

# Current Trends in Exercise Management for Chronic Low Back Pain: Comparison between Strengthening Exercise and Spinal Segmental Stabilization Exercise

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**Abstract.** Exercise is recognized as one of the optimal managements for chronic low back pain. Among the numerous therapeutic exercises, the approaches of traditional strengthening exercise and segmental stabilization exercise are considerably different. The purpose of this study was to compare the effectiveness of the two different exercise approaches, on chronic low back pain through evaluating previous randomized control trial (RCT) studies. Pain, functional ability and physical improvement were analyzed to evaluate the recovery from chronic low back pain. While both exercises demonstrated positive effects on pain relief, functional ability and physical improvement, the evidence level of the strengthening exercise studies was not strong enough because of some methodological flaws. On the other hand, the methodological superiority of the segmental stabilization exercise studies provided high quality evidence. Another positive aspect of the segmental stabilization exercise studies was the significant long-term effect on low back pain and its low recurrence rate. Considering the overall evidence level, the segmental stabilization exercise seems to be more effective than the traditional strengthening exercise on chronic low back pain. However, the number of studies related to the segmental stabilization exercise is currently limited, therefore more direct comparative RCT studies including many other exercise approaches are necessary to confirm the effectiveness of the segmental stabilization exercise.

**Key words:** Low back pain, Exercise, Review

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## INTRODUCTION

Low back pain (LBP) is a common health problem. The expanding socio-medical costs associated with LBP has been a serious issue in many countries<sup>1)</sup>. It is reported that LBP is the second most frequent reason for visits to the physician in the US, and about 2% of the US workforce is compensated for LBP injuries each year<sup>2)</sup>. Although more than 70% of the population has LBP during their lifetime, the prognosis is

generally good. Approximately 80–90% of acute LBP patients recover within 6–8 weeks, regardless of the type of treatment received<sup>3)</sup>. Chronic low back pain (CLBP) is defined as a back pain that lasts more than three months<sup>4)</sup>. The enormous cost of LBP is not distributed evenly, and about 10% of patients with prolonged symptoms, 3 months or more, are responsible for 80% of the total cost<sup>5)</sup>.

Considering the serious economic and social influence of CLBP, appropriate management is essential. Exercise is recognized as one of the

optimal managements for CLBP. Based on various exercise rationales, many therapeutic exercises have been introduced. However, in contrast to the various exercise approaches, scientific evidence to justify the exercise efficacy is limited<sup>1, 6)</sup>. In addition, some essential questions, such as what aspects of exercise positively affect CLBP and whether any specific exercise is more effective than another, are still unanswered.

Since 1990, many randomized controlled trial (RCT) studies have been published and provide highly scientific evidence demonstrating the effectiveness of exercise for CLBP. In the 1990's, intensive strengthening exercises were highlighted<sup>7)</sup>. More recently, new evidence demonstrating the effect of the segmental stabilizing exercise has been emerging. The approach of the segmental stabilizing exercise is considerably different from the traditional strengthening exercises<sup>8)</sup>. Therefore, it may be worth comparing the effectiveness of these two exercise programs. This study has mainly investigated previous RCT studies because of their high scientific value. Among the numerous LBP studies, selecting studies of similar quality may be a reasonable strategy for evaluating the evidence level.

The purpose of this study was, therefore, to evaluate the effect of the two exercises, strengthening exercise and segmental stabilizing exercise, on relieving CLBP. In addition, this study attempts to draw a conclusion as to which exercise is more effective for CLBP through evaluating the value of previous studies.

#### *The Effect of Strengthening Exercises on CLBP*

A significant relationship between trunk muscles weakness and CLBP has been demonstrated<sup>9, 10)</sup>. "Intensive dynamic back exercise" was one of the most popular exercise regimens in the early 1990s. Plum<sup>11)</sup> was the first to develop this exercise methods for patients with CLBP. The exercise program consists of three parts: leg lifting in the prone position, body lifting in the prone position, and pull to the neck. The main aim of the intensive dynamic back exercise is to improve trunk muscles endurance and strength<sup>12)</sup>. Since the 1990s, many RCT studies have been published that demonstrate the effectiveness of the intensive dynamic back exercise program<sup>12-14, 16)</sup>.

