Dynamic Back Extension Exercises Versus Endurance Exercises on Non Specific Low Back Pain

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ABSTRACT

Purpose: *The purpose of this study was to compare dynamic back extension exercises with endurance exercises programs in improving back endurance, reducing pain and disability in non specific low back pain patients.* ***Subjects and Methods::*** *Seventy-three subjects (male and female) participated in this study, their age ranged from 28 to 45 years old. They were divided into three groups.* ***Group A****: included twenty-one patients with non-specific low back pain with mean age (35± 6.1) years old. Each patient practiced dynamic back extension exercises program three sessions per week for 8 weeks* ***Group B:*** *included twenty-two patients with non-specific low back pain with mean age (38± 4.3) years old. Each patient practiced endurance training program three sessions per week for 8 weeks* ***Group C:*** *included thirty healthy subjects with mean age (39± 5.2) years old as a control group. Each subject was assessed before and after the physical therapy intervention by using: Visual analog scale (for pain intensity), "Roland-Morris" disability questionnaire (for disability), "Biering-Sorensen" test (for measurement of holding time in sec.) and by Hanoun computer impairment rating and evaluation system for the measurement of maximum isometric endurance tension in Kgm. "MIET"). MIET of patients was compared with that of healthy individuals.* ***Results:*** *Paired and student t-tests showed that the mean values of the pain and disability were significantly reduced after the treatment in group A and B. But the holding time and "MIE`T" were significantly improved only in-group B with significant difference between both treatment groups. In a comparison of the MIET in-patients and normal subjects group-B was better than group-A.* ***Conclusion:*** *The endurance training program has the upper hand in improving back endurance in non specific low back pain patients. While both dynamic back extension exercises and endurance training are effective in relieving pain and disability. So the* back endurance exercises program could be recommended for the rehabilitation of patients with non-specific chronic low back pain.

Key words: *low back pain, back endurance, disability, extension exercises, endurance training*

INTRODUCTION

Back pain is a very common and costly condition in medical field[36]. It causes major medical and economical problems in industrialized countries[46]. It has been estimated that 24 billion dollars in United State is required per year for medical costs of low back pain management and at least a quarter of the working population report low back pain at any given time[39]. The non-specific low back pain was defined as low back pain without a specific physical cause. It is a common referral diagnosis for physiotherapists. So it becomes an interesting

problem for investigators and researchers in this field[2].

It was recommended that during the assessment process of low back pain the examiner should focus on the disability and participating problems resulting from back pain rather than the pathological process responsible for back pain[13, 31,35,41] .The examiner should understand and evaluate the everyday functioning, [12,34] signs and symptoms of the patients[14,45].

Pain is one of the most important symptoms of the patient to be relieved[31,48].

The psychosocial factors generally have a big impact on pain, so the psychological state of the patients is an important factor to be considered during patient's assessment[16].

Consequently several pain scales, self-report questionnaires and disability scales have been developed for low back pain patients[13,20, 24,35]. "Roland-Morris" disability questionnaire and "Oswestry" disability index are most widely used disability scales[3,37,38]. Roland-Morris disability questionnaire is mainly measuring physical function and physical disability due to low back pain and is recommended for general populations[5,38].

In addition, many methods of back muscle testing have been developed in the assessment process of low back pain[33]. Endurance tests appear to have more value than strength tests in predicting the incidence of low back pain[40]. So in the literature there is a focus on back muscle endurance and its relation to low back pain. Several investigators evaluated back extensor muscles endurance in normal[29,30,40,45] and in low back pain patients[18,19]. Several studies proved that Electromyographic (EMG) spectral and temporal indices is an objective tool to measure back muscle endurance and to monitor local lumbar back extensor fatigue in both healthy and low back pain patients[10,19,29,40]. In addition Isokinetic sagittal lumbar performance measurement methodology has been developed by other investigators to measure dynamic back muscle endurance[29,39].

