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Effect of Plantar Flexor Stretching Exercises in Low Back Pain Management

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Abstract:
Objective*: Effect Of Plantar Flexor Stretching Exercises In Low Back Pain Management*
Design: *Randomized clinical trial*
Method and Measurements*: 40 patients (M=20, F=20) from spinal clinic at Riyadh military hospital and king Saud medical city (Age 25-40 yrs) with Low back pain, onset >1-3 months (chronic) were randomly assigned to either group A (control group) receiving, stretching exercises (hamstring, back, and iliopsoas muscles),strengthening exercises (hamstring, iliopsoas, and abdominal muscles) or group B (experimental group) receiving, stretching exercises (hamstring, gastrocnemius, back, and iliopsoas muscles), Strengthening exercises (hamstring, gastrocnemius, iliopsoas, and abdominal muscles). Treatment was given 3 times per week for 6 weeks. Before treatment and after 6 weeks of treatment pain was assessed on VAS, fingertip-to-floor (FTF), test for the spine movement, and Low back pain disability questionnaire (OSWESTRY Questionnaire).*
Results: *There was a significant difference between post results of the first group and the second group in ROM of trunk flexion and disability Questionnaire (OSWESTRY Questionnaire) where: p value of ROM of trunk flexion in the first group 0.012, and p value in the second group 0.0001, p value of disability questionnaire in the first group 0.001, and p value in the second group 0.0001. But, there is a significant difference in pain in the second group only where ; p value of pain in the first group 0.415, and p value in the second group 0.0001.*
Conclusion: *In this study, the results indicate that the program is a safe, reliable and effective method that produces satisfactory results if it is carried out day by day with following the instructions concerning correct ADL.*
Keywords: *Starching Exercise, low back pain, Strengthening Exercises, tightened muscles.*

I. Introduction

Low back pain (LBP) is the most frequent self-reported type of musculoskeletal pain, is often recurrent, and has important socio-economic consequences[1]. 80% of population suffers from LBP at some time in their lives, and chronic LBP is the biggest factor limiting activity in young adults under the age of 45.[2]

LBP is defined as pain and discomfort in the lumbosacral region, below the twelfth rib and above the gluteal crease. There are three types of LBP 1) non-specific 2) pain with nerve root symptoms 3) pain resulting from serious pathology. In non-specific LBP there is no recognized pathoanatomic cause, is usually a benign condition but without appropriate management can develop into chronic LBP. LBP is also categorized according to its duration from onset, as acute (<6 weeks), sub-acute (6 weeks - 12 weeks), and chronic (>12 weeks)[3-4] .The main objective of treatment for chronic LBP is for the patient to return to their desired level of activities and participation, as well as the prevention of chronic complaints and recurrences[5].

Many treatments are used for LBP such as medication, physiotherapy, and surgery. Many of these interventions have been evaluated in randomized controlled trials and systematic reviews. Evidence shows that the effectiveness of some of the interventions is supported (e.g. exercise), while other interventions are not effective for LBP (e.g. laser therapy and traction)[6-8].

There is no evidence regarding the benefit of using electrotherapy modalities such as interferential, laser, TENS, even though these modalities are commonly used in physiotherapy practice.

Several studies have shown a relation between muscle tightness and injury. Krivikas and Feinberg reported a significant relation between increased muscle tightness and incidence of lower extremity injury. Knapik et al found low levels of hamstring flexibility, to be twice as likely to incur injury as those with average flexibility. Increased tightness of gastrocnemius was found to be a risk factor for Achilles tendinitis (RR = 3.57, 95% CI = 1.01 to 12.68)[9].No significant difference in abdominal muscle strength between asymptomatic individuals and those LBP and no association exists between the length of the abdominal muscles and the extent of lumbar lordosis. Another studies conducted in athletic population concluded that there is no difference in the back extensors flexibility in athletes with and without LBP. Recent studies have found no association between the length or flexibility of the iliopsoas and the extent of lumbar lordosis or LBP symptoms.[10]

Exercise may not only help decrease low back pain, but it may also help you recover faster, prevent reinjury to your back, and reduce the risk of disability from back pain. Strengthening exercises, focusing on your abdomen, back and legs muscles, it's to keep your muscles and other supporting tissues flexible and less prone to injury. Exercise and staying active may relieve low back pain and can help speed your recovery. Stretching and strengthening your abdomen, back, and leg muscles helps make them less susceptible to injury that can cause back pain. Strong abdomen, back, and leg muscles also better support your spine, reducing pressure on your spinal discs. This may help prevent disc injury. Choose a couple of stretching and strengthening exercises that you enjoy doing, or vary them from day to day.[11,12,]

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].
The aim of study to examine the effect of gastrocnemius stretching in treatment of LBP.

