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The Effect of Water Exercise on Pain and Disability in Patients with Non-Specific Chronic Back Pain and Its Relationship with Changes in Inflammatory Factors

Mohammad Ali Kohanpour [1]
1. Department of Physical Education and Sports Sciences of Zand Shiraz University, Iran

Saeideh Najd [2*]
2. Senior expert in corrective movements, Ferdowsi University of Mashhad, Iran

Monireh Khademi [3]
3. Senior expert in sports pathology and corrective movements, Binaloud Institute of Higher Education, Mashhad,Iran

Sirous Farsi [4*]
4. Department of Physical Education and Sports Sciences, Islamic Azad University, Marvdasht Branch, Iran

* Corresponding author: Sirous Farsi
Email: sirous.farsi@gmail.com

***Abstract*— the aim of this study was to investigate the effect of exercise in water on pain and the disability of patients with non-specific chronic back pain and its relationship with changes in inflammatory factors. The statistical sample of the research included 20 women suffering from non-specific chronic back pain purposefully selected and randomly assigned to three groups: exercise in water and control (10 people in each group). The exercise group participated in a course of 8-week program, while the control group received no intervention and had their normal routine activities. 48 hours before and 48 hours after the intervention, pain and disability and serum levels of CRP and TNF-α were measured. In order to examine and compare the changes of the variables, mixed analysis of variance was used. The results showed that pain and disability as well as serum levels of CRP and TNF-α in the training group were significantly reduced compared to the control group (P<0.05). Also, the results indicated that there was a positive significant relationship between all the variables (P<0.05). It seems that eight weeks of training in water leads to improvement of pain and disability in patients with non-specific chronic back pain. In the meantime, the reduction of inflammation caused by these exercises probably plays a role. However, we need more studies in this field.**

Keywords*— *Non-specific chronic back pain, inflammation, pain, exercise in water, CRP

Introduction

Work-related low back pain is the most common debilitating musculoskeletal injury in the world and can negatively affect working quality. Most of the medical costs are related to patients with chronic pain. This situation ultimately leads to reduced productivity and increased sick leave. Therefore, its economic dimension has drawn the attention of managers. So these people should quickly recover and return to work to prevent further economic loss (1-4). Low back pain is more common in women than men (5) and is one of the most common reasons for absences from work and using health insurance and health services.

According to the research, 70 to 85 percent of people have experienced back pain during their lives, and 80% of them have reported recurrence (6, 7). Because of the complexity of the mechanism of this type of pain, there is no proven method of treatment (8). Recent studies have shown that flexibility, strength, and endurance exercises, referred to as conventional methods of exercise therapy, are used to reduce pain and improve function in patients with chronic low back pain (9-11). The main causes of back pain are not clear yet but it seems that in most cases, back pain is caused by muscle weakness and awkward posture of the body (12). Research has shown changes in the degree of lumbar lordosis, abdominal muscle weakness, posterior lumbar muscle weakness, and loss of muscle endurance of thigh are the main factor contributing to low back pain (13, 14). The decrease in trunk muscle endurance is one of the most common findings in patients with back pain. Trunk flexor-extensor muscles are among postural muscles of body which act against gravity to keep the body in an upright position and control it when bending (15, 16).

