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The Impact of Functional Resistance Training on Proprioception and Pain in Men with Non-Specific Chronic Low Back Pain

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Key words: Functional resistance training, pain, proprioception, distribution, ANCOVA, Sidak

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Abstract: The aim of this study was to investigate the effect of 8 weeks of functional resistance training on pain and proprioception of men with non-specific chronic low back pain. The research methodology according to experimental-control groups was pretest-posttest and the research design was quasi-experimental (interventional). Statistical population of the study were men aged 25-45 who came to the rehabilitation clinic due to chronic low back pain, then the subjects entered to the study after completing the written consent form of knowingly participation in research, the personal information questionnaire (including age, height, weight and the history of sport activities and injuries) and Roland-Morris questionnaire (earning a score above 4 in this questionnaire) and being eligible for the study, so that, the study subjects were divided into two groups with 10 subjects of control and functional resistance training. First, patients in both groups took the pretest and then experimental group subjects attended in training sessions for 8 weeks. But control group patients did not participate in any particular treatment program. After holding treatment sessions, all subjects participated in posttest and the respective indices were measured. Then in order to measure pre-test and post-test, amount of pain and proprioception, visual analogue questionnaire and handheld goniometer were used, respectively. Also, data in both descriptive and inferential statistics sections were analyzed in SPSS21 Software. After confirming normal distribution of data using K-S test, covariance analysis test ANCOVA and Sidak post hoc test were used at significance level of $p = 0.05$. Research findings showed significant improvement in pain and proprioception in the experimental group compared to the control group ($p>0.05$).

INTRODUCTION

Low back pain is an epidemic. In 1993, the prevalence of low back pain in United Kingdom had seen in 6 and a half million people and treatment cost was about 480 million dollars annually. However, it seems that its prevalence is still increasing (Campbell and Muncer, 2005). Despite the progress of science in the field of spine diseases and increment in treatment approaches, low back pain continues to be a major public health problem in industrialized and non-industrialized countries. According to, the evidences low back pain is one of the most common musculoskeletal disorders, so that, 58-84% of people experience it at least once in their lifetime (Walker *et al*., 2004; Rubin, 2007). In Iran, it is the third leading cause of disability in people at the age range of 15-65 years old (Roomezi *et al*., 2012). About 90% of patients with low back pain suffer from its nonspecific type. The cause of this type of low back pain has no specific pathology and its location is under the ribs to the top of gluteal fold (Maetzel and Li, 2002). A small percentage of patients with low back pain enter the chronic phase of the disease that this low percentage will cause direct and indirect costs. Many suggestions offered in relation to the primary cause of the disease among which the lumbar spine lesions, involvement of facet joint, involvement of intervertebral disk, ligaments, nerves and muscle weakness and imbalances can be mentioned (Stankovic *et al*., 2008). Information about chronic low back pain is often incomplete and much of the treatment is done without relying on reasoned evidences. Despite a significant increase in randomized clinical trials in recent decades, only 2% of these trials have examined low back pain. Considering the diversity of treatment approaches, yet there is no consensus on the most effective treatment approach for low back pain (Furlan *et al*., 2009). Due to the numerous risk factors for chronic low back pain, every patient can take advantage of training programs tailored to their disease. For example, a patient with hamstring flexible muscles cannot benefit from stretching and flexibility exercises of hamstring muscles in treating the low back pain. As a result before using any treatment, patients should be examined properly and similar exercises should be prescribed for those patients who have similar chronic low back pain (Airaksinen *et al*., 2006). In addition, since, chronic back pain is multifactorial phenomenon, several approaches have been considered for its treatment (Moseley, 2002). Among them, analgestic and anti-inflammatory drugs, muscle relaxants and benzodiazepines, antidepressants, epidural injection, exercise therapy, behavior therapy, manual therapy, biofeedback, electromyography, stretching, TENS, orthosis, acupuncture and spa treatment method can be mentioned. Overall, there is no strong evidence for the effectiveness of one treatment method for patients with chronic low back pain (McGill, 2002; Karimi *et al*., 2009).