II. Material And Method

Subjects: 40 patients from spinal clinic at Riyadh military hospital and king Saud medical city (Age25-40 yrs) diagnosed with Low back pain, onset >1-3 months (chronic) were randomly assigned to either group A (control group) receiving stretching exercises (hamstring, back, and iliopsoas muscles), strengthening exercises (hamstring, iliopsoas, and abdominal muscles) or group B(experimental group) receiving stretching exercises (hamstring, gastrocnemius, back, and iliopsoas muscles).Strengthening exercises (hamstring, gastrocnemius, iliopsoas, and abdominal muscles). Treatment was given 3 times per week for the period of 6 weeks. Before treatment and after 6 weeks of treatment pain was assessed on VAS, fingertip-to-floor (FTF) Test for the spine movement, and Low back pain disability questionnaire (OSWESTRY Questionnaire).

Design: This study is randomized clinical trial

Equipments & Measuring Tools:
Examination table, Towel, VAS, fingertip-to-floor (FTF), Low back pain disability questionnaire (OSWESTRY Questionnaire).

Procedure:
- Stretching exercises program for hamstring, gastrocnemius, iliopsoas, and back muscles through manual passive stretching movement. (30 sec) stretching, (30 sec) release, (3 repetitions), (3 sets), (3 sets / week for 6 weeks).
- Strengthening exercises program for hamstring, gastrocnemius, iliopsoas, and abdominal muscles (10 repetitions), (5 sec holed), (3 sets / week for 6 weeks).
- ADL instruction.

The patients were referred from spine clinic with diagnosis of low back pain

- All participants were informed about the study "purpose, groups, treatment intervention and benefits". Upon patient acceptance, the patient must sign up the consent form.
- Participants in both groups, were received health education on low back pain by researcher, including correct posture, appropriate behavior changes to enhance functional outcomes, adjust to the environment to accommodate functional deficit and manage their status at home.
- All participants had baseline assessment.
- The participants were divided into two groups randomly and neither group was aware of the treatment that the other group was receiving:

Exercises Program:

1. Stretching **hamstring and back muscles** for group (A): The patient on long sitting sit, with the knee fully extended, the feet free or on planter flexion. Asked the patient to bended forwards from the hips to reach towards your feet with the head flexion. The therapist comes behind of the patient, pushes him forward, fixed the patient knee by the therapist.

2. **Stretching hamstring, gastrocnemius, and back muscles** for group (B): The patient on long sitting sit, with the knee fully extended and the ankle dorsiflexed, the feet flat against the wall. Asked the patient to bended forwards from the hips to reach towards your feet with the head flexion. The therapist comes behind of the patient, pushes him forward, fixed the patient knee by the therapist.

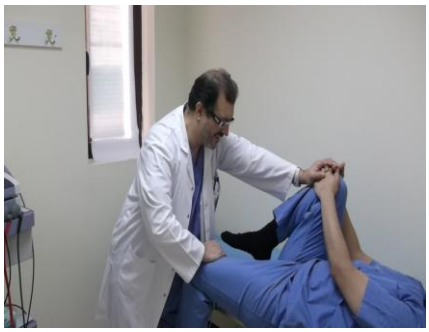
3. Stretching **iliopsoas (Kneeling Hip Flexor Stretch):** Back lying with the right hip off of the edge of the bed, and the left knee held to the chest. The therapists do over stretch on the right leg.

Strengthening exercises programs consist of:

1. **Strengthening hamstring muscles:**

Lie face down on the weight bench. Position the pad just above your ankles. Slowly bend your knees, pulling your feet toward your buttocks 90^0. Only go as far as you can without feeling your pelvis or spine move. You'll feel tension in the back of your thighs. Then slowly return to the starting position. Repeat. When you're doing lying hamstring curls, use the handgrip for support only. Let your leg muscles do most of the work. Don't pull with your arms or arch your neck or lower back.