Since Waddell<sup>17)</sup> stated in 1987 that the

assessment and management of CLBP should be different from acute LBP, three aspects, pain, functional disability and physical impairment, have been highlighted as indicating recovery from CLBP. The sections below, therefore, have been divided into three parts showing how strengthening exercises have contributed to pain relief, and improvement of functional ability and physical ability.

#### 1) Pain as an outcome measure

Providing patients with effective pain relief is a high priority in CLBP management. Previous studies provide evidence that strengthening exercises reduce pain in patients with CLBP<sup>12-16, 18)</sup>.

Manniche et al.<sup>12)</sup> were the first to conduct a RCT study demonstrating the effect of the intensive dynamic back exercise. One hundred five CLBP patients were allocated into three groups: 1) an intensive dynamic back exercise group, 2) a moderate exercise group (exercise intensity was approximately 1/5 of the first group), and 3) a mild trunk isometric exercise including thermotherapy and massage (control group). Groups 1 and 2 trained a total of 30 times over three months. The control group performed a total of 8 sessions in one month. Pain was reduced more significantly in the intensive back exercise group than in the other two groups. However, the different intervention periods between the groups might have affected the outcome, and longer exercise periods in the experimental group might have caused bias, which might have positively affected the experimental group. In addition, the authors did not describe whether the study was blinded to the patients or not. Another difficulty is whether the measurement scale was appropriate or not. Pain was measured by an original scale designed by the authors, but its reliability and validity were not documented. Although the authors concluded that the intensive dynamic exercise was effective in reducing pain, the effect of bias and the unconvincing measurement scale, raise the question of whether the level of evidence is strong enough.

Hansen et al.<sup>13)</sup> compared three interventions: 1) intensive dynamic back exercise, 2) standard physiotherapy, and 3) placebo-control. One hundred eighty patients who had chronic and sub-chronic LBP participated in the study. The standard physiotherapy combined several interventions, such as soft-tissue treatment, manual traction, isometric

trunk muscle strength, flexibility, coordination exercises and ergonomics counseling. The placebo group received semi hotpack and light traction (10% of the body weight). Each group continued treatment for four weeks. All groups had significantly reduced pain after intervention, and there were no significant differences among the groups.

The co-intervention effect of the standard physiotherapy might have reduced demonstrable differences between the first two groups. However, the question still remains as to why there was no significant difference between these two groups and the placebo-control. The study was not blinded; therefore it might have caused the placebo effect. The subject inclusion criteria might also have affected the outcome; patients with CLBP and sub-chronic LBP were mixed in this study. Whether exercise is effective in patients with sub-acute LBP is controversial<sup>19)</sup>. A recent Cochrane review concluded that exercise therapy is not effective for LBP patients whose symptoms are less than 12 weeks<sup>1)</sup>.

In conclusion, although previous studies have demonstrated the effectiveness of the strengthening exercise in reducing pain in CLBP patients, some of the evidence may need to be reconsidered. The reliability of the measurement method, minimization of confounding factors and appropriate inclusion criteria are important factors in determining the level of evidence. Considering these factors, the effectiveness of the strengthening exercise in reducing pain in patients with CLBP is still controversial.

## 2) Functional ability as an outcome

Functional improvement is considered to be one of the primary objectives of CLBP treatment<sup>5, 6)</sup>. Previous studies also measured patients' functional ability and demonstrated the effect of the strengthening exercises<sup>12-16, 19)</sup>.

