Effect of 8-Week Core Stabilization Exercises on Low Back Pain, Abdominal and Back Muscle Endurance in Patients with Chronic Low Back Pain due to Disc Herniation

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ABSTRACT

Purpose: The aim of this study was to investigate the effect of core stabilization exercises on low back pain and abdominal and back muscle endurance in patients with chronic low back pain caused by disc herniation.

Methods: For this purpose, 30 male and female patients with chronic low back pain due to disc herniation (age =48.55 ± 3.35) were divided into experimental and control groups (n=15). The experimental group underwent 8-weeks core stabilization exercises; whereas the control group received conventional treatment at the same time. Analysis of covariance test was used to analyze the data. VAS scale, trunk flexion endurance test, and modified Biering-Sorenson test were used to assess variables, abdominal muscle endurance and back muscle endurance, respectively.

Results: Results showed that 8-weeks core stabilization exercises caused a significantly low back pain reduction (P=0.001) and a significant increase in abdominal muscle endurance (P=0.001) and back muscles endurance (P=0.001) in the experimental group compared to the control group.

Conclusion: According to the findings of the study, core stabilization exercises in improving low back pain, abdominal and back muscle endurance in patients with chronic low back pain caused by disc herniation have been effective. Hence, cautious prescription of core stabilization exercises for these patients would be beneficial.

1. Introduction

Low back pain is one of the most common health problems in different communities of the world, especially in industrialized countries. According to the current statistics, about 80 % of people in these countries is affected by this problem at least a period of time during their life [1,2]. In general, low back pain can be classified as a variety of mechanical, rheumatic, infectious, tumoral, psychological, etc. The mechanical back pain is the most common form of back pain and 90% of cases suffer from this pain [3]. Although it is very difficult to define chronic pain, but most clinicians reported that if the pain does not be relieved after 6 to 12 weeks, it will alter to chronic pain [1,2]. Different factors cause back pain including aging, smoking, chronic stress, trauma, nutrition disorders and genetic factors, weight gain, lifting heavy weights incorrectly, decreased flexibility, decreased disc fluid, and in other words, the poor physical conditions of individuals, all reduce the efficiency of a disc placed in the spinal cord [4-7]. Treatment by improving the coor-

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dination, flexibility, endurance, and strength of muscles through proper exercises will return the balance and proper function of muscles and joints; thereby, the problem of disc herniation will be solved by two main ways [5]. In this regard, even if the pain medication or surgery be used, the problem may be temporarily solved but bad moods or in other words, poor physical function of the body makes the problem be recurred soon and again [6].

Results of researches suggest that exercise therapy for treatment of low back pain is more effective than common treatments [8,9], fitness programs, and general sports [9]. Most of the contemporary perspectives are on the basis of this theory that the frequent micro-trauma to structures of the spine, and poor control and stabilization are the causes of low back pain [8,9]. It is suggested that exercise not only improve the function of patient but also reduces the pain and significantly increases the strength and endurance of patient. Also, these patients have the chance of being safe from surgery or recurrence of low back pain. Studies have shown that there are flexibility, movement, strength and endurance exercises are performed for abdominal muscles, the trunk extensors, latismousdorsi, transverse abdominal muscles, abdominal obliqueous muscles, multifidus muscles and extremities muscles with aerobics and core stabilization exercise in routine program of patients with chronic low back pain [10,8]. Few studies have been performed about effect of core stabilization exercises on pain, disability, and physical function of patients with chronic low back pain resulting from disc herniation. Due to the increasing rate of spine problems among subjects, physical complications, high costs for treatment, spine damages lead to lengthy absences of subjects from daily living activities and exercise. One of the aims of core stabilization exercises is to train the body to use the middle and outer layers of the muscles properly. These exercises can be done by all individuals. It is assumed that these exercises activate main muscles and improve posture and significantly reduce the pressure on the spinal cord [11].

Currently, there are little evidences that show core stabilization exercises are more effective than other treatments but due to the importance of these exercises as an effective method, these exercises are used to reduce the disc herniation-related pain and returning the patients to their daily activities. Considering the importance of the issue and its high costs, prevention and treatment of low back pain caused by disc herniation, seems essential. In last decades, the question that what is the proper exercise has remained an open question because of the controversy on the cause of this pain. Therefore, the aim of this study was to investigate the effect of core stabilization exercises on chronic low back pain due to disc herniation to provide nonpharmacological and nonsurgical treatment for patients with low back pain caused by disc herniation.