1. **Strengthening iliopsoas muscles:** Back lying with the right hip off of the edge of the bed, and the left knee held to the chest. The patient do hip flexion on the right leg, and the therapist give the resistance on the right leg as tolerate the patient.



2. Strengthening **gastrocnemius muscles: Heel rises from standing, facing a wall, place** both hands against the wall, rise up on his toes, **then** lower and repeat.

3. Strengthening **abdominal muscles**: "Sit Up" From Supine Position with Hips and Knees Flexed, Exercise: Head and shoulder are lifted with a gradual curl to touch the knees with the hands. The abdominal muscle becomes more efficient. Thus isotonic Abdominal exercise should begin with the hips and knees flexed.

Data Analysis: After collecting the data was treated statistically and the following values was found mean, S.D., T value and P value One sample paired T-test used to compare between pre and post values in the same group, at a confidence level of (P = 0.05).

III. Findings:

In this study, 40 patients divided into two groups aiming to show the effect of gastrocnemius stretching exercises in treatment of low back pain. The first group submitted to the effect of physical therapy program in the form of abdominal strengthening exercises, stretching of tightened muscles of back, hamstrings and gastrocnemius muscles at the time in one exercise and isolated stretching of iliopsoas muscle for 20 patients with low back pain. Their age ranged between 25 and 40 (mean 32.1, SD ±6.6) years. The second group submitted to the effect of physical therapy program in the form of abdominal strengthening exercises, stretching of tightened muscles of back, hamstrings muscles at the time in one exercise and isolated stretching of iliopsoas muscle for 20 patients with low back pain. Their age ranged between 25 and 40 (mean 32.8, SD ±6.68) years with low back pain. The program of exercise mentioned above was carried out 3 sessions per week for 6 weeks. Both of groups were followed up after 6 weeks.

The Results Of The Control Group Were Summarized As The Following:

A history of each patient included age, height, weight, and BMI, pre and post measures of pain by VAS,fingertip-to-floor (FTF) Test for the spine movement, and Low back pain disability questionnaire(OSWESTRY Questionnaire). Table (1)

Table (1): age, height, weight, and BMI, pre and post measures of pain by VAS, fingertip-to-floor (FTF) Test for the spine movement, and Low back pain disability questionnaire (OSWESTRY Questionnaire).

MALE									FEMALE								
No		Age	The Length of the Patient (Cm)	The Patient's Weight (Kg)	Body mass index	Visual analogue scale (pain)	Finger to Floor Test (Cm)	Oswestry Questionnaire (%)	No		Age	The Patient's Length of (Cm)	The Patient's Weight (Kg)	Body mass index	Visual analogue scale (pain)	Finger to Floor Test (Cm)	Oswestry Questionnaire (%)
1	Pre	30	178	80	25.2	9	59	82	1	Pre	31	165	70	25.7	8	47	94
	post					3	34	50		post					3	37	56
2	Pre	23	169	72.3	25.3	6	44	72	2	Pre	32	160	65	25.4	8	39	60
	post					2	29	54		post					2	27	42
3	Pre	36	170	72	24.9	5	50	68	3	Pre	26	167	57	20.4	9	39	70
	post					1	24	32		post					3	25	36
4	Pre	40	179	80	25	7	34	72	4	Pre	40	165	67	24.6	4	46	60
	post					1	25	40		post					4	40	46
5	Pre	32	168	72	25.5	10	44	70	5	Pre	27	159	58	22.9	9	32	80
	post					3	31	36		post					2	28	60
6	Pre	20	165	70	25.7	6	39	66	6	Pre	40	177	80	25.5	9	59	80
	post					2	24	32		post					1	29	48
7	Pre	23	169	60	21	9	44	92	7	Pre	36	170	68	23.5	10	56	100
	post					2	25	52		post					3	39	70
8	Pre	40	168	72	25.5	8	39	72	8	Pre	38	156	48	19.7	9	49	82
	post					3	19	60		post					2	38	60
9	Pre	37	167	72	25.8	8	39	62	9	Pre	25	170	75	26	7	44	90
	post					2	29	44		post					2	29	56
10	Pre	40	178	81	25.6	10	44	80	10	Pre	40	165	64	23.5	8	52	84
	post					4	30	58		post					3	39	60

There was a significant difference between pre and post measures of pain of the control group where: The pre results:

Table (1)

The results of pain assessment, Mean 7.95 grades and SD ± 1.669.