Bentsen et al.<sup>14)</sup> compared intensive, supervised strengthening exercise with a light home exercise program in patients with CLBP. Seventy-four females with CLBP participated in the study. The intensive exercise was designed to strengthen back and abdominal muscles. Treatment was performed for three months. 'Million questionnaires' was used to measure functional disability and its reliability has already demonstrated. Both exercise groups had significant reductions in sick leave and use of

health care services at 3 months and 12 months follow-up, but no significant differences were found between the two groups. However, only patients who continued to exercise for more than one year demonstrated a significant improvement in functional ability at the 3-year follow-up regardless of the exercise type.

This finding may be partially consistent with the study of Deyo et al<sup>15)</sup>. They compared two treatments, stretching exercises and transcutaneous electrical nerve stimulation (TENS). One hundred forty-five LBP patients were randomly allocated into four groups: 1) TENS alone, 2) TENS and exercise, 3) sham TENS with no exercise, and 4) exercise and sham TENS. The stretching exercise was designed to improve lumbar and hip flexibility. Subjects continued each treatment for one month. Functional ability was measured by using a modified "Sickness Impact Profile." The result demonstrated that only the exercise groups had significantly improved functional ability. However, the exercise effect did not last long; at the two-month follow-up most patients had discontinued the exercise.

To summarize, exercises' effect on functional ability may last only when patients continue the exercise for the long term. However, the question as to what type of exercise is most effective still remains, because large variations of exercise regimens were adopted in the previous studies, making it difficult to compare the superiority of each exercise. Considering these factors, once again strong evidence has not emerged confirming the effectiveness of the strengthening exercise.

## 3) Physical improvement as an outcome

Previous studies investigated physical improvement such as muscle strength, endurance and flexibility to demonstrate the effectiveness of the strengthening exercise, and positive result have been reported in the literature<sup>13-16, 18)</sup>.

Risch et al.<sup>16)</sup> investigated the effect of the strengthening exercise on trunk muscles endurance. Fifty-four CLBP patients were randomly allocated into an exercise group and a 'waiting list' control group. The exercise group performed lumbar extensor strengthening exercise for 10 weeks. The maximum isometric strength of the lumbar extensor significantly improved in the exercise group. However, measurement of maximum muscle strength is often affected by subjective factors such

**Table 1.** Study characteristics of the strengthening exercise (Pain)

| Study                          | Participants   | Intervention  | Outcomes  |
|--------------------------------|--|---|---|
| Hansen et al. <sup>13)</sup>   | 180 subchronic and chronic LBP patients, 123 men, 57 women aged 21–64 years. | 1) Intensive dynamic back exercise (Trunk lifting, leg lifting, pull to neck) 1 hour, 2 times a week for 4 weeks (n=60)<br>2) Standard physiotherapy soft-tissue treatment, manual traction, trunk muscles strengthening, flexibility, and coordination 1 hour, 2 times a week for 4 weeks (n=59)<br>3) Placebo control semi-hotpack and light traction (10% of body weight) 1 hour, 2 times a week for 4 weeks (n=61)                | Each group had significantly reduced pain (10-point scale) after treatment. and at 1, 6, and 12 months follow-up. No significant difference between groups. |
| Manniche et al. <sup>12)</sup> | 105 chronic LBP patients, aged 20–70 years.                                  | 1) Intensive dynamic back exercise 1.5 hour, 3 times a week for the first month, 2 times a week for the next 2 months (n=27)<br>2) Moderate exercise (intensity was 1/5 of group 1) 45 min, 3 times a week for the first month, 2 times a week for the next 2 months (n=31)<br>3) Alternative exercise (=control) thermotherapy, massage, mild exercise 8 sessions over the first month, no treatment for the next two months. (n=32) | Significant difference between groups 1, 2, and 3 in reducing pain (original scale) at 3 months and 1-year follow-up.                                       |