2. Methods

Patients with chronic low back pain caused by disc herniation who referred to physiotherapy department of a medical clinic in Tehran were included in this study. At first, the patients were examined by related expert in the clinic, and then their radiological findings were studied. The patients who participated in this study should had no significant canal stenosis, osteoporosis, osteoarthritis, cancer or its history, infection (fever and clinical symptoms), the spine surgery, history of accident or direct trauma, urinary and gastrointestinal problems and more than six deliveries (in women). Their Straight Leg Raising Test (SLR) should also be positive within more than 30 ° because if there were conflict in disc, leg raising would be limited about 30 °. In addition, pain ranging 70 to 90° could indicate nerve stimulation without disc herniation. Positive Cross-SLR test that represents a major problem in the disc (disc herniation into the nerve root) is used. Straight leg raising is used for the uninvolved side; raising healthy leg of the patients causes pain in involved leg shows that test is positive. Laseque,s Test that is performed on patient in supine position inactively; when the leg is in full open position and hip in internal rotation and adduct position, flex the hip slowly until the patient report the pain in the low back or leg or feel inflexibility at hip back, and again flex the knee to relieve the pain slightly; positive response occurs when the patient report low back pain as experienced before. Normal range should be 80 to 90 ° and if there is a disc conflict, the test is positive. In negative femoral test that is actively performed in prone position, the knee is in flexion position and hip in extension position. If the test is positive, disc herniation is at the L2-L3 and L3-L4, and if the test is negative, disc herniation is at the L5-S1. The patients while walking on the toe or heel, showed obvious weakness and also showed appearance and exacerbation of symptoms in back flexion and a reduction in symptoms of back extension.

Considering the above-mentioned conditions, 30 available patients (15 men and 15 women) with chronic low

back pain caused by disc herniation who met the inclusion criteria of this study were included. An informed consent in the form of written and oral was gathered from all subjects to participate in this study, and patients were randomly divided into two experimental groups (n = 15) and control (n = 15) groups. Using available sampling, participants were selected from patients who referred to pain control clinic. The inclusion criteria for the study were that patients with chronic low back pain caused by disc herniation should have a history of more than three months pain (age range, 69/2±78/47=) and the type of their disc herniation should be the posterior and lateral at the L4 -L5, or L5-S1, respectively.

All assessments and measurements before and after the exercise program were conducted by the researcher under the supervision of a physiotherapist. After classification of the participants in the pre-test, to assess the pain and abdominal and back muscle endurance, visual analogue scale (VAS), trunk flexion endurance test, and modified Biering-Sorenson test were used. After measuring the data in pre-test, to obtain the other required information, the researcher applied independent variable that is the core stabilization exercises for 8 weeks, 3 times a week for an hour (on Saturday, Monday and Wednesday), by a physiotherapist and a coach, in the experimental groups.

As mentioned before, core stabilization exercises include stretching and strengthening exercises are different. In this study, core stabilization exercises were used, respectively as following:

- 9 stretching exercises: Quadriceps stretching in a prone position, stretching the hip flexors at the launch, stretching adductors in standing out front position, stretching hamstring in standing out front position, dynamic stretching of hamstring in supine position, stretching Iliotibial band in side position the, stretching Iliotibial band in cross-standing position, stretching gluteals in standing out front position, cat camel exercise.

- 18 elementary strengthening exercises: Hip rotation in supine position using a ball, pulling in the abdomen in the supine position, pulling in the abdomen in the supine position with flexed knees into the chest, pulling in the abdomen in the supine position by sliding heels on the ground, pulling in the abdomen in supine position by flexing both knees into the chest, rotating trunk using the legs in the supine position, the elbow bridging, elbow bridging to the side, upward pressing on the ground in a prone position, Cobra in the prone position, the Superman in the supine position, upward holding the arms and legs (arms and legs in opposite position), bridging in the supine position, bridging in the supine position by placing hands on the chest, bridging in the supine position on one leg, pulling in the abdomen in sitting position on a ball, pulling in the abdomen in sitting position on a ball and marching.