Also, in researches recently carried out on treatment of non-specific chronic low back pain, researchers concentrate on exercises that simultaneously focus on sense and movement (Wand *et al*., 2011; Paolucci *et al*., 2012). So that, in patients with chronic low back pain, proprioceptive acuity of lumbosacral region, trunk muscles control (Brumagne *et al*., 2004) and balance (Brumagne *et al*., 2008) will change. In addition, studies on people posture have shown that reduced proprioception causes a problem in indices such as reaction time, postural control and balance (Brumagne *et al*., 2008). Recent studies have suggested that indices such as proprioception, neuromuscular coordination and balance are associated with low back pain (Brumagne *et al*., 2004). It is possible that one or more indices of reduction in proprioception and reduction in neuromuscular coordination also be seen in patients with non-specific chronic low back pain. These factors lead to false gestures and movement patterns in the patient, reduction of motor performance and more pressure on lumbar spine of these people and finally, the phenomenon of pain will appear in these patients (Mohseni-Bandpei *et al*., 2006, 2011).

Also, in recent years performing exercise training and exercise therapy in the treatment of patients with low back pain have taken into consideration (Bogduk, 2006). So that, the functional resistance training is of the common methods used for resistance training which means the whole body endurance training (Mikesky *et al*., 1994) that patients use them for creating resistance in training, controlled traction and strengthening tendinous-muscular units (Bang and Deyle, 2000). Among its benefits low cost, being compact and safe, easy to use, high variability in training exercises and use as home exercises can be mentioned. In addition, the functional resistance training biomechanically imports a different resistance to the muscle at any angle of the range of motion while training with free weights is not like this and a fixed resistance applies to the whole range (Han *et al*., 2009).

Thus, given that the main causes of low back pain are not clear but it seems that in most cases, low back pain is caused by muscle weakness and improper body posture (Shoja *et al*., 2009). So that, in a study Kong *et al*. (2015) examin the exercise training on disability index and proprioception of patients with chronic back pain. After, 8 weeks of training the results showed a significant difference in disability index and joint position sense in area of low back pain and flexion and extension among the groups (Kong *et al*., 2015). Learman *et al*. (2009) conducted a study on the effects of spinal manipulation on trunk proprioception in patients with chronic low back

pain during their symptoms improvements. The results showed very little impact of exercises on trunk proprioception (Learman *et al*., 2009). Maryam *et al*. (1973, 1974) in their researches evaluate the effectiveness of sensory-motor exercises on proprioception, neuromuscular coordination, motor control and pain in patients with non-specific chronic low back pain. The results of these studies showed a significant improvement in proprioception, motor control and neuromuscular coordination as well as a significant reduction of pain in patients with non-specific chronic low back pain. Also, Soheila *et al*. (1971) examined the effect of core stabilization training on pain and function in female patients with non-specific chronic low back pain. The results showed a significant improvement in pain and function of patients in the experimental group following the core stabilization training. Reza *et al*. (1971) conducted a study entitled as the effect of exercise therapy and massage protocol on the amount of pain and physical function in men with non-specific chronic low back pain. The results showed that compound exercises and massage therapy protocol can be a good and useful method to reduce or eliminate factors and symptoms in patients with non-specific chronic low back pain (Reza *et al*., 1968) and (Mino *et al*., 1968) conducted a study on the effect of lumbar stabilization exercises on the proprioception of lumbosacral spine. They concluded that lumbar stabilization can create a significant reduction in lumbosacral proprioception error in healthy and young people (Mino *et al*., 1968).