**Table 2.** Study Characteristics of the strengthening exercise (Functional ability)

| Study                         | Participants  | Intervention  | Outcomes   |
|-------------------------------|---|---|--|
| Bentsen et al. <sup>14)</sup> | 74 female chronic LBP patients (57 years).                    | 1) Supervised intensive dynamic trunk exercise 30 min, 2 times a week for 3 months, plus home exercise, 10 times a day at home, 1 year. (n=41)<br>2) Home exercise only, 10 times a day at home, 1 year. (n=33) | Functional ability (Million Scale): significantly improved after treatment, but no significant difference between groups.  |
| Deyo et al. <sup>15)</sup>    | 145 chronic LBP patients, 61 men, 84 women, aged 18–70 years. | 1) TENS and stretching exercises (n=34)<br>2) sham TENS and stretching exercises (n=29)<br>3) TENS alone (n=31)<br>4) sham TENS and no exercise (n=31)<br>Each treatment period is 1 month                      | Functional ability (modified sickness impact profile): significantly improved only in exercise group after treatment, but no significant difference at 2 months follow-up. |

as patient motivation and pain. In addition, excluding other muscles activities such as those of the hip extensors and thoracic extensors is difficult, and the measurement method was not clearly documented in the study. Therefore, whether isolated lumbar extensors were accurately measured remains questionable.

Another question is whether the group allocation was appropriate or not. Patients were allocated into

a ‘waiting list’ control group. Psychological aspects should be considered in CLBP patients<sup>4)</sup>. Patients who wait more than 10 weeks for treatment might have been affected emotionally. The authors also suggested that the control subjects might become more dependent on others for help, which would potentially increase their psychological stress.

Kankaanpaa et al.<sup>18)</sup> demonstrated the

effectiveness of strengthening exercises in improving lumbar extensor endurance. They succeeded in measuring the isolated lumbar extensor strength using a specific device, spectral electromyography. The reliability and validity of this tool has been demonstrated in their study. Fifty-nine CLBP patients participated in the study. The exercise group performed four exercise programs which included trunk muscle strength, flexibility and coordination exercises for 12 weeks. In addition, all of them received behavioral supports and ergonomic advice. The control group received massage and thermal therapy. The result demonstrated that the exercise group had a significant improvement in lumbar endurance after the 12-week treatment. However, once again the exercise program was not specified and the multiple-treatment interaction makes it difficult to determine what specific intervention contributed to improve the lumbar extensor endurance. In conclusion, methodological problems affect the validity of the strengthening exercise studies, and weakens their evidence of reductions in pain, and functional and physical improvement.

#### *The effect of the segmental stabilization exercise*

Lumbar instability is considered to be one of the potential causes of LBP<sup>20)</sup>. Based on the concept that specific muscles are able to stabilize the lumbar spine, Richardson et al.<sup>8)</sup> were the first to develop the segmental stabilization exercise regimen. They highlighted the role of specific deep trunk muscles, such as the transversus abdominis (TrA) and multifidus (MF), in stabilizing the lumbar spine. "Abdominal drawing" is a widely adopted exercise to teach isolated co-contraction of TrA and MF without contraction of the global muscles.

As above, pain, functional ability and physical improvement reported in previous studies are examined in analyzing the effectiveness of the segmental stabilization exercise.

1) Pain and functional improvement as an outcome

O'Sullivan et al.<sup>21)</sup> investigated the effect of the segmental stabilization exercise, comparing it with general exercise. Specific radiological diagnosis of spondylolysis or spondylolisthesis was adopted as the inclusion criteria. Demonstrating the exercise effect on the homogeneous LBP population can enhance the value of clinical relevance. Forty-four

CLBP patients were randomly allocated into an exercise group and a control group. The control group received general exercise, ultrasound and massage. The McGill Pain Questionnaire (MPQ) and the Oswestry Low Back Pain Disability Questionnaire (ODQ) were used to measure pain and functional status. The reliability and validity of both measurement scales are well established<sup>4)</sup>. Pain and functional disability were significantly reduced in the exercise group after a 10-week program. In addition, the effect was maintained at the 30-month follow-up assessment.

