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ARTICLE

# A Study on the Effect of Core Strength Strengthening Training on Exercise-Induced Lumbar Injuries

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**ABSTRACT**

**Objective:** This study aims to analyze the effect of core strength strengthening training on exercise-induced lumbar injuries. **Methods:** Sixteen athletes suffering from lumbar injuries were randomly divided into two groups, group A and group B. Group A performed core strength strengthening training, while group B only performed normal study and life. Before and after the experiment, the Visual Analogue Scale (VAS) score, lumbar spine mobility, Oswestry Disability Index (ODI) and overall effect evaluation of the two groups were recorded and compared. **Results:** After the experiment, the VAS score of group A decreased to 2.78 ± 1.89 points, the anterior flexion distance was 0.85 ± 0.03 cm, the left lateral flexion distance was 4.97 ± 0.02 cm, and the right lateral flexion distance was 3.32 ± 0.02 cm, and the ODI was 15.68 ± 6.73% ($p < 0.05$ compared to group B before and after the experiment). Overall, in group A, two athletes were cured, four athletes had significant improvements, and two athletes had a mild response, while the treatment was ineffective in group B. **Conclusion:** Core strength strengthening training enhances lumbar muscle strength and improves lumbar stability, showing a significant improvement effect on lumbar injuries.

**KEYWORDS**

Core strength; lumbar injury; training; lumbar spine mobility

## 1 Introduction

The lumbar region is a weight-bearing part of the human body with complex anatomy and various types of lesions [1]. Lumbar injury is a common injury [2,3], including injury to lumbar muscles and ligaments [4]. Lumbar injury is especially common in athletes [5]. In daily sports training, athletes are prone to minor lumbar injuries or sprains due to insufficient warm-up and overloading of the lumbar region, and such conditions, if not treated in a timely manner or treated incompletely, can easily lead to lumbar injuries, which will not only affect the effectiveness of training, but also be detrimental to the physical health of athletes. Softball [6], high jump [7], gymnastics [8], and soccer [9,10] have a high likelihood of causing lumbar injury; therefore, the treatment of lumbar injury has received a lot of attention from researchers. Feng et al. [11] studied the rehabilitation effect of massage combined with thermomagnetic therapy on lumbar injury and found that the therapy significantly improved the lumbar muscle strength and spinal column activity after two to four weeks of treatment and could be promoted in clinical applications. Lu et al. [12] compared the efficacy of Tai Chi exercise and auricular acupressure treatment for lumbar injury

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by treating 74 patients for 12 weeks. The lumbar injuries of the two groups had different degrees of improvement after 12 weeks ($p < 0.05$). Li et al. [13] conducted a comparative analysis of acupuncture and cupping triple therapy and combined exercise and massage therapy and found that there were significant differences in Visual Analogue Scale (VAS) score between the two methods and that combined exercise and massage therapy was more effective for lumbar injuries. Li et al. [14] compared the effect of acupuncture combined with celecoxib and celecoxib monotherapy on lumbar injuries. Six patients were randomly divided into two groups. All of them took celecoxib, but the observation group was treated with acupuncture in addition to the medication. They found that the combined therapy was superior to monotherapy. In this study, an experiment was conducted with 16 athletes to study the improvement effect of core strength strengthening training on lumbar injuries, in order to provide some theoretical bases for reducing and improving lumbar injuries in athletes.

## 2 Research Subjects and Methods

### *2.1 Research Subjects*

Sixteen athletes suffering from lumbar injuries at the University of Electronic Science and Technology of China were used as study subjects. The diagnostic criteria included:

(1) having a long history of lumbar pain, with recurrent episodes;

(2) without significant impairment of lumbar movement;

(3) having aggravated pain after fatigue and relieved pain after rest.

These athletes were all certified by specialists at Sichuan Provincial People's Hospital as having moderate lumbar muscle strain. In addition, the athletes had no severe trauma, no limb injury in the last year, no cardiovascular disease, and no history of lumbar and spinal surgery. All of them understood the purpose and content of the experiment and signed the informed consent. The athletes were randomly divided into two groups, group A and group B. Group A underwent core strength strengthening training, and group B lived a normal life without additional training. The general data are shown in Table 1.