- 11 medium strengthening exercises: pulling in the abdomen in the supine position with a leg on the ball, doing the dead lift in supine position, flexing and rolling the body on the ground in shape of a ball, bridging on an elbow, bridging on an elbow to the side, moving arms and legs while raising them in opposite position with dumbbells, crunching on a ball, crunching on a ball with trunk rotation, bridging the head over a ball, bridging in the supine position by putting a leg on the ball, pulling in the abdomen with opening up the knee.

- 6 advanced strengthening exercises: bridging in a prone position and rolling on the floor, bridging to the side and moving the foot in different directions, putting arm and leg on a foam and raising them in the opposite position, , Russian rotation in sitting position while carrying medicine ball, bridging the head over the ball with a leg.

At the first session, basic principles of core stabilization exercises were explained and general information were given. These basic principles were applied at all session. At the beginning of each session after preparation of exercise arrangements, the exercise including checking posture (including the pelvis and spine) and stretching exercises with coach and physiotherapist description, were begun (about 10 minutes). The session was continued by doing modulated specific exercises (about 40 minutes). At the end of the session, cooling and recovery were also done (about 5 minutes). The exercises were started from elementary level and gradually progressed until the participants were able to control their spine in different positions. The intensity of exercises for each subject, were controlled based on the exercise tolerance and pain thresholds. Those who were absent more than three consecutive sessions were excluded from the study. At the end of the eighth week in post-test stage, again VAS, back extensor muscles endurance and abdominal muscles endurance were used.

To measure the pain intensity, visual analog scale (in percent), was used. It is a horizontal bar with a length of 100 mm or 10 cm that its one side is indicated as zero means no pain and the other side as 10 means the most severe pain. Its reliability and validity, and internal reliability is ICC=0.91 [12,13]. To measure the muscle endurance of posterior spine, modified Biering-Sorensen test was used [14]. In this test, the subject was placed in a prone position so that his pelvis was at the edge of the examination table. Knees, hip, and hip joint of participants were fixed firmly by another subject or belts. While the subject had placed her hands in cross position over his chest, upper trunk (from the hip joint to the top) was maintained in a horizontal position outside the edge of the table. In this situation, the subjects were asked to maintain the horizontal position of the body as much as possible. The amount of time that subjects could maintain a horizontal position was recorded as his record. When the horizontal position of the body was disturbed or the subject took the table with his hands, the stopwatch was stopped. The test was repeated three times and the best time as point of spine extensor muscles endurance was recorded in the registration form of the pre-test and post-test [14]. To measure abdominal muscle endurance, the trunk flexion endurance test was used. In this test, the subjects were placed in a sitting position with flexed knees so that the legs were on the bed and firmly fixed to the bed by a belt. Then, a board with angles of 55 ° relative to the bed was placed behind the subjects and the subject while his hands were on his chest in cross position, flexed his trunk close to the board and kept the position. When the subject lose endurance and touch the board, his time were over and recorded in registration form of the pre-test and post-test . The knee and hip of the subjects were in flexion position of 90 °, and the arms in cross position in front of the chest, and hands on shoulders. An assistant fixed legs in order to keep the position [15]. Goniometer, was also used to measure the angles. After data collection, descriptive statistics including frequency distributions, central and dispersion indicators were used. Also, the inferential statistics Kolmogorov-Smirnov test (for normal data distribution) and analysis of covariance (to measure the mean difference) were used significantly (P≥0.05). To determine the status, the dependent t-test related to modification of freedom rate in Bonferroni method was used. In order to data analysis, software SPSS version 20 was used.

3. Results

When Kolmogorov-Smirnov test showed that data distribution was normal, in order to assess the homogeneity of covariances, Levine test was used that confirmed the homogeneity of covariances (37/0 P =). Accordingly, in order to assess the dependent variables, analysis of covariance was used. The results show that the difference between the two groups in pain intensity (F1, 26)=142.65; p=0.000; η^2 =0.84); abdominal muscle endurance (F1, 26)=65.64; p=0.000; η^2 =0.71) and back muscle endurance (F1, 26) =57.59; p=0.000; η^2 =0.68) is significant. It is worth mentioning that the pre-test values are considered as the covariance factor. The differences between the two groups in terms of mean differences are shown in Table 3.