Although the overall quality of this study is high, some caution is still required. Contrary to the consistent exercise protocol in the exercise group, the control group performed individual exercises prescribed by their own practitioner; therefore, exercise type and intensity were not consistent. Secondly, subject selection may not have represented the general CLBP population as the average age of both groups was between 29 and 33. This might have affected the external validity of the study, since whether segmental stabilization exercise is useful for other CLBP age groups determined.

Hides et al.<sup>22)</sup> compared the effect of segmental stabilization exercise with general medical management and medical treatment alone in acute LBP patients. Forty-one acute LBP patients participated in the study. There was no significant difference between the groups in pain reduction and functional improvement after 4 weeks treatment. However, a significant finding emerged at one year follow-up<sup>23)</sup>. The recurrence rate of LBP of the segmental stabilization exercise group was significantly lower than the control group. The recurrence rate of the exercise group was 30% whereas that of the control group was 80%. Besides, at two to three years follow-up the recurrence rate was still significantly lower in the exercise group (segmental, 35%; control, 75%).

In summary, two studies have provided high quality evidence that demonstrates the effectiveness of segmental stabilization exercise in pain reduction and functional improvement in CLBP. In addition, both studies demonstrated the long-term effect which may be a significant positive factor for the segmental stabilization exercise.

2) Physical improvement as an outcome

The major concept of the segmental stabilization

**Table 3.** Study Characteristics of the strengthening exercise (physical improvement)

| Study                            | Participants   | Intervention   | Outcomes   |
|----------------------------------|--|--|--|
| Kankaanpaa et al. <sup>18)</sup> | 59 chronic LBP patients, 37 men, 22 women, aged 30–49 years. | 1) Active rehabilitation (trunk muscles strengthening, coordination, stretching, relaxation, behavioral support and ergonomic advice)<br>1.5 hours, 24 sessions for 12 weeks (n=30)<br>2) Passive rehabilitation (thermal therapy and massage)<br>4 sessions in 1 month (n=24) | Lumbar endurance (MPF slope): significantly improved in the active rehabilitation group at the 1-year follow-up. |
| Risch et al. <sup>16)</sup>      | 54 chronic LBP patients, 34 men, 20 women, aged 22–70 years. | 1) Treatment group<br>isometric lumbar extensor muscle strengthening exercise<br>10 weeks (2 times a week for the first 4 weeks, 1 time a week for the other 6 weeks) (n=31)<br>2) Waiting-list control group<br>No treatment for 10 weeks (n=23)                              | Treatment group significantly improved maximum isometric lumbar extensor strength at post-treatment.             |

exercise is to reeducate patients in normal motor control<sup>10)</sup>. Hodges<sup>24)</sup> demonstrated a significant TrA role working as a feed forward, and they provided evidence that there was a significant delay of the TrA activation in LBP patients.

O'Sullivan et al.<sup>25)</sup> demonstrated that the segmental stabilization exercise altered the abdominal muscle activation pattern in patients with CLBP. Forty-four CLBP patients were allocated into a specific segmental stabilization exercise group and a control group performed the 'double leg raise' which is designed to train the rectus abdominis training. EMG was used to measure the specific area of the deep abdominal muscles. The segmental exercise group showed significant improvement of the deep fibers of the internal oblique muscle activation during exercise after ten-week intervention whereas the control group did not change their activation pattern. The results of this study support the finding that the segmental stabilization exercise is effective at changing the deep abdominal muscles activation pattern.

Hides et al.<sup>22)</sup> measured the size of MF cross-sectional area to demonstrate the muscle recovery in 41 acute LBP patients. MF recovery was significantly rapid and complete in the segmental stabilization exercise group after four weeks treatment and at the 10-week follow-up. Rissanen et al.<sup>26)</sup> also demonstrated that the size of MF was significantly increased in CLBP patients after three

months strengthening exercise, however, only type 2 fibers in MF were improved after the exercise. In contrast, Hides et al.<sup>22)</sup> measured the size of type 1 fibers in MF and found a significant change in the segmental stabilization exercise group whereas the muscle size in the control group was diminished at the 10-week follow-up. These findings imply that the segmental stabilization exercise may be more effective at improving the deep fibers of MF, which is considered to play an important role as a lumbar spinal stabilizer.