**Table 1:** General data of the study subjects

| | Group A (n = 8) | Group B (n = 8) |
|---|---|---|
| Age/years | 22.34 ± 1.12 | 21.69 ± 1.09 |
| Height/m | 181.35 ± 4.62 | 179.92 ± 5.87 |
| Body weight/kg | 80.42 ± 3.08 | 79.28 ± 2.12 |
| Training time/year | 7.62 ± 1.64 | 6.97 ± 1.89 |

### *2.2 Research Methodology*

Before the formal experiment, ten healthy athletes were first selected for a pre-experiment to see if the difficulty and time load of the protocol would have an effect on the athletes' backs and to ensure that it was error-free. The experiment was conducted in a gym for eight consecutive weeks. Group A was trained from 15:00 to 16:00 on Monday, Wednesday and Friday of each week, including 15 min of preparation activities, 30 min of core strength strengthening training and 15 min of relaxation activities. Group B did not perform any exercise except for normal study and life. The training movements of group A included:

(1) Taking a supine position with hips thrust out: The subject bent the knees, lay on his back, placed his hands on either side of the body, separated two legs by about 10 cm, and tucked the abdomen so that the trunk and thighs were in the same plane.

(2) Taking a supine position with legs lifted: The subject took a supine position, lifted the head slightly off the ground, straightened two legs to make the heel keep a distance of 15 cm with the ground, lifted the legs to form an angle of 45° with the ground, and put down legs after 3 s.

(3) Lying on the side with scissor legs: The subject lay on the left side, raised the right leg to keep the body on an upright surface, held the leg at the highest point, and put down the leg after 3 s. When the right leg was exhausted, the subject lay on the right side and did the same movement.

(4) Lying on the side with hips lifted: The subject lay on the right side. The right hand supported the ground, and the left hand crossed at the waist. The torso and legs were in the same plane. The left leg was stacked on the right leg. The hips were lifted and dropped slowly. The movement was repeated on the right side ten times, followed by the left side.

(5) Taking a supine position and cycling: The subject took a supine position and held his head with both hands. One leg extended and kept about a distance of 10–15 cm away from the ground. The other leg knee flexed to the chest to reach the elbow on the opposite side and then extended. Afterward, the other leg was flexed to reach the elbow on the opposite side. The left and right sides were alternated.

(6) Cross: The subject took a supine position and opened his hands with palms facing up. He straightened two legs to make them form an angle of 90 degrees with the body. The head was slightly lifted off the ground. The legs moved towards the right side to form an L shape with the body and lifted to the original position before touching the ground. Then the legs moved towards the left side and repeated the above movement.

(7) Taking a prone position and lifting limbs: The subject took a probe position, extended two hands forward, lifted the limbs upward. The torso and hip joints were close to the ground. The limbs stayed at the highest point for 3 s and then slowly put down.

(8) Crunching: The subject bent the knees, crossed the arms in front of the chest, and curled the abdomen so that the elbows were close to the thighs.

(9) Placing legs on the ball: The subject put legs together on a Swiss ball, kept a 90° angle between the arms and the body, made the spine parallel to the ground, and breathed as usual.

(10) Squatting on the ball: The subject stood on a Swiss ball with legs separated and squatted.

Every movement was repeated ten times. The athlete rested one minute before doing the next time of movement and rested two minutes before doing the next movement.

### *2.3 Research Indicators*

(1) Visual analog scale method (VAS) [15]: An 11 cm paper slip (Fig. 1) was provided for a selection of the pain level, and the pain level scale is shown in Table 2.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1cm | 2cm | 3cm | 4cm | 5cm | 6cm | 7cm | 8cm | 9cm | 10cm | 11cm |

**Figure 1:** VAS scale

(2) Schober experiment [16]: The athlete stood on the ground. The researcher made a mark on the position where the line of the athlete's two posterior superior iliac spines and the spine intersected. Taking the mark as the starting point, another mark was made 10 cm above it (Fig. 2). The athlete straightened both knees and bent the waist with full force to do forward flexion. The distance between the two marked points was measured by the researcher. After the forward flexion measurement, the athlete took the standing position, straightened the arms to stick to the middle point of the legs, and straightened

both knees. The researcher made a mark at the tip of the athlete's middle finger. Then, the athlete's body was flexed to the left and right side, but the knees were not flexed. The researcher made another mark at the athlete's middle finger. Then, the athlete's lumbar spine mobility was obtained. Every athlete was measured three times, and the average value was taken.