Table 1. Mean and standard deviation of pre-test and post-test dependent variables in the experimental group.

Groups	Stage / Variables	Pre-test (M±SD)	Post-test (M±SD)
Experimental Group	Pain Intensity	1.89±3.67	0.78± 0.25
	Abdominal Muscle Endurance	8.23±26.71	6.35±41.28
	Back Muscle Endurance	8.14±33.46	7.10± 48

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Table 2. Mean and standard deviation of pre-test and post-test variables in the control group.

Groups	Stage / Variables	Pre-test (M±SD)	Post-test (M±SD)
Control Group	Pain Intensity	1.30±4.83	1.32±4.93
	Abdominal Muscle Endurance	6.04±26.14	4.39± 25.06
	Back Muscle Endurance	5.55±31.40	7.25± 27.60

PHYSICAL TREATMENTS

Table 3. The differences between experimental and control groups in terms of mean differences.

Dependent Variables	Group (I)	Group (J)	Mean (I-J)	Standard Deviation	P value	Minimum	Maximum
Pain	Experimental	Control	3.73-	0.31	0.000*	37.4-	09.3-
Abdominal Muscle Endurance	Experimental	Control	16.11	1.99	0.000*	12.01	20.20
Back Muscle Endurance	Experimental	Control	20.69	2.72	0.000*	15.08	26.29

* P≤0.05 was considered significant.

Figures (1), (2), and (3) show the pre-test and post-test differences of the two groups in different variables.

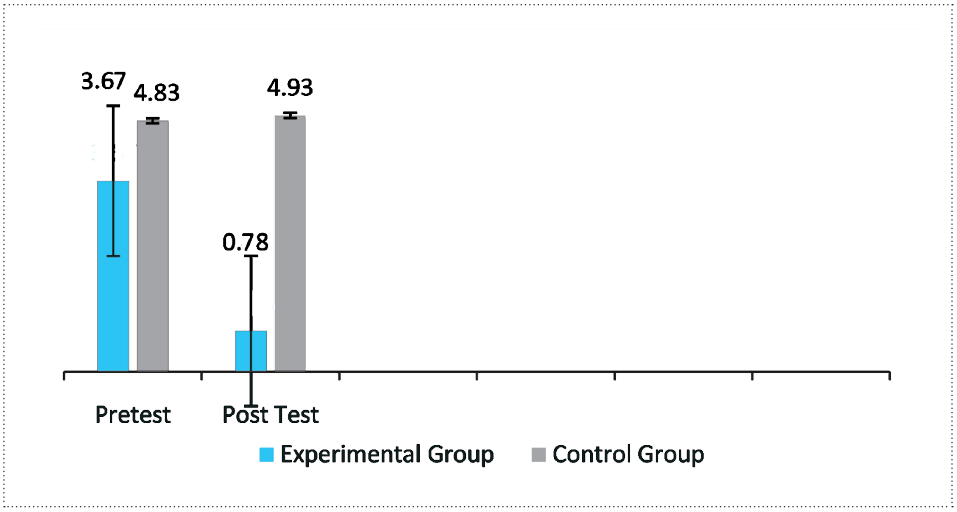

Figure 1. The mean of pre-test and post-test of experimental and control groups in pain intensity.