In conclusion, previous studies of the segmental stabilization exercise succeeded in identifying and measuring the specific muscle actions contributing to the demonstration of a clear cause and effect between the exercise and physical improvement. Therefore, these studies provide strong evidence demonstrating the advantage of the segmental stabilization exercise in improving physical function.

## CONCLUSION

This section attempts to draw a conclusion as to which exercise, segmental stabilization exercise or strengthening exercise, is more effective for treating patients with CLBP through the evaluation of previous RCT studies. A direct comparison between the two exercises may not be possible because no previous study has compared the effect of these two exercises. However, evaluating the

**Table 4.** Study Characteristics of the segmental stabilization exercise (pain, functional ability and physical improvement)

| Study                            | Participants   | Intervention   | utcomes   |
|----------------------------------|--|--|---|
| Hides et al. <sup>22, 23)</sup>  | 41 acute LBP patients, aged 18–45 years.                                     | 1) Treatment group<br>medical management (advice of bed rest, absence from work and medication) and specific multifidus stabilizing exercise.<br>4 weeks including home exercise (n=21)<br>2) Control group<br>medical management only<br>4 weeks (n=20) | No significant difference in pain level after 4 weeks. Significantly lower recurrence rate in the treatment group at 1 and 2-year follow-up. Type1 fiber size of multifidus was significantly increased at post-treatment and 10 weeks follow-up. |
| O’Sullivan et al. <sup>21)</sup> | 44 chronic LBP patients, spondylolysis, spondylolisthesis, aged 16–44 years. | 1) Segmental stabilization exercise group<br>multifidus, deep abdominal muscles<br>10 weeks (once a week) program (n=21)<br>2) Control group<br>general exercise (walking, swimming, gym work, heat, massage)  | Segmental stabilizing exercise group significantly reduced pain (MPQ) and improved functional ability (Oswestry-LBP disability questionnaire) after treatment. improvement at maintained 30-month follow-up.                                      |
| O’Sullivan et al. <sup>25)</sup> | 44 chronic LBP patients, spondylolysis, spondylolisthesis.                   | 1) Segmental stabilizing exercise group<br>deep abdominal muscles training<br>10 weeks, once a week (n=22)<br>2) Control group<br>double-leg raise: rectus abdominus training<br>10 weeks, once week (n=22)  | Segmental stabilizing exercise significantly increased the ratio of the deep fiber of the internal oblique. muscles.  |

evidence level of previous studies may give a reasonable idea as to which exercise regime is superior. Despite the number of studies being limited, the segmental stabilization exercise studies may have an advantage in the quality of evidence.

First, the studies of segmental stabilization exercise specified the exercise program. Identifying the specific exercise regimen demonstrated clear cause and effect between the exercise, and dependent variables. Conversely, previous strengthening exercise studies had large variations in the intervention. Co-intervention tends to generalize the treatment effect, thus, making it difficult to demonstrate a specific exercise effect.

Second, measurement methods of the segmental stabilization exercise studies appear to have been more appropriate. Specific muscle actions were appropriately measured. In contrast, the measuring methods of the strengthening exercise studies appeared to have some flaws. Some studies did not specify isolated muscles and each study measured different aspects of the muscle’s work, such as strength, endurance or flexibility, which made it

hard to compare the findings of each study.

Third, the studies of the segmental stabilization exercise tried to specify the diagnostic inclusion criteria. The definition of a homogeneous LBP population is very important. None of the previous strengthening studies evaluated in this paper defined the specific diagnostic inclusion criteria. A heterogeneous study may create a high risk, such as inclusion of a different sub-population, which seriously affects the outcome.

Another advantage of the segmental stabilization exercise is the long-term exