attachments to the posterior leg and to the ischial tuberosity, may limit forward bending and cause back pain due to their influence on lumbar pelvic rhythm. So, stretching of hamstring must be carried out at the same exercise of stretching back muscles, to guaranty stretching of all the muscle attachments[13,14].

Stretching exercise of gastrocnemius muscles was decreasing spasm and tightness of the muscles, where there is a direct relationship between lumbar erector spinae, hamstring, and gastrocnemius muscles. So, they must be stretched with the same time to achieve complete stretching of the whole length of the posterior muscles. The gastrocnemius shares in knee flexion and its shortening will affect indirectly the hamstring muscles and may limit forward bending and cause back pain due to their influence on lumbar pelvic rhythm. So, stretching of gastrocnemius should be included in the same exercise of stretching back and hamstrings[13,14].

Strengthening of the abdominal muscles which is considered the anterior wall of the spine and must be strong enough to protect the spine from anterior aspect. A recent focus in the physiotherapy management of patients with back pain has been the specific training of muscles surrounding the spine (deep abdominal muscles and lumbar multifidus), considered to provide dynamic stability and fine control to the lumbar spine[18].

The stretching exercises were creating a controlling and balancing between agonist and antagonist muscles of the lumbosacral region

and coordination of lumbar-pelvic rhythm i.e, decreasing of hypertonicity of the back muscles and anterior tilting of the pelvis, and the line of gravity come back approximately to the normal passway.

In the second group, there was a significant results of pain, ROM of trunk flexion, and no significant results of lumbo-sacral angle due to using of exercises program which include:

Stretching exercise of back muscles which decreasing spasm of the muscles and improve the circulation which is decreasing the concentration of metabolites, decreasing the hypertonicity and hyperactivity of the lumbar erector spinae, and increasing of ROM due to increasing elasticity of the back muscles. Stretching exercise of hamstrings muscles was decreasing spasm and tightness of the muscles where forward bending is a complex movement of combined lumbar and hip motion and is considered an important activity and can be restricted due to low back pain. Short hamstring muscles, because of their attachments to the posterior leg and to the ischial tuberosity, may limit forward bending and cause back pain due to their influence on lumbar pelvic rhythm. So, stretching of hamstring must be carried out with stretching back muscles to guaranty stretching of all the muscle attachments[13,14].

Strengthening of the abdominal muscles which is considered the anterior wall of the spine and must be strong enough to protect the spine from anterior aspect. A recent focus in the physiotherapy management of patients with back pain has been the specific training of muscles surrounding the spine (deep abdominal muscles and lumbar multifidus), considered to provide dynamic stability and fine control to the lumbar spine[18].

There is no significant results of the second group in lumbo-sacral angle due to decreasing elasticity of gastrocnemius muscles which is affecting by indirect way on hamstrings and back muscles (lumbo-pelvic rhythm).

In comparison of results of both groups, there is a significant improvement of pain, ROM, and lumbo-sacral angle in the first group more than the second group, because of there is balancing between agonist and antagonist muscles of the lumbo-sacral region and coordination of lumbar-pelvic rhythm i.e, decreasing of the hyperlordosis and anterior tilting of the pelvis, and the line of gravity come back approximately to the normal passway. This was controlling and minimizing the anterior shear stress in the lower spine.

The results of this study showed the effect of gastrocnemius muscles. This is explained by the assumption that the hyperlordotic curve was decreased and the mechanical defect problem of spondylolisthesis patients decreased. Because of there is decreasing spasm of back, hamstrings, gastrocnemius, and iliopsoas muscles and increased power of abdominal muscle with concomittant increased intra-abdominal pressure which is the anterior support for the spinal column.[2]. This lead to balance of muscles of anterior and posterior component of lumbo-sacral region and also affect on lumbo-pelvic rhythm and indirectly on lordotic curve.

From all of the above, we found that the abdominal routine program and stretching of tight muscles as back, hamstrings, gastrocnemius, and iliopsoas muscles and following instructions of correct way of ADL are the appropriate regimen for spondylolisthetic patients with moderate or even severe symptoms[4,12,24].

At the end, it was suggested that patients who have a degenerative spondylolisthesis can live without any hindering problems if they follow the abdominal routine program and stretching of tight muscles with active daily living (ADL) instructions.

Conclusion

This study showed that gastrocnemius stretching exercise is very important to be included in the program of management of spondylolisthetic patients and its sharing in the correction of lumbo-sacral angle which is the pathomechanic in the spondylolisthesis.

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الملخص العربي

تأثير العضلة الخلفية للساق في معالجة الانزلاق الفقاري الأمامي

الهدف من هذه الدراسة تقييم مدى تأثير برنامجين مختلفين للعلاج الطبيعي لمرضى الانزلاق الفقاري الأمامي الناتج عن وجود خشونة بمنطقة الانزلاق ،حيث يعتبر الانزلاق الفقاري الأمامي الناتج عن وجود خشونة بمنطقة الانزلاق من أهم أسباب آلام أسفل الظهر مما يؤدى إلى إعاقة بعض الأنشطة اليومية . تشمل الدراسة أربعون مريضا من الذكور والإناث تتراوح أعمارهم من أربعين إلى خمسين عاما . بعد أن تم تشخيص المرضى اكلينيكيا ، تم تقسيم المرضى عشوائيا إلى مجموعتين متساويتين في العدد : المجموعة الأولى عشرون مريضا خضعت لبرنامج العلاج الطبيعي المتمثل في تمرينات لتقوية عضلات البطن ، شد عضلات الظهر ، وثنى مفصل الركبة والعضلة الخلفية للساق مع شد لعضلة ثنى مفصل الفخذ لعمل توازن عضلي حول منطقة الظهر مع البطن وقد أجرى البرنامج لمجموعة واحدة ثلاث جلسات أسبوعيا لمدة ثلاثة أشهر ويتضمن البرنامج أيضا التعليمات الصحيحة للأنشطة اليومية . المجموعة الثانية عشرون مريضا ، تم استخدام تمرينات لتقوية عضلات البطن ، شد عضلات الظهر ، وثنى مفصل الركبة مع شد فردى لعضلة ثنى مفصل الفخذ لعمل توازن عضلي حول منطقة الظهر مع البطن وقد أجرى البرنامج لمجموعة واحدة ثلاث جلسات أسبوعيا لمدة ثلاثة أشهر ويتضمن البرنامج أيضا التعليمات الصحيحة للأنشطة اليومية . تم تقييم الألم بالمدرج البصري للألم والمدى الحركي لثنى الجزء العلوي من الجسم بمقياس المدى الحركي للمفصل وانحناء الفقرات القطنية بأشعة اكس . وقد بينت النتائج الاحصائية وجود تحسن ملحوظ في الألم والمدى الحركي وفى انحناء الفقرات القطنية في المجموعة الأولى وفى المجموعة الثانية وجود تحسن ملحوظ في الألم و المدى الحركي ولا يوجد تحسن في انحناء الفقرات القطنية ، ووجود فوارق ذات دلالة إحصائية عند المقارنة بينهما . وقد ظهر من الدراسة أن برنامج العلاج الطبيعي الأول أكثر تأثيرا لعلاج مرضى الانزلاق الفقاري الأمامي مع شد العضلة الخلفية للساق ويمكن استخدامه كعلاج وقائي لمرضى الانزلاق الفقاري الأمامي. وفى هذه الدراسة أثبتت النتائج أهمية شد العضلة الخلفية للساق ومدى تأثير ذلك على النتائج .