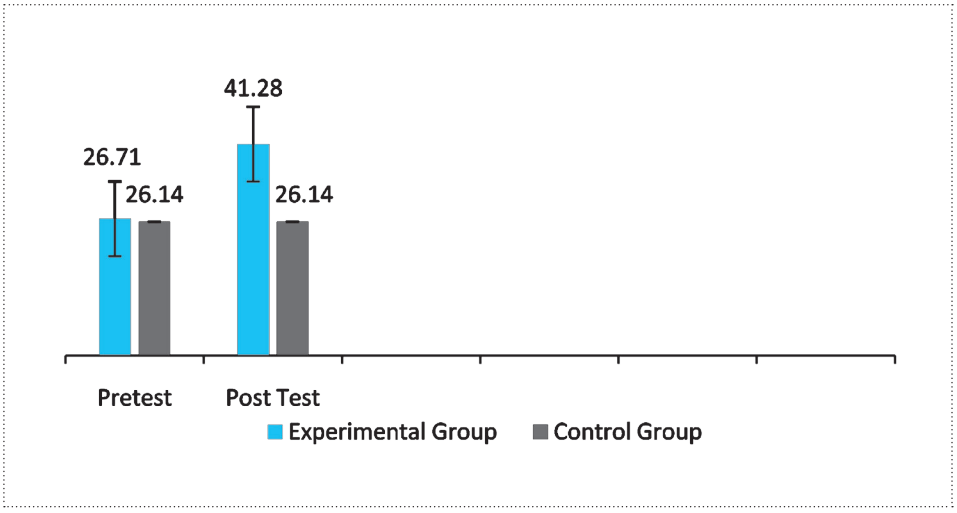

Figure 2. The mean differences of pre-test and post-test of experimental and control groups in abdominal muscle endurance.

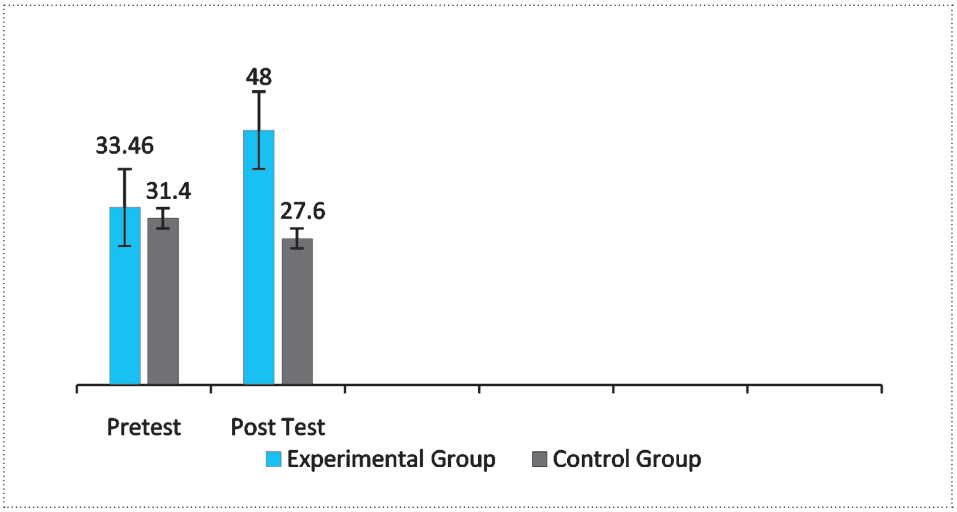

Figure 3. The mean differences of pre-test and post-test of experimental and control groups in back muscle endurance.

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4. Discussion

In this study, the effect of core stabilization exercises on pain and lumbar muscles endurance in patients with chronic low back pain caused by disc herniation was studied. Findings of this study show significant difference between the intensity of pain in the experimental group (with core stabilization exercises) and control group (with no exercise). Therefore, eight-week core stabilization exercises significantly reduce the intensity of pain. These results are consistent with findings of Nezhad Roomezi who examined the impact of core stabilization exercises on female patients with chronic nonspecific low back pain [16] and Bakhtiari who studied the effect of core stabilization exercises on improving the daily activities of patients with disc herniation [17].

Factors that cause chronic pain include: loss of the strength, flexibility and endurance of trunk muscles and excessive pressure on the lumbar spine that can be due to improper standing and sitting position of the body. Core stabilization exercises strengthen the deep muscles of the back area like Multi fidus and transversus abdominal muscles, enhance coordination, enhance trunk stabilization and reduce the pressure on spine and subsequently reduce the low back pain. Thus, this method can be used to prevent chronic low back pain and reduce the pain in patients with disc herniation. The effect of core stabilization exercises on neuromuscular performance of patients with chronic low back pain has been demonstrated [18]. Local stabilizers including multifidus, transversus abdominal and obliqueous muscles are small deep muscles that bind the spine vertebra together and stabilize them. In contrast, there are large right abdominal muscles and lumbar muscles that are responsible for production of the main movement of the back. In patients with low back pain, controlling the trunk muscles is failed and deep muscle activity is reduced [19]. Core stabilization exercises with maximal or submaximal effort reverse the selective atrophy of type II in multifidus muscle and affect the diameter of muscular fibers [20]. There is a relationship between increasing the cross-sectional area of multifidus muscles and reduction of pain in patients who did stabilization exercises [21]. The results of this study show that stabilization exercises enhance the endurance of central part of the trunk, reduce tension on the ligaments and joints of the spine, fix them in normal position, reduce the pain intensity, and make patients to trust to the treatment method.