**Table 2:** Pain levels

| Grade | Pain level |
|---|---|
| 0 | No pain |
| 1–3 | Mild pain |
| 4–6 | Moderate pain |
| 7–9 | Severe pain |
| 10 | Extreme pain |

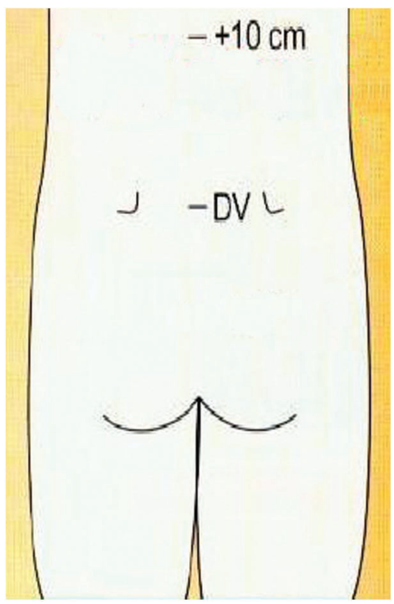


**Figure 2:** A sketch map of Schober experiment

(3) Oswestry dysfunction index (ODI) questionnaire [17]: It was used to evaluate the degree of limited dysfunction in lumbar pain. Every question had six options. The score of option 1 was zero, and the score of option 6 was five; the total score was 50 points. The scoring method is: the sum of the actual scores/50 × 100%.

(4) Overall role evaluation; recovery index = (total pre-experimental score–total post-experimental score)/total pre-experimental score × 100%. There were four levels, as shown in Table 3.

**Table 3:** Evaluation of the overall efficacy

| | |
|---|---|
| Cured | Total score reduction ≥ 90% |
| Significantly effective | Total score reduction ≥ 60%, < 90% |
| Effective | Total score reduction ≥ 30%, < 60% |
| Ineffective | Total score reduction < 305 |

### *2.4 Statistical Analysis*

The experimental data were recorded and sorted in Excel and then statistically analyzed in SPSS 17.0 software. The data were expressed by x ± s. If $p < 0.05$, the difference was statistically significant.

## 3 Study Results

The selection results of VAS of groups A and B before and after the experiment are shown in Table 4.

**Table 4:** The selection results of VAS

| Group A | Before experiment | After experiment |
|---|---|---|
| 1 | 4 | 3 |
| 2 | 4 | 3 |
| 3 | 5 | 3 |
| 4 | 3 | 2 |
| 5 | 3 | 2 |
| 6 | 4 | 3 |
| 7 | 5 | 4 |
| 8 | 3 | 3 |
| Group B | Before experiment | After experiment |
| 1 | 3 | 3 |
| 2 | 4 | 4 |
| 3 | 5 | 4 |
| 4 | 5 | 4 |
| 5 | 4 | 4 |
| 6 | 3 | 3 |
| 7 | 5 | 5 |
| 8 | 4 | 4 |

The VAS scores of the two groups are shown in Fig. 3.

It was seen from Table 4 that there was no significant difference in the selection of VAS between groups A and B before and after the experiment; the pain degree selected by group B after the experiment was not significantly different with that before the experiment, but the pain degree selected by group A after the experiment reduced compared with that before the experiment. It was seen from Fig. 3 that there was no difference in VAS scores between groups A and B before the experiment, and the score was

3.87 ± 1.72 points in group A and 3.76 ± 1.73 points in group B ($p > 0.05$); after the experiment, the VAS score in group A decreased to 2.78 ± 1.89 points, which showed a significant decrease compared to the pre-experiment ($p < 0.05$), while the score of group B was 3.62 ± 1.68 points, which was not significantly different compared to the pre-experimental group, but compared to group A, $p < 0.05$.

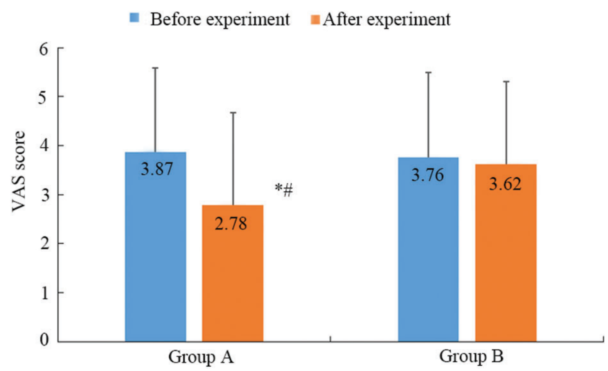


**Figure 3:** Comparison of VAS scores. *: $p < 0.05$ compared to pre-experiment; #: $p < 0.05$ compared to post-experimental group B

The results of lumbar spine mobility in groups A and B before and after the experiment are shown in Table 5.