The post results: The results of pain assessment, the mean 2.40 grades and SD ± 0.882 There is no significant difference between pre and post measures of pain, were where P. value of pain 0.415, tab.(2) figure (1)

Table (2): pain, pre and post in control group

	Pain VAS	
	pre	Post
Mean	7.9500	2.4000
S.D	1.66938	0.88258
T-Test	14.336	
P. value	0.415	

$P < 0.05$

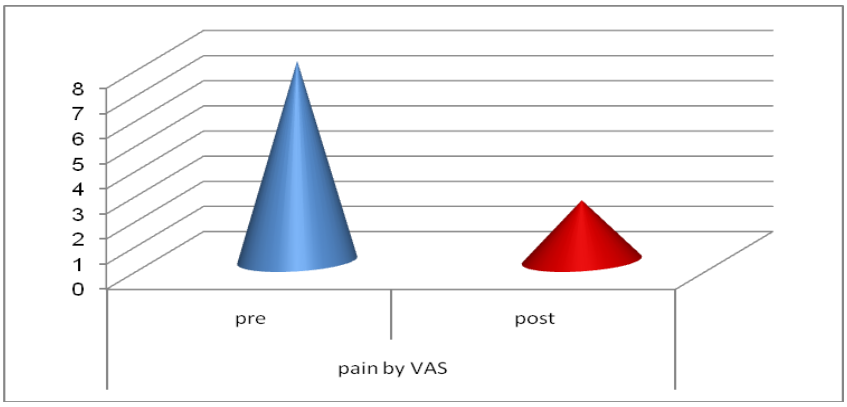


Fig (1) pain, pre and post in control group.

There was a significant difference in Finger to Floor Test for flexibility of the spine between pre and post measures where: The pre results:
The results of Finger to Floor Test was, the mean 44.95 grades, and SD ±7.549.

The post results:
The results of Finger to Floor Test was, the mean 30.05 grades, and SD ±5.969. The significant difference between pre and post measures of Finger to Floor Test where P. value 0.012. Table (3) fig.(2)

Table (3)

	Finger to Floor Test (Cm)	
	pre	Post
Mean	44.9500	30.0500
S.D	7.54966	5.96900
T-Test	10.182	
P. value	0.012	

$P < 0.05$

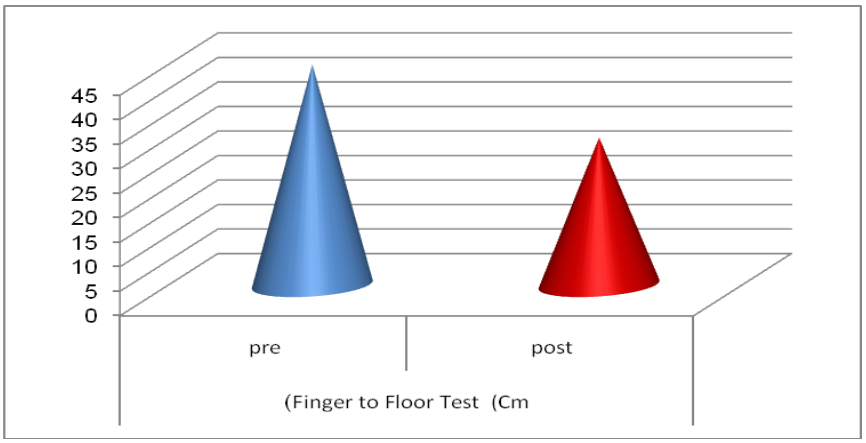


Fig. (2) Pre and Post of Finger to Floor Test in exercise group

There was a significant difference in Low back pain disability questionnaire (Oswestry Questionnaire) between pre and post measures where:The pre results:
The results of Oswestry Questionnaire was, the mean 76.8 grades, and SD ±11.505.

The post results: The results of Oswestry questionnaire was, the mean 50.6 grades, and SD ±9.97.
The significant difference between pre and post measures of Oswestry Questionnaire where P. value 0.001. Table (4) fig. (3).