According to many researchers, decreased endurance of these muscles leads to early fatigue, increased pressure, force on passive tissues of lumbar spine, damage to these tissues, and finally the incidence of low back pain (15-17). Similarly, the results of EMG tests prove increased muscle fatigue in people with low back pain compared to healthy individuals (18, 19). Farahpour e. al (2005) examined muscle endurance in patients with chronic low back pain and the changes in different modes of therapy and showed that patients with low back pain have significantly less strong trunk flexor-extensor muscles in the pre-test compared to normal individuals (17). Thinness and atrophy of trunk muscles in patients with low back pain compared to healthy individuals could be among the causes of lower muscular endurance in these people. Hides et al. (1994) showed in their study that in patients with low back pain, multifidus muscle cross-sectional area is 31% lower than in healthy individuals (20). Verbunt et al. (2003) also state that back muscles as postural and body maintenance muscles contract more than other muscles and are more prone to atrophy and weakness (21). So, it can be a cause of reduced endurance and fatigue of the muscles and the subsequent incidence of back pain and disability in such patients. Therefore, it can be helpful to enhance muscle endurance and delay the onset of fatigue. So far, several methods for the treatment of patients with chronic low back pain have been considered including using pain medication, muscle relaxants, therapeutic yoga, stretching and flexibility exercises, stability exercises, massage therapy, and therapeutic exercise (13, 22, 25). Exercise therapy is a common practice in the treatment of patients with chronic low back pain (24, 26, 27). Hayden et al have found exercise therapy effective in the treatment of back pain (10). The importance of exercise in patients with low back pain is so considerable that different sport programs have been offered by researchers (10). Overall, the results show exercise therapy can reduce pain, increase muscle endurance, and improve the performance of patients with low back pain (28). By reviewing the literature of the studies on low back pain, it seems that in most studies, common exercises that can affect back pain are separately studied. Few studies have focused on a combination of several methods. Physiotherapy exercises have always been used for treatment.

Various studies show that there is a possibility of increasing inflammatory indices in people with back pain. C-reactive protein (CRP) is among the indicators that have been mentioned to be increased in people with back pain in some studies. Various findings indicate that IL-6, which is considered to be one of the factors that increase CRP, increases significantly in people with back pain (29). On the other hand, due to the effectiveness of IL-6 on CRP, this reactive protein also increases significantly and leads to inflammation in the lower back. It seems that CRP, which increases the activity of prostanoids and leukotrienes, leads to inflammation, followed by pain, and part of the pain in the lower back in people with lower back pain is caused by inflammation (29, 30). Sturmer et al. (2005) also found CRP effective in inflammation and sciatica pains (31). Considering the role of physical activity in reducing inflammatory factors, it seems that the use of sports activities is effective in this field (10). Various studies have reported a significant decrease in CRP following physical activities (32). However, Nickolas et al. (2004) investigated the effect of 18 months of combined resistance and aerobic training in elderly obese men and women with symptoms of

knee osteoarthritis and reported that the level of inflammatory markers including CRP did not change significantly (33). On the other hand, exercise in water is one of the therapeutic methods that is used in all therapeutic fields recently. Water pressure on the body, joints, muscles and internal organs during exercise relaxes the whole body like a good massage and prevents bruises. Also, due to the reduction of pressure inside the disc, the size of the intervertebral space may increase, which often allows patients with back problems to feel less discomfort during exercise (34). In the use of water therapy, no pressure is applied to the damaged tissue and the person continues to exercise while he is really far from the injury. One of the major benefits of water treatment is reducing the forces related to weight bearing (34).

Considering the conflicting results and since no study has investigated the effect of exercise in water on pain and disability related to inflammation in patients with non-specific chronic low back pain, the aim of this research was to determine the effect of exercise in water on pain and the disability of patients with non-specific chronic back pain and its relationship with changes in inflammatory factors.

Methodology

The current research was a clinical trial type.

The statistical sample of the research included 20 women suffering from non-specific chronic back pain purposefully selected and randomly assigned to two groups: exercise in water and control (10 people in each group).

After the aim of the research and all the steps were described in details for the participants, all of them volunteered and completed a written consent form. Criteria for inclusion of patients in the study included being female, suffering from chronic non-specific low back pain, having low back pain of at least 3 months, a reduction in trunk flexor-extensor muscle endurance, and being aged between 20 and 45 years. Exclusion criteria included having acute and subacute low back pain, being pregnant, having a history of diseases, injuries and disorders affecting the underlying back pain such as a herniated disc, arthritis, sciatica, narrowing of vertebral canal, osteoporosis, the existence of bone Spurs in lumbar spine, hip and vertebral fractures, previous surgery, tumor, infection, ponytail syndrome, lumbar, scoliosis, flat back, kyphosis and history of any medication or health measures to remove low back pain. In addition, all the subjects were examined by a specialist, their MRI images were studied, and based on the criteria of inclusion they were homogenized.