**Table 5:** Comparison of lumbar spine mobility

| | Before the experiment | | After the experiment | |
|---|---|---|---|---|
| | Group A (n = 8) | Group B (n = 8) | Group A (n = 8) | Group B (n = 8) |
| Forward flexion/cm | 0.15 ± 0.01 | 0.14 ± 0.02 | 0.85 ± 0.03*# | 0.15 ± 0.02 |
| Left lateral flexion/cm | 4.02 ± 0.03 | 4.04 ± 0.02 | 4.97 ± 0.02*# | 4.05 ± 0.01 |
| Right lateral flexion/cm | 2.16 ± 0.02 | 2.18 ± 0.03 | 3.32 ± 0.02*# | 2.17 ± 0.03 |

Notes: *: $p < 0.05$ compared to pre-experiment. #: $p < 0.05$ compared to post-experimental group B.

It was seen from Table 5 that groups A and B showed no difference in lumbar spine mobility and had similar distances in anterior flexion, left lateral flexion, and right lateral flexion before the experiment ($p < 0.05$), while the anterior flexion distance in group A increased to 0.85 ± 0.03 cm, the left lateral flexion distance increased to 4.97 ± 0.02 cm, and the right lateral flexion increased to 3.32 ± 0.02 cm after the experiment, which showed significant increases compared to group B before and after the experiment ($p < 0.05$).

The ODI of groups A and B before and after the experiment are shown in Fig. 4.

Higher ODI value indicated greater degree of functional limitation of the human body in daily life. The comparison of the ODI before and after experiment could help understand the clinical effectiveness of core strength strengthening training for lumbar injuries. It was seen from Fig. 4 that the ODI of groups A and B was 31.27 ± 10.12% and 32.08 ± 9.98% before the experiment, respectively, showing that two groups of athletes had no statistical difference in the ODI before the experiment ($p > 0.05$). After the experiment, the ODI of group A decreased to 15.68 ± 6.73%, which showed a significant decrease compared to the pre-experiment ($p < 0.05$), and the ODI of group B was 30.69 ± 8.95%, which showed no significant change compared to pre-experiment ($p > 0.05$), i.e., the ODI of group B nearly had no changes and kept stable after the eight-week experiment. After the experiment, the comparison between groups A and B showed that $p < 0.05$, indicating that the lumbar pain of athletes in group A significantly relieved after core strength strengthening training.

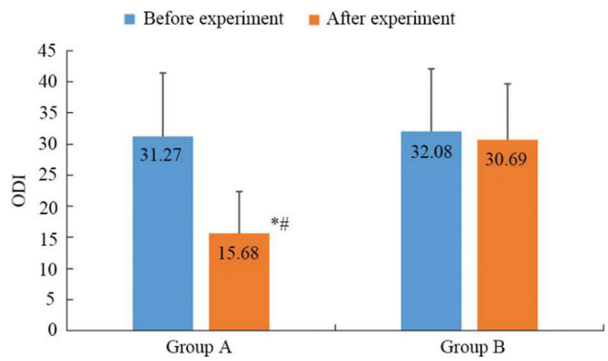


**Figure 4:** Comparison of ODI. *: $p < 0.05$ compared to pre-experiment; #: $p < 0.05$ compared to post-experimental group B

Finally, a comparative experiment was conducted to evaluate the overall effect of lumbar injuries in both groups of athletes, and the results are shown in Fig. 5.

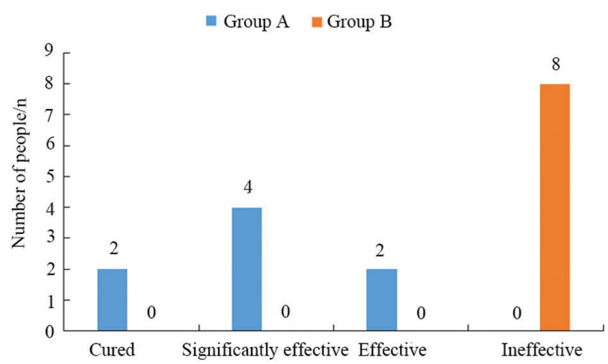


**Figure 5:** Evaluation results of the overall experimental efficacy

It was seen from Fig. 5 that two people in group A were finally cured, accounting for 25%, four people had significant efficacy, accounting for 50%, and two people had effective efficacy, accounting for 25%, and there was no ineffective case; the final evaluation results of group B were all ineffective, accounting for 100%, which indicated that group A showed more or less improvement under the effect of core strength strengthening training and group B which lived and worked normally had no relief in lumbar injuries.