The "Bering-Sorensen" test is probably the most clinically useful test for evaluation of isometric back muscle endurance[4,33]. This test has many advantages, as it is simple to perform and uses inexpensive equipment[21].It provides a reliable measure of position-holding time from a horizontal unsupported posture and can discriminate between subjects with and without nonspecific low back pain[8,21]. Bering- Sorensen[21] considered this holding time, as a measure of mechanical capability. It is a predictor for first-time incidence of low back pain. Recently some authors found significant electromyography activities of back extensors during Sorensen test in evaluation of back extensor endurance[8].

In clinical practice the reduced endurance capacity of the trunk extensor musculature has a great association with a previous history of low back pain[17,28] and it is a good predictor for future back injury[4,23,25]. Evidence suggests that muscle endurance is lower in individuals with low back pain than in healthy subjects[8,19,33]. So trunk extensor muscles' fatigue is considered an important factor in the etiology of low back pain[44]. Fatigue can affect the ability of people with low back pain to respond to the demands of an unexpected load[49]. This demonstrated an association between the low functional capacity of trunk extensors and low back pain[22,43].

Consequently in rehabilitation of low back pain, it is generally accepted that the therapist has not primarily focused on removing an underlying pathology, but on reducing the pain and disability and improving the functional capacity of trunk muscles[47],

aiming to return to the highest level of activity and to prevent the chronic complaints and recurrence[2]. Many authors suggested that active rehabilitation are more successful in reducing pain, self experienced disability and also in improving lumbar endurance than passive control treatment[18,26]. The active approach in the rehabilitation programs is considered the best treatment approach for patients with chronic nonspecific low back pain by which the patients learn to take control over their back pain[26,42]. Active programs are depending on education and exercises [7,10,46]. Exercises are relatively inexpensive, easily administered treatment and have appeared to be an efficacious solution for back pain patients[7,42]. A large variety of exercise programs are suggested in treatment of low back pain[26,42,46]. Muscle strength and endurance represent the main two components of treatment programs in addition to the flexibility and aerobic exercises[15]. But the evidence about which program is the most optimal was still unclear[46].

Although there are numerous studies of low back pain management and back endurance in the literature there is little studies about the best approach to increase back muscle endurance, reduce pain and disability, and consequently protect the patients from repetitive attacks of low back pain. So the purpose of this study was to predict which is better dynamic back extension exercises program or endurance training program in improving back endurance, reducing pain and disability.

SUBJECTS AND METHODS

Subjects

Seventy-three subjects (male and female) ranged in age from 28 to 45 years old. Twenty-one patients with non specific low back pain with mean age (35± 6.1) years old (Group- A), twenty-two patients with non specific low back pain with mean age (38± 4.3) years old (Group- B), and thirty healthy subjects with mean age (39± 5.2) years old "controls" (Group-C) were participated in this study. The diagnosis of back pain for the patients was confirmed to be nonspecific by an orthopaedic surgeon. Disc protrusion/nerve root compression, spondylo-arthrosis, scoliosis, previous back surgery, and any other specific causes of back pain were excluded. The patients in *Group-A* treated with dynamic back extension exercises for 8 weeks. *Group-B:* treated with endurance training for 8 weeks. The study was conducted at the Laboratory of Electronic Measurements, Faculty of Physical Therapy, Cairo University.

Instrumentations

1- Visual analogue scale (VAS)[6,19,42].
2-Roland-Morris disability questionnaire[37,38].
3- Biering-Sorensen test for measurement of the time holding(in seconds) in the tested position[4,21], by using a stop watch.
4-Hanoun computer impairment rating and evaluation system (CIRES) (ODES manual 2002, Hanoun com.), for measurement of Maximum Isometric Endurance Tension in K gm (MIET)[27].

PROCEDURES

Assessment procedure

Each patient was evaluated before and after the treatment programs in both groups.

Assessment included the following

1. Pain intensity: was assessed by 100 mm visual analogue scale (VAS) to determine intensity of pain. It scored from 0 to 100 mm, where 0 is pain free and 100 is maximum pain[6,19,42].