	Oswestry Questionnaire	
	pre	Post
Mean	76.8000	50.6000
S.D	11.50561	9.97048
T-Test	13.173	
P. value	0.001	

$P < 0.05$ **Table (4)**

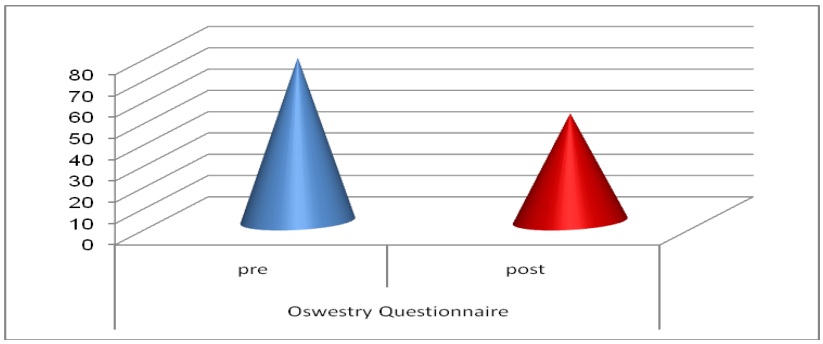


Fig. (3)

The Results Of The Experimental Group Summarized As Following:
A history of each patient included age, height, weight, and BMI, pre and post measures of pain by VAS, fingertip-to-floor (FTF) Test for the spine movement, and Low back pain disability questionnaire(OSWESTRY Questionnaire). Table (5)
Table (5): age, height, weight, and BMI, pre and post measures of pain by Visual Analog Scale (VAS), Fingertip-To-Floor (FTF) Test for the spine movement, and Low Back Pain disability questionnaire (OSWESTRY Questionnaire).

MALE									FEMALE								
No		Age	The Length of the Patient (Cm)	The Patient's Weight (Kg)	Body mass index	Visual analogue scale (pain)	Finger to Floor Test (Cm)	Oswestry Questionnaire (%)	No		Age	The Patient's Length of (Cm)	The Patient's Weight (Kg)	Body mass index	Visual analogue scale (pain)	Finger to Floor Test (Cm)	Oswestry Questionnaire (%)
1	Pre	30	176	75	24.2	7	39	80	1	Pre	37	158	53	21.1	9	56	92
	post					1	19	6		post					1	19	4
2	Pre	30	173	70	23.4	7	29	70	2	Pre	22	137	47	25	10	49	100
	post					0	14	0		post					1	26	8
3	Pre	32	177	80	25.5	8	34	72	3	Pre	25	159	60	21	7	56	82
	post					0	19	8		post					0	21	26
4	Pre	40	174	75	24.8	7	49	16	4	Pre	25	152	57	24.7	8	42	78
	post					1	19	2		post					0	19	8
5	Pre	30	165	70	25.7	7	39	78	5	Pre	25	168	70	24.8	8	42	88
	post					1	19	8		post					0	22	6
6	Pre	40	175	70	22.9	8	54	88	6	Pre	40	165	68	25	9	44	94
	post					0	20	6		post					0	19	4
7	Pre	20	168	65	23	5	44	74	7	Pre	40	166	60	21.8	9	49	90
	post					0	19	2		post					0	19	6
8	Pre	39	169	65	22.2	9	49	86	8	Pre	30	168	70	24.8	8	39	72
	post					1	19	4		post					0	19	18
9	Pre	34	170	70	24.2	5	34	72	9	Pre	35	165	66	24.2	7	34	60
	post					0	19	6		post					0	19	4
10	Pre	40	175	70	22.9	9	41	80	10	Pre	28	162	63	24	7	47	98
	post					0	19	8		post					0	19	4

Table 5

There was a significant difference between pre and post measures of pain of the second group where:
The pre results: The results of pain assessment, Mean 7.70 grades and SD ± 0.30.

The post results: The results of pain assessment, the mean 1.30 grades and SD ± 0.470.
There is highly significant difference between pre and post measures of pain, were where P. value of pain 0.0001, tab. (6) fig.(4).

Table (6): pain, pre and post in second group

	Pain VAS	
	pre	post
Mean	7.7000	0.3000
S.D	1.30182	0.47016
T-Test	25.993	
P. value	0.0001	