So that, the studies have stated that changes in the size of lumbar lordosis, abdominal muscles weakness, posterolateral lumbar muscle weakness, strength loss of hip erector muscles and hip flexor muscles tightness are the main causes of low back pain (Descarreaux *et al*., 2002). In the meantime, decrease in trunk muscle endurance is one of the most common findings in patients with low back pain (Kim *et al*., 2006). Which according to many researchers, reduction in the strength of these muscles causes their early fatigue, increase in pressure and force more than usual on passive tissues of the lumbar spine, damage to the tissues sensitive to pain and eventually low back pain (Farahpour *et al*., 2005). So, enhancing trunk muscle endurance and delaying the onset of their fatigue can be useful in these patients. This study sought to answer the question that does running a functional resistance training has any effect on pain and proprioception of patients with non-specific chronic low back pain?

MATERIALS AND METHODS

Statistical population of the study were men aged 25-45 who referred to rehabilitation clinic due to chronic low back pain and after completing the data collection form, those with initial conditions of the research were participated in this study in case of having nonspecific chronic low back pain. So that, 20 of them who were diagnosed with nonspecific chronic low back pain were chosen as subjects and then patients were randomly divided into two groups of 10 people in both Total-body Resistance Training (TRX) and control group.

Before the study began, steps were described for subjects of research then they were asked if desired to visit rehabilitation clinic for conducting preliminary studies on specific time. Also it explained for subjects that at any time of the investigation, they can opt out if they do not desire to continue the cooperation. Then, the subjects entered to the study after completing the written consent form of knowingly participation in research, the personal information questionnaire (including age, height, weight and the history of sport activities and injuries) and Roland-Morris questionnaire (earning a score above 4 in this questionnaire) and being eligible for the study, so that, the study subjects were divided into two groups with 10 subjects of control and functional resistance training. First, patients in both groups took the pretest and then experimental group subjects attended in training sessions for 8 weeks. But control group patients did not participate in any particular treatment program. After holding treatment sessions, all subjects participated in posttest and the respective indices were measured. To perform training protocol, experimental group exercised within 8 weeks, 3 sessions per week and each session for an hour (10 min warm-up, 40 min special exercises and 10 min cool-down) and after 8 weeks of training, posttest was taken. In addition, the descriptive and inferential statistics were used for data analysis. Descriptive statistics were used to calculate the central and dispersion parameters, drawing diagrams and tables and inferential statistics were used for data analysis with having pretest and posttest data and by using t-test and analysis of covariance and using the Software SPSS (Version 21).

Research findings: Characteristics about age, height and weight of the two groups studied samples are presented in Table 1. The information provided in Table 1 show that there is no significant difference between the two groups in age, height and weight variables ($p>0.05$). To verify the normal distribution of data, Kolmogorov-Smirnov test was used which results are presented in Table 2. The test results showed that the distribution of variable data is normal in both groups.

In the present study, the amount of pain and proprioception were considered as dependent variables. Characteristics of these variables have been individually reported in pretest and posttest in Table 3.

Table 1: Anthropometric characteristics of experimental and control groups, the mean and standard deviation

Study groups	No.	Variables	Mean±SD
Functional resistance training	10	Age (year)	41.00±3.39
		Height (m)	176.93±8.27
		Weight (kg)	83.50±13.25
Control	10	Age (year)	41.20±5.07
		Height (m)	184.06±28.89
		Weight (kg)	82.80±11.17

Table 2: Kolmogorov-Smirnov test results in order to evaluate the normal distribution of data in the research variables

		Pretest		Posttest	
Study groups	Variables	K-S (Z) statistics	Significance level	K-S (Z) statistics	Significance level
Functional resistance	Amount of pain	0.520	0.950	0.692	0.725
training	Proprioception	0.546	0.927	0.626	0.828
Control	Amount of pain	0.513	0.955	0.667	0.766
	Proprioception	0.342	0.825	0.993	0.278

Table 3: Descriptive data of the study dependent variables in pretest and posttest

Study groups	No.	Tests	Variables	Mean±SD
Functional resistance	10	Pretest	5.90±1.10	9.20±4.14
training		Posttest	1.90±1.10	3.60±1.71
Control	10	Pretest	5.50±1.08	9.10±4.18
		Posttest	4.14±0.13	8.12±2.87