The exercises were done for 8 weeks and 3 sessions per week in the swimming pool with a temperature of 29±1 and an ambient temperature of 32 degrees Celsius. An orientation session was held to familiarize patients with the pool environment, exercises, hydrotherapy tools, training and emphasis on proper posture and the use of deep muscles during exercises. In this session, the patient was introduced to the RPE 6 to 20 assessment method to evaluate the intensity of aerobic exercise more accurately. Each training session was 55-60 minutes and was done under the direct supervision of the hydrotherapist. Each training session consisted of 10 minutes of warm-up, 15-20 minutes of strength training, 20-25 minutes of endurance training, 5 minutes of balance training, and 10 minutes of cooling down (stretching exercises) (35).

48 hours before and 48 hours after the intervention, the level of pain (Quebec Standard Pain Questionnaire) and disability (Oswestry Disability Questionnaire) and were measured. Also, a blood sample was collected to measure CRP and TNF levels in a state of 12 hours of fasting. TNF-α levels were measured with a kit from Diaclone, France, with a sensitivity of 8pg/ml. C-reactive protein (CRP) levels were obtained by ELISA method using a commercial ELISA kit from Ontario Canada Company with a sensitivity of 10ng/ml.

Quebec pain questionnaire consists of 25 five-item questions (minimum 0 and maximum 4) which scores

the pain perceived while doing daily routines between 0 and 100. Scoring 0 implies complete health, 1-25 mild pain, 26-50 moderate pain, 51-75 strong pain, and 75-100 severe pain causing trouble for the patient (36). Oswestry questionnaire measures functional ability of patients by ten 6-option sections in the field of tolerance and coping with pain, personal care, lifting objects, walking, sitting, standing, sleeping, social life, travel, and change in the degree of pain. At worst disability conditions, score 5 is given to each section and the total score of the ten sections is 50. Total disability is obtained by multiplying the score in each section by 2. In fact, the range of scores is between 0 and 100. Thus, a score of zero indicates perfect health and a pain-free functionality, 1-25 mild disability, 26-50 moderate disability, 51-75 high disability, and 75-100 severe disability causing trouble for the patient (37). It should be noted that in this study, samples were selected among those who scored over 25 for pain and disability. Previous studies have approved and confirmed the validity and reliability of Quebec and Oswestry questionnaires to assess pain and disability in daily activities and the reliability of them has been reported 84% (38).

To analyze the data, descriptive and inferential statistics were used. In descriptive statistics, mean and standard deviation were used. In inferential statistics, In order to investigate and compare the changes of the variables, the statistical method of mixed variance analysis was used. The significant level was considered $P \leq 0.05$ and the SPSS software (version 16) was used to perform statistical operations.

Results

The results of mixed analysis of variance are reported in Table 1. The results of the Pearson correlation coefficient test are also presented in Table 2. The results showed that pain and disability as well as serum levels of CRP and TNF-α in the training group were significantly reduced compared to the control group ($P<0.05$). Also, the results indicated that there was a positive significant relationship between all the variables ($P<0.05$).

Table1. Results of mixed variance analysis

Variables	Groups	Before	After	F	P	Effect size
Pain	Training	39.40 ± 11.68	28.80 ± 11.26	8.91	0.008 *	0.33
	Control	46.90 ± 12.52	44.40 ± 11.57			
Disability	Training	54.30 ± 9.25	42.60 ± 10.78	10.19	0.005 *	0.36
	Control	52.70 ± 7.37	49.90 ± 8.37			
CRP (ng/ml)	Training	1879.60 ± 376.90	1390.30 ± 298.93	9.34	0.007 *	0.34
	Control	2139.20 ± 450.16	2094.70 ± 501.30			
TNF-α (pg/ml)	Training	11.21 ± 1.65	8.98 ± 1.45	9.21	0.007 *	0.33
	Control	9.99 ± 1.19	10.15 ± 1.07			

*significant at the level of $P \leq 0.05$

Table2. Pearson correlation coefficient test results

Correlation matrix	Pain	Disability	CRP	TNF-α
Pain	-	r= 0.88	r= 0.55	r= 0.56
		p= 0.001 *	p= 0.011 *	p= 0.010 *