$P < 0.05$ **Table (6)**

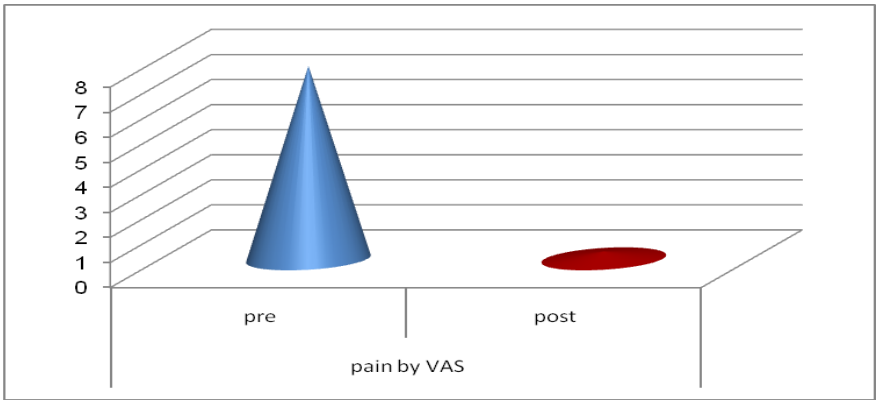


Fig. (4)

There was highly significant difference in Finger to Floor Test for flexibility of the spine between pre and post measures where:
The pre results: The results of Finger to Floor Test was, the mean 43.5 grades, and SD ±19.40.

The post results:

The results of Finger to Floor Test was, the mean 7.639 grades, and SD ±2.112.

The highly significant difference between pre and post measures of Finger to Floor Test where P. value 0.0001, Tab.(7) fig.(5).

	Finger to Floor Test (Cm)	
	Pre	Post
Mean	43.5000	19.4000
S.D	7.63992	2.11262
T-Test	15.575	
P. value	0.0001	

P < 0.05 **Table (7)**

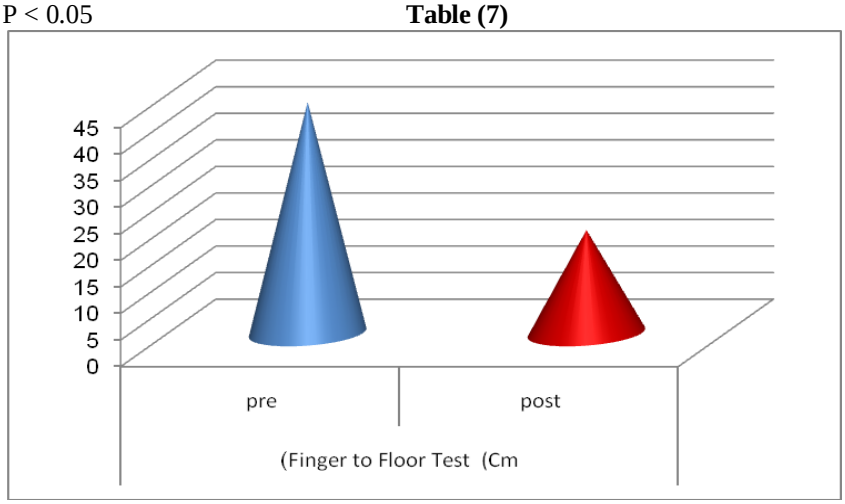


Fig. (5) Pre and Post of Finger to Floor Test in exercise group.

There was highly significant difference in Low back pain disability questionnaire (Oswestry questionnaire) between pre and post measures where:

The pre results:

The results of Oswestry questionnaire was, the mean 78.5 grades, and SD ±17.945.

The post results:

The results of Oswestry questionnaire was, the mean 6.9 grades, and SD ±5.784.

The significant difference between pre and post measures of Oswestry questionnaire where P. value 0.0001, Table (8) fig.(6).

	Oswestry Questionnaire	
	pre	Post
Mean	78.5000	6.9000
S.D	17.94582	5.78473
T-Test	17.696	
P. value	0.0001	

$P < 0.05$ **Table (8)**

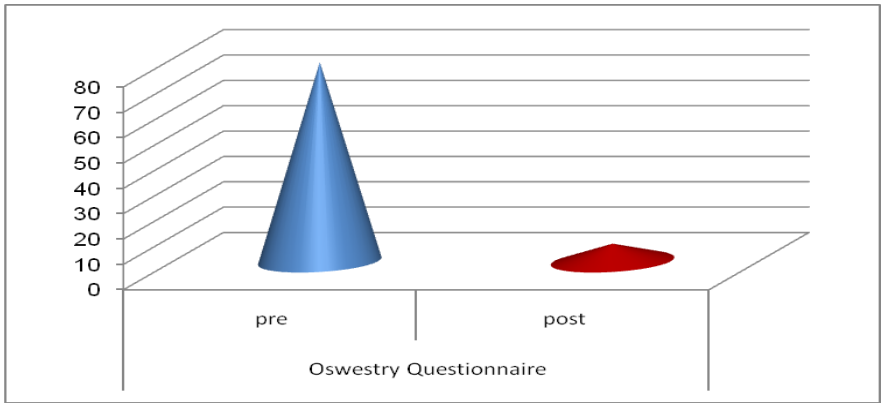


Fig. (6)

There was a significant difference between post results of the first group and the second group in ROM of trunk flexion and disability Questionnaire (OSWESTRY Questionnaire) where: p value of ROM of trunk flexion in the first group 0.012, and p value in the second group 0.0001, p value of disability questionnaire in the first group 0.001, and p value in the second group 0.0001. But, there is a significant difference in pain in the second group only where ; p value of pain in the first group 0.415, and p value in the second group 0.0001,

IV. Discussion

Low back pain (LBP) is a common condition. On any given day 12–33% of the people report some back pain.[15] It was suggested that LBP is a benign self-limiting disease with a recovery rate of 80–90% within 6 weeks irrespective of the management or type of treatment[16], but a recent systematic review did not find any evidence for this.[17] In view of the characteristics of the natural course, LBP should be viewed as a persistent condition in many patients.[18]

Many studies was concluded that imbalance of muscles causing biomechanical defect which is hyperlordotic posture on the lumbosacral region,[19] kyphotic deformity in the sagittal plane of the sacrum,[20] and incoordination of the lumbar-pelvic rhythm.[21] All of these problems lead to primarily low back pain with restriction of ADL as restriction of forward bending which is a combined lumbar and hip motion and considered one of most important activity due to limitation of lumbar-pelvic movement and shortening of hamstring muscles, because of their attachments to the posterior leg and to the ischial tuberosity[22].

Forward bending is a coupled movement combining lumbar flexion and pelvic rotation, the so-called lumbar–pelvic rhythm.[23] It results from coordinated activity between the back extensor muscles (erector spinae) and the hip extensor muscles (gluteals and hamstrings). Hamstring tightness is a common finding in the LBP patient,[24] and it has been argued that lengthening the hamstrings may allow greater motion to occur at the hips and therefore reduce stress on the lumbar spine[25].

Hamstrings tightness is one of the most common findings in patients with LBP.[207] It is thought that, due to the attachments of hamstrings to the ischial tuberosity, hamstrings tightness generates posterior pelvic tilt and decreases lumbar lordosis, which can result in LBP[26,27].

The Gastrocnemius is a two-joint muscle that spans the knee and the ankle joints. In spite of the fact that the gastrocnemius has no relationship with the hip, this muscle can alter the SRT result because it

crosses the knee. Thus, when the subject performs a trunk forward flexion in a sitting position, with the knee fully extended and the ankle dorsiflexed, all posterior muscles (hamstrings and gastrocnemius) will be in tension.[28,29] During the standard SRT the subjects put the ankle in dorsiflexion position (DF) with the knee fully extended. When the subject performs trunk forward flexion with the knee extended and ankle in dorsiflexion, an uncomfortable tension can be felt in the gastrocnemius if this muscle is shortened and this is the limiting factor to continue the test. Thus, the subject will be unable to stretch the hamstring maximally because of the previous gastrocnemius tension (discomfort). We believe that the standard SRT with ankle DF is not the best form of measuring hamstring flexibility. It is supposed that performing the SRT with the ankle plantar flexed (PF) is the best way to evaluate only hamstring muscle flexibility, because the gastrocnemius muscles will be in a relief position and the discomfort in the calf will not occur.

From all of the above, we found that the stretching of gastrocnemius muscles in treatment of patients with mechanical low back is important to correct the mechanical defect.

At the end, it was suggested that patients who have a mechanical low back can live without pain and any hindering problems if they follow the correct physical therapy and the correct ADL instructions.

V. Conclusion

Mechanical low back is considered a common problem and one of causes of pain and restriction of daily activities. So the physical therapy program in the form of flexion program with stretching of back, and hamstrings and gastrocnemius at the same exercise and isolated stretching of iliopsoas muscles was beneficial in treatment, and stretching of gastrocnemius is important.

In this study, the results indicate that the program is a safe, reliable and effective method that produces satisfactory results if it is carried out day by day with following the instructions concerning correct ADL.

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