Table 4: Levene's test results in order to evaluate group's variance equality in research variables

Variables	Levene statistic (F)	DOF	Significance level
Amount of pain	2.185	1 and 18	0.157
Proprioception	0.347	1 and 18	0.563

Table 5: M Box test results in both groups

Parameters	Values
M Box	12.186
F statistic	1.659
DOF 1	6
DOF 2	2347.472
Probability value	0.127

In order to use parametric tests in this section, first, the default of group's variance equality in all variables were examined in pretest step. Results obtained from Levene test are shown in Table 4 that the default of variance homogeneity of subjects scores exist in all variables in the pretest ($p>0.05$). In order to investigate the lack of interaction between the group and pretest scores, the assumption of linearity of covariate variable (control) and independent variable was studied and its results are presented separately in every hypothesis. Then, the M-Box test was used to investigate the homogeneity of variance-covariance matrices which is of assumptions of covariance analysis. Also Sidak test was used to evaluate the groups in case that difference between the means is significant.

Table 4, the default of equality in scores variance exists in all variables in pretest step ($p>0.05$). As can be seen in Table 5, the probability value of M Box test is not significant ($p>0.05$). This indicates that the assumption of homogeneity of variance-covariance matrices is observed.

In order to evaluate the impact of conducted interventions on variables of the amount of pain, proprioception and motor control, analysis of covariance was used and in case of being significant, Sidak post hoc test was used to interpret the significant level, the results of which are presented in the following with respect to hypotheses.

As can be seen in Table 6, functional resistance training had a significant effect on the amount of pain (power = 0.371, Partial$\eta 2$ = 0.241, p = 0.015 and F = 2.782). Given the significant results of analysis of covariance and in order to evaluate differences between groups, Sidak post hoc test was used which results are separately presented in Table 7. As it can be seen in Table 7, the difference between functional resistance training group and control group is significant (p = 0.001). Second assumption: eight weeks of functional resistance training affects on the proprioception of men with non-specific chronic low back pain.

Table 8, pretest reports a significant level >0.05 (p = 0.211) which means that the selected pretest is not appropriate, however, there was no effect on the results of covariance and test results are correct. On this basis and according to the information provided in the above table, functional resistance training had a significant effect on proprioception (power = 0.717, Partial $\eta 2$ = 0.313, p = 0.016 and F = 7.290). Given the significant results of analysis of covariance and in order to evaluate differences between groups in influencing the proprioception, Sidak post hoc test was used and the results of which are presented in Table 9. Table 9, the difference between functional resistance training group and control group was significant (p = 0.001).

Table 6: One-way covariance analysis for evaluating the effectiveness of training on the amount of pain

Variables	Source of changes	Sum of squares	DOF	Mean squares	F-values	Significance level	Effect size	Observed power
Amount of pain	Pretest	15.910	1	15.910	49.196	0.001	0.263	
	Group	0.900	1	0.900	2.782	0.015	0.241	0.371
	Error	5.174	16	5.598				
	Total	360.000	20					

Table 7: The results of Sidak post hoc test for evaluating the differences between functional resistance training group and control group

Variables	Group (I)	Group (J)	The mean difference (I-J)	SE	Significance level
Amount of pain	TRX	Control	6.749	1.235	0.001

Table 8: One-way covariance analysis for evaluating the effectiveness of functional resistance training on proprioception

Variables	Source of changes	Sum of squares	Degrees of freedom	Mean squares	F-values	Significance level	Effect size	Observed power
Proprioception	Pretest	61.559	1	48.035	48.035	0.211	0.750	
	Group	9.343	1	7.290	7.290	0.016	0.313	0.717
	Error	20.505	16	1.282				
	Total	1063	20					

Table 9: Sidak post hoc test for evaluating the difference between functional resistance training group and control group

Variables	Group (I)	Group (J)	The mean difference (I-J)	Standard error	Significance level
Proprioception	TRX	Control	3.012	2.001	0.001