2. The patient disability: was assessed by Roland-Morris disability questionnaire. It consists of 24 questions about activity limitations due to back pain. The score ranged from 0 (no disability) to 24 (maximum disability)[5,38].

3. Endurance of back muscles during Biering-Sorensen test: Each patient was lying prone, and the upper trunk extended out of the table with the anterior superior iliac spines at the edge of the testing table. The patient was strapped to the table at the gluteal, knee, and ankle regions. The straps were tightened as firmly as possible to support the patient to the table. Before beginning the test the patient was allowed to rest the upper half of the body on a chair. Then the patient was asked to lift the upper trunk clear off the chair with the arms across the chest and to maintain the trunk in neutral position for as long as he can tolerate. The time "in seconds (sec.)" the patient taken to maintain the trunk in horizontal position was recorded as the "holding time"[6,21] by using stop watch.

* Maximum Isometric Endurance Tension (MIET), by Hanoun system: Each patient was positioned prone in Biering-Sorensen position then instructed to hold this position for 20 seconds against maximum resistance. The patient performed these test 3 trials with rest interval 20 sec. between the trials. The computer recorded the tension of paraspinal muscles in (numerical and in form of graphs) of 3 trials and calculating the mean value "in K gm." for statistical analysis.

TREATMENT PROCEDURE

Dynamic back extension exercises

Each patient in group-A, practiced this program 3 sessions/week for 8 weeks. Each exercise was done 3 sets of 10 repetitions, with 6 sec rest between each repetition, and 1 minute rest between the sets[7,10,15].

*** First 4 weeks:** Each patient performed the following exercises from flexed position, and reached to normal extension.

1- Upper back extension from side lying position, with hands beside the body then with hands folded behind the buttocks.
2- Unilateral hip extension from side lying position.
3- Upper back extension from sitting on high chair.
4- Upper back extension from quadruped position.
5- Upper back extension from standing, with hands in the waist.
6- Unilateral hip extension from quadruped position.

*** Second 4 weeks:** Each patient reached to maximum hyperextension range in each exercise from previous exercises then he or she performed the following exercises:

1- Upper back extension from prone lying position with hands beside the body, hands folded behind the buttocks, hands folded on the chest, behind the head, and finally with hands forward in V shape.
2- Unilateral hip extension from prone lying position.
3- Bilateral hip extension from prone lying position.
4- Combined upper back and lower back extension from prone lying position.

Endurance program

Each patient in group-B practiced this program 3 sessions/week for 8 weeks. The program consisted of 4 levels from prone lying position

* First level consisted of bilateral shoulder lifts.

* Second level was contra lateral arm and leg lifts.
* Third level required the patient place both hands behind the head and perform bilateral shoulder lifts.
* Fourth level consisted of bilateral shoulder lifts with arms fully extended.

The patients holding the back in these positions for 10-20 seconds with 25 repetitions and 6 sec rest between efforts. First and second levels were concentrated in first 4 weeks, while third and fourth levels in other 4 weeks. They progressed to the next level when performing the exercise in a given level without pain or discomfort[6,32].

Statistical analysis

The collected data were statistically analyzed using paired *T-test* to detect the significance within each group after treatment. The student *T-test* was used to compare the mean difference values between group-A and group-B, and to compare the MIET of normal subjects with that of the patients in both groups.

RESULTS

1- The pain, disability, Sorensen time, and MIET in group –A

In group A (treated with dynamic back extension exercises) the pain and disability significantly reduced from (65.5±11.5) to (31.2±7.8) and from (15.5±1.8) to (9.5±1.7) respectively after treatment program. While there were no significant changes in Sorensen time in sec. and maximum isometric endurance tension in Kgm. (MIET) from (88.7±22.0) to (90.4±24.1) and from (49.2±7.9) to (50.1±8.1) respectively after treatment (table 1, fig. 1)

Table (1): The mean values of pain, disability, Sorensen time, MIET in group-A.

Variable	Pain		Disability		Sorensen time (sec.)		MIET "K gm."	
	Pre-t	Post-t	Pre-t	Post-t	Pre-t	Post-t	Pre-t	Post-t
Mean	65.5	31.2	15.5	9.5	88.7	90.4	49.2	50.1
SD	11.5	7.8	1.8	1.7	22.0	24.1	7.9	8.1
T-value	12.798*		24.421*		1.065†		1.498†	

*Significant P<0.05 † non significant P>0.05
MIET: Maximum Isometric Endurance Tension

Fig. (1): The mean values of pain, disability, Sorensen time, MIET in group-A..

2- The pain, disability, Sorensen time, and MIET in group –B

In group B (treated with endurance training) the pain and disability reduced significantly from (65.0±11.2) to 28.4±8.9) and from (14.7±1.66) to (8.54±1.33) respectively after treatment program. At the same time the Sorensen time in sec and MIET Kgm. significantly increased from (79.4±17.1) to (159.8±32.6) and from (50.5±4.3) to (70.3±6.7) respectively after training program (table 2, fig. 2)

Table(2): The mean values of pain, disability, Sorensen time, MIET in group-B.

Variable	Pain		Disability		Sorensen time (sec.)		MIET "K gm."	
	Pre-t	post-t	pre-t	post-t	pre-t	post-t	pre-t	post-t
Mean	65.0	28.4	14.7	8.54	79.4	159.8	50.5	70.3
SD	11.2	8.9	1.66	1.33	17.1	32.6	4.3	6.7
T-value	17.952*		15.739*		13.110*		13.826*	

*Significant P<0.05 † non significant P>0.05

MIET: Maximum Isometric Endurance Tension

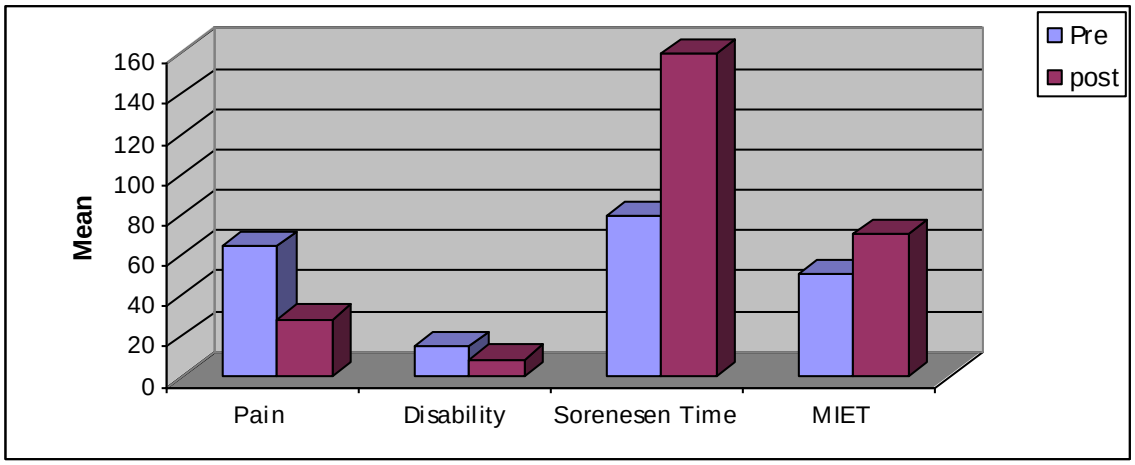

Fig. (2): The mean values of pain, disability, Sorensen time, MIET in group-B.

3- Comparison of the pain, disability, Sorensen time, and MIET between both treatments groups:

With Comparison of the mean difference (difference of pre and post test values) of pain, and disability between both treatment groups there were non- significant differences between patients treated with dynamic back extension exercises or with endurance training program (table 3, fig. 3). But there was a significant difference in the endurance of back muscles through the differences of Sorensen time in sec and MIET in K gm., with significant improvement in the patients treated with endurance training only. (table 3, fig. 3)

Table (3): Comparison of the mean difference of pain, disability, Sorensen time, MIET in both treatment groups.

Variable	Pain		Disability		Sorensen time (sec)		MIET "K gm."	
	G A	G B	G A	G B	G A	G B	G A	G B
Mean diff	34.28	36.59	5.95	6.18	1.72	80.36	0.848	19.84
SD	12.27	9.56	1.12	1.84	7.37	28.75	2.59	6.73
T-value	0.689†		0.491†		12.15*		12.09*	

*Significant P<0.05 † non significant P>0.05 GA: group A GB: group B
MIET: Maximum Isometric Endurance Tension

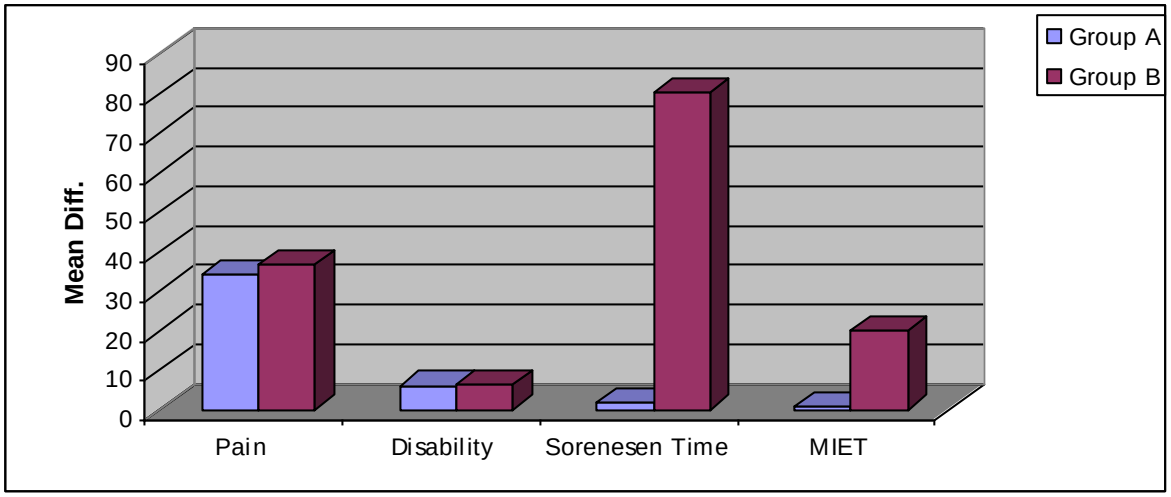

Fig. (3): Comparison of the mean differences of pain, disability, Sorensen time, MIET in both treatment groups.

4- Comparison of the MIET in patients with normal subjects

In a comparison of the mean value of MIET in normal subjects with that of LBP patients (pre and post treatment) in group A "treated with dynamic back extension exercises" the % of tension deficits was 35.8% before treatment and 34.6% after treatment with highly significant differences of the mean value of MIET between patients and normal subjects before and after treatment. While in group B "treated with endurance training" the % of tension deficits was 34.05% before treatment then reduced to 8.16% after treatment, which means that the patients in group B get great improvement in back muscle endurance and become near to the normal subjects after endurance training program (table 4)

Table (4): Comparison of the mean values of MIET in LBP patients with that of normal subjects, with % of tension deficits from normal.

variable	Group A and normal			Group B and normal		
	Pre-t	Normal subjects	Post-t	Pre-t	Normal Subjects	Post-t
Mean	49.2	76.58	50.1	50.5	76.58	70.3
SD	7.9	8.64	8.1	4.3	8.64	6.7
%	35.8%	100%	34.6%	34.05%	100%	8.16%
T-value	11.524*	11.102*		13.003*	14.296*	

***Significant P<0.05**

DISCUSSION

The results of this study showed that there was a significant reduction of pain and disability in both treatment groups after rehabilitation without significant difference between patients in both treatment groups. This revealed that either dynamic back extension exercises or endurance training are effective in the reduction of pain and improvement of functional ability of LBP patients. This may be explained by that the exercises as an active treatment approach have a beneficial effect on the emotional and cognitive aspects of pain experience[6]. The subject's pain perception has influenced their perception of disability as a result of their back pain[16].

The outcome of the present study was comparable to previous studies[19,26,42,46].Van Tulder et al. (1997)[46] provide a good evidence of the effectiveness of exercise for chronic LBP through a recent systemic review study. Kankaanpaa et al. (1999)[19] found that 24 exercise sessions for 12 weeks was more successful in reducing pain and disability and also improving lumbar endurance in chronic LBP than passive treatment.

Taimela et al. (2000)[42] applied an exercise program for 12 weeks/once or twice a week to improve lumbar stability and coordination with specific equipment that applying load against resistance. The authors reported that the self-experienced benefits regarding pain and function are important indicators of success in low back rehabilitation. Mannion et al. (2001)[26] compared three different active programs twice weekly for 3 months on chronic LBP patients. They found that the three treatments were equally efficacious in reducing pain intensity and frequency for up to 1year after therapy. The endurance in the current study was evaluated by recording the holding time "in seconds" in Biering- Sorensen test and the maximum isometric endurance tension (in Kgm.) "MIET" measured by Hanoun system during Sorensen position. In the literature the endurance tests that used in back muscle endurance assessment were commonly based on the measurement of maximum isometric endurance[19]. From previous studies the Biering- Sorensen test recorded high degree of reliability in LBP patients. In addition it is easy to perform, it doesn't require special equipment and gain support from the literature[4,8,21,33]. Biering-Sorensen (1984)[4] considered low trunk extensor muscle endurance measured during Biering-Sorensen test is a risk factor for non specific low back pain. In contrast to this idea few researches reported that the reliability of Sorensen isometric test is unacceptably low in comparison with isokinetic endurance[29]. Mayer et al.,[29] used a "Roman chair" in evaluation of isometric endurance and compared it with dynamic isokinetic endurance. The study included reciprocal sagittal movement rather than a constant contraction[29].

The results in this study showed that back extensor endurance was improved only in the second treatment group (group B) after endurance training program without significant difference in (group A) after dynamic back extension exercises. In support of this finding some authors suggested that the prescription of rehabilitation programs for LBP should probably focus on the development of muscular endurance as opposed to muscular strength[15].

Contrary to the current study Dolan et al. (2000)[10] found that there was increase of Sorensen holding time after extension

exercises for back and hip for lumbar microdiscectomy patients. But it was be interesting that the rehabilitation program in Dolan et al.,[10] study including aerobic exercises, stretching exercises, abdominal exercises, and designed exercises to improve strength and endurance of the back and abdomen in addition to extension exercises for back and hip. So the improvement of patients may be due to the addition of other different exercises to extension exercises for back and hip. While in the current study the exercise program in group A only included dynamic extension exercises for back and hip.

The maximum isometric endurance tension "MIET" measured by Hanoun system during Sorensen position and this come in agreement with previous studies which insist on record trunk muscle activity during back isometric endurance tests[8,40]. They predicting that trunk muscle activity during isometric endurance tests may provide clues to etiology of neuromuscular-based LBP[40]. Most of the previous researches about trunk muscle activity during isometric endurance tests used EMG assessment[10,19,30,40]. Hanoun system is a new valid computerized evaluation system to detect muscular functional capacity of musculoskeletal system. It was used in the current study "using the manufacture's procedures and protocols" to measure back extensor endurance[27].

In a comparison of MIET of LBP patients with normal MIET there was a significant deficit in LBP patients before treatment intervention and this was comparable with earlier findings in many previous reports[17,19]. Ito et al. (1996)[17] found that the trunk muscles in chronic LBP were easily fatigued, compared with healthy subjects. Kankaanpaa et al. (1998)[19] found the chronic LBP patients had weaker maximal back extension torque, measured by EMG, than healthy controls. This may be explained by that the persistent pain lead to reflex inhibition of the muscle and prolonged period of in-activity and this cause fatigue, deconditioning, and poor endurance in the affected muscles[43]. Pain may also lead to abnormal use of certain muscles perhaps to splint and protect a painful part of the spine and this may cause chronic fatigue in the affected muscles and increased loading of the underlying spine[9,10]. Then the fatigue leads to low level of fitness and this might be a potential risk factor for further LBP[1,22,23,25].

At the same time the "MIET" was significantly increased in patients treated with endurance training program after rehabilitation with 8.16% of deficit only from normal. While 'MIET' in the patients treated with dynamic back extension exercises was not significantly improved, with 34.6% from normal after rehabilitation. In contrast to these findings Chok et al. (1999)[6] found that the muscle endurance training did not improve the back extensor endurance in subacute LBP either after 3 or 6 weeks. This may be due to short time of rehabilitation or the patients were in subacute stage (onset of pain within 7 days to 7 weeks). While the patients in the current study were non specific chronic low back pain (with onset of pain 3 months or more) in addition to that the program was longer than 6 weeks. Also Moffroid et al. (1993)[32] found that no significant change in spectral electromyographic compression in healthy women during a 6-week exercise program. Their program may not be intensive enough to improve lumbar muscle endurance. While in this work the endurance training program extended to 8 weeks, with total 24 sessions 3 sessions/ week which was the recommended rehabilitation period in the literature to have lasting effects on patients with chronic LBP[11].

Conclusion

It can be concluded from the results of this study that the endurance training program is more effective than dynamic back extension exercises on improving back extensor muscles endurance. At the same time both programs are similarly effective in reducing pain and disability in non specific low back pain patients. So it was recommended to apply back endurance exercises in rehabilitation of non specific low back pain patients

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الملخص العربى

تمرينات مد الظهر الحركية مقابل تمرينات التحمل على الآم اسفل الظهر الغير محددة

تهدف هذه الدراسة إلى مقارنة تأثير برنامج تمرينات مد الظهر الحركية و تدريبات التحمل في تحسن تحمل الظهر و تقليل الألم و الإعاقة في مرضي الآم اسفل الظهر الغير محدد. تشمل هذه الدراسة ثلاثة و سبعون شخصاً (من الذكور والإناث) تتراوح أعمارهم من 28 الي45 عاماً. تشتمل التجربة علي ثلاثة مجموعات: (مجموعة أ) واحد وعشرون مريضاً بالآم اسفل الظهر الغير محدد متوسط أعمارهم 35 ± 6,1 عاماً تم علاجهم ببرنامج تمرينات مد الظهر الحركية . (مجموعة ب) إثنان وعشرون مريضاً بالآم اسفل الظهر الغير محدد متوسط أعمارهم 38 ±4,3 عاماً تم علاجهم ببرنامج تدريبات التحمل. (مجموعة الضبط) ثلاثون شخصاً من الأصحاء متوسط أعمارهم 39±5,2 عامًا). تم تقييم الألم بالمدرج البصري للألم و الإعاقة باستفتاء "رولاند للإعاقة" ،تم تقييم مقدار تحمل الظهر باختبار"بيرنج سورنس" لتحديد وقت الثبات و ونظام هانون لقياس الشد الأقصى المتساوي للتحمل لكل مريض قبل وبعد العلاج. وتم مقارنة الشد الأقصى المتساوي للتحمل "بنظام الهانون" للمرضي والأصحاء. بينت النتائج الإحصائية وجود تحسن ملحوظ في الألم و الإعاقة في المجموعتين (أ و ب) بينما وقت الثبات و الشد الأقصى المتساوي للتحمل لم يتحسن إلا في (مجموعة ب) مع وجود فوارق إحصائية بين المجموعتين. بالإضافة إلى أن مقدار الشد في (مجموعة ب) كان الأقرب الي مقدار الشد الطبيعي للأصحاء. يستخلص من نتائج هذا البحث أن برنامج تدريبات التحمل لها اليد العليا في تحسن تحمل الظهر بينما تمرينات مد الظهر الحركية و تدريبات التحمل تتساوى في تقليل الألم و الإعاقة في مرضي الآم اسفل الظهر الغير محدد. لذا يوصي باستخدام تدريبات التحمل في علاج هؤلاء المرضي.