## 4 Discussion

Long-time, high-intensity sports training will bring great load and fatigue to the lumbar region. Some fixed movements in sports training are easy to cause static muscle strain or improper muscle load [18], and improper movements, tumbling [19], and sprain in the lumbar region can also cause different degrees of lumbar injury. Lumbar injury is usually manifested as swelling or pain in the lumbar region, and some patients may feel stabbing or burning pain. When in a state of fatigue, the pain will be more severe so that the bending movements cannot be maintained, and there will be pressure pain points in the lumbar region, such as in the sacrococcygeal muscle and the dorsal iliac spine. At present, there are methods such as physical therapy [20], massage [21], acupuncture [22], electrotherapy [23], physical exercise therapy [24], and medicine [25] for the treatment of lumbar injuries.

The "core" refers to the part between the shoulder joint and the hip joint, which has a very important role in the posture and stability of the human body. Training for core strength can enhance the stability of the limbs and improve the control of the body. The reason why the human body will have back injury is that the back is not strong enough to support the body for movement; therefore, training can enhance muscle strength, improve the stability of the joints, and strengthen body coordination; under the same intensity of movement, the possibility of causing lumbar injury will be reduced.

The experiment found that core strength strengthening training significantly reduced the VAS score of the athletes in group A, indicating that lumbar pain was greatly relieved after the experiment, and group A was significantly different from group B before and after the experiment ($p < 0.05$). Under the effect of core strength strengthening training, the muscle strength of the lumbar region was effectively enhanced, the stability of the spine was improved, and the flexibility of the ligaments was also improved, which reduced and avoided sprains brought about by stiff ligaments. In addition, the training also strengthened blood circulation and relieved muscle spasms, thus improving the pain of the lumbar region. Then, the scores of lumbar spine mobility suggested that the lumbar spine mobility in group A was also significantly improved after the experiment, which was significantly different with that in pre-experimental and post-experimental group B ($p < 0.05$). After eight weeks of core strength strengthening training, all the lumbar muscles were activated and strengthened, and the muscle strength was enhanced, thus improving the imbalance of the lumbar spine and increasing the mobility of the lumbar spine. The ODI demonstrated that the ODI of athletes in group A decreased significantly after the experiment, which was significantly different from that in pre-experimental and post-experimental group B ($p < 0.05$). The above result indicated that the athletes showed great changes in the degree of physical limitation in daily life and reduced the pain of lumbar injury after the core strength strengthening training. Finally, the evaluation results of the overall effect showed that the effect of core strength strengthening training on the lumbar injury was very significant, and the athletes in group A all showed different degrees of mitigation in lumbar injury. Therefore, for athletes with lumbar injuries, the future training should not only focus on the training of the technical movements of athletes but also strengthen the training of lumbodorsal muscles. The core strength strengthening training is integrated into daily training scheme to improve the lumbar muscle strength and joint stability and the ability to control the body, which can enhance physical fitness and prevent and relieve lumbar injury.

The study of core strength strengthening training in this paper verifies its improvement effect on lumbar injury. Core strength strengthening training can effectively relieve lumbar pain, improve lumbar muscle strength, and remit the degree of limitation in daily life. This method can be applied not only in the daily training of athletes to help prevent and improve lumbar injury and improve training effect but also in the physical exercise of the general public to prevent lumbar injury and protect the normal function of the lumbar region. However, there are some shortcomings in this study. For example, the sample size of the study was small, and the compared indexes were not comprehensive enough, which need to be improved in further research.

## 5 Conclusion

This paper mainly studied the effect of core strength strengthening training on the lumbar injury of athletes. The experiment of 16 athletes suffering from lumbar injury found that the VAS scores of athletes decreased significantly, the lumbar spine mobility improved significantly, and the ODI decreased significantly after eight weeks of core strength strengthening training, which was significantly different compared with the pre-experimental and post-experimental group B ($p < 0.05$). The evaluation of the overall efficacy also found that lumbar injuries in group A showed different degrees of relief, verifying the effectiveness of core strength strengthening training for lumbar injuries. Core strength strengthening training can be promoted and applied in practice.

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**Conflicts of Interest:** The author declares that they have no conflicts of interest to report regarding the present study.

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