Findings of this study showed that there is a significant difference between abdominal muscle endurance of the experimental group (with core stabilization exercises) and control group (with no exercise) after the intervention. The results of our study is consistent with findings of Karimi who examined the impact of intensive functional exercises with stabilizers of the spine in patients with chronic non-specific low back pain [22], with findings of Ali who assessed the effects of Pilates on pain intensity, disability and endurance of trunk flexor and extensors muscles in female patients with chronic low back pain [23], with findings of Gib-

son who evaluated the effect of Pilates on trunk flexor and extensors muscles reviewed [24], and with findings of Sekendiz who studied the effect of a new period of Pilates with matt on strength, flexibility and endurance of trunk [25].

Weakness and decreased strength of muscles around the spine is as a prominent and potential factor in the etiology of low back pain. In this regard, particular attention is given to transversus abdominal and obliqueous muscles because these muscles can control the motion and stabilize the spine. Muscular endurance is the main factor to evaluate physical fitness and functional ability of the human body. In this regard, most of the researches have been evaluated the role of trunk muscles in protecting the spine from harmful pressures [26]. These muscles help the body to maintain a natural posture and control the body while flexing and extending. Based on the theory, reduction of trunk muscle endurance lead to muscle fatigue and increased pressure on the soft tissues and inactive structures of the spine [26]. Also, because the muscles endurance capacity indicates the fatigue of muscles, it is believed that people with less muscular strength in trunk muscles, are more prone to structural pressures; it may cause inappropriate pressure on the spine and chronic low back pain [28, 26]. Williams believe that because the human posture is more likely to be seated, during daily activities, it makes back muscles being under pressure and abdominal muscles being in rest position and weaken. Therefore, in his view, the trunk muscles should be given exercises. Findings from this study showed that there were significant differences between lumbar muscle endurance of the experimental group (with core stabilization exercises) and control group (with no exercise) after the intervention. Hence, eight-week core stabilization exercises have significant effect on increasing the lumbar muscle endurance of the patients.

The findings of this study is consistent with findings of Karimi who examined the impact of intensive functional exercises with stabilizers of the spine in patients with chronic non-specific low back pain [22], and with findings of Aggarwal who assessed the effect of core stabilization exercises on lumbar muscle endurance in active subjects [29].

Factors such as proprioception, proficiency of stabilizer of the spine and trunk, and muscle endurance in patients with low back pain are varied. Clinically, increasing the level of activity of local muscles as well as reducing and delay in activity of deep stabilizer muscles of the trunk and spine is considered as an objective marker of dysfunction of stable system in patients with chronic low back pain. Researches show that there is a significant correlation between low back pain and back muscles endurance [30]. Hence, good muscular endurance and coordination of the involved muscles are the most important factors in prevention and treatment of musculoskeletal disorders such as chronic low back pain.

The eight-week core stabilization exercises are effective in reducing pain and disability and increasing abdominal and back muscle strength and endurance in patients with chronic low back pain caused by disc herniation. In patients with disc herniation like patients with low back pain, trunk muscles are weak and disable and as for spinal stabilization, there is a significant correlation between global and local muscular system, in this study, doing core stabilization exercises, both group of muscles were strengthen. Although having stronger muscles reduces pressure and mechanical damage to the bones, but it seems that having more muscular strength in the central area of the body lead to stabilization of vertebra by enhancing more stabilization in local muscles and can reduce the damages to the nerve roots and pain in lumbar muscles. Therefore, strengthening endurance of muscles around the spine is effective in reducing the pain and recovery of patients with chronic low back pain caused by a disc herniation. Core stabilization exercises in addition to the strength, highlight the endurance and proprioceptive receptors. Patients' awareness about normal position of spine for proper activities and the ability to maintain the proper posture and core stabilization of central muscle is the main key for these exercises.

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