RESULTS AND DISCUSSION

The results of this study showed that 8 weeks of functional resistance training had an effect on pain of men with non-specific chronic low back pain. So that, in studying the mean difference of pretest-posttest, there is a significant differences between control group and functional resistance training group ($p>0.05$). Low back pain is one of the main and costly health care problems in many developed and developing countries that leave great economic and social effects. However, 3 major mechanisms can be involved in creating pain in pelvic girdle region, which include biomechanical factors, hormonal and vascular factors and musculoskeletal factors (Stuge, 2012) so that, anterior displacement of body's gravity center, trunk and abdomen may unconsciously cause hyperlordosis of spine. This transfer and translocation of pressure will concentrate the pressure forces on intervertebral plates and articular surfaces and ligaments and causes articular inflammation. Inflammation and inappropriate pressure on the joints capsule cause pain and increase the sensitivity of the region when moving (Hanfy *et al*., 2011). Also, researches have proven a relationship between dysfunction of lumbar performance and trunk internal muscles performance. Basic strength training programs for back muscles alone may not be enough for improving the performance of trunk internal muscles. Specific and local exercises are for neuromuscular control of trunk internal muscles which can be crucial for improving muscles recruitment patterns which are needed to maximize the local stability in lumbar part of spine (Hall, 2005). Since, the foundation of functional resistance training is activities that include a combination of different movements and using the muscle groups around the trunk and pelvis, the situation of trunk middle muscles will improve. Hence, it seems that functional resistance training improves muscle strength, muscle recruitment patterns and local stability in pelvic girdle region and the body line is maintained in such a way that it seems all these factors cause improvement in the amount of pain in the region. So that, the results of this study were in line and consistent with the results of Nazarzadeh Dehbozorgi *et al*. (1394), Maryam *et al*. (1973, 1974) Reza *et al*. (1971).

In addition, the results of this study showed that 8 weeks of functional resistance training had an effect on pain of men with non-specific chronic low back pain. In studying the mean difference of pretest-posttest there is a significant differences between control group and functional resistance training group ($p>0.05$).

In patients with chronic low back pain, proprioceptive acuity of lumbosacral region, trunk muscles control (Brumagne *et al*., 2004) and balance (Brumagne *et al*., 2008) will change and also the studies on people's posture have shown that reduction in proprioception impairs indices such as reaction time, posture and balance control (Brumagne *et al*., 2008). So, it is possible that one or more of these indices of reduction in proprioception and reduction of neuromuscular coordination are seen in people with non-specific chronic low back pain. So that, these factors leads to create wrong movement and movement patterns in patient, reduction in motor efficiency and a greater pressure on lumbar spine in

these people and finally, the phenomenon of pain will arise in these patients (Mohseni-Bandpei *et al*., 2006). Functional resistance training is used to create resistance in exercise, controlled traction and strengthening the tendinous-muscular unites (Bang and Deyle, 2000). So that, it improves the condition of trunk middle muscles. Hence, it seems functional resistance training improves muscle strength, muscle recruitment patterns, local stability in the pelvic girdle region, pain and subsequently, proprioception in the area. So, this study results was in line and consistent with the results of Kong *et al*.; Maryam *et al*. 1973, 1974 and Mino *et al*. (2011). On the other hand, it did not match with the results of Learman *et al*. (2009). But probably the observed difference in this study with the above-mentioned research findings may be due to the age range of subjects and measuring tools.

CONCLUSION

The results of this study showed that the 8-week functional resistance training program is effective on improving pain and proprioception in men with non-specific chronic low back pain. Hence, it seems that functional resistance training improves muscular strength and endurance, muscles recruitment patterns and local stability in pelvic girdle region and subsequently prevents the shifting of body's gravity center and the body line is also maintained, so, it seems that all the factors cause improvement in the pain in this area and improvement in pain is associated with improvement in proprioception in the area.

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