Disability	r= 0.88 p= 0.001 *	-	r= 0.59 p= 0.006 *	r= 0.63 p= 0.003 *
CRP	r= 0.55 p= 0.011 *	r= 0.59 p= 0.006 *	-	r= 0.44 p= 0.047 *
TNF-α	r= 0.56 p= 0.010 *	r= 0.63 p= 0.003 *	r= 0.44 p= 0.047 *	-

*significant at the level of P≤0.05

Discussion

Based on the findings of the present study, eight weeks of training in water led to a significant reduction in pain and disability, as well as the serum levels of CRP and TNF. Also, there was a significant positive relationship between changes in pain and disability with changes in inflammatory factors, so that with the reduction of these inflammatory factors, the pain and disability of patients with non-specific chronic back pain also decreased significantly.

Considering the impact of exercise on reducing pain and disability, the results of the present study are in line with the results of Barr (39). Previous research has showed that patients with chronic low back pain have weakness and atrophy of deep and central muscles, especially abdominal and multi-headed lumbar muscles (40). Also, it is aid that in patients with chronic low back pain, muscle dysfunction may be due to deformation and change of one of neuromuscular control mechanisms affecting trunk stability and efficiency in motion. Exercise may reduce pain and increase performance by increasing strength, endurance, flexibility, coordination, static and dynamic stability, neuromuscular control, motor control, correcting movement patterns and relaxation of muscles (39, 41).

Motealeh (2005) stated that endurance and coordination exercises and a combination of them improve pain and disability in patients with chronic low back pain and believes using a combination of endurance and coordination exercises is more effective in reducing pain and disability (42). Farahpour et al (2005) also pointed out that a 12-week physical therapy decreased the pain and disability of patients with chronic low back pain with the weakness of the flexor-extensor muscles of the trunk (17). However, the research done by Grifka (2006) reported contrasting results (43). Rainville et al (2004) pointed out that there is no evidence that exercise therapy increases back pain or disability of patients and suggested that therapeutic exercise and endurance activities reduce the risk of injuries and lower back pain. They believe these exercises can be used for treating patients as they increase the flexibility of muscles, improve their performance, and reduce pain (24). Differences in different findings are probably due to differences in training protocols.

Also, the reduction of inflammatory factors due to exercise is consistent with the results of previous studies (33, 44). CRP is a general measure of body inflammation and can be caused by various reasons. The possible important role of CRP such as binding to the phospholipids of damaged cells to activate some compounds and increasing the uptake of these cells by macrophages, activating endothelial cells to grow molecules, reducing the expression and biological availability of endothelial oxidase synthase And the reduction of endothelial expression of nitric oxide compounds is considered for it (45). Various findings show that IL-6 is one of the factors that increase CRP and its levels increase significantly in people with back pain (29). On the other hand, due to the effectiveness of IL-6 on CRP, this reactive protein also increases significantly and leads to inflammation in the lower back area (30). It seems that CRP leads to inflammation, followed by pain, by increasing the activity of prostanoid and leukotrienes, and includes part of the pains in the lower back in people with lower back pain (29, 30).

From different studies, it can be seen that sports activity leads to the reduction of CRP values through

different mechanisms. Fat tissue values, body mass index and ratio of waist circumference to hip circumference are among the effective indicators in the secretion of inflammatory indicators. Many researchers believe that an increase in the amount of body fat reserves causes an increase in serum CRP, so there is a possibility that sports activity is effective in reducing CRP levels through the reduction of fat reserves (46). However, some researchers have also reported that sports activity without significant reduction of body fat had a significant effect on CRP values and its reduction (47). On the other hand, the effect of inflammatory cytokines such as TNF-α on CRP also seems to be important. TNF-α is among the cytokines that are released from fat tissue and other tissues and leads to the increase of IL-6. However, it has been found that exercise has an effective role in reducing TNF-α levels and increasing IL-6. Therefore, changing the amount of inflammatory cytokines due to sports activity is also effective in reducing CRP (48).

Conclusion

It seems that eight weeks of training in water leads to improvement of pain and disability in patients with non-specific chronic back pain. In the meantime, the reduction of inflammation caused by these exercises probably plays a role. However, we need more studies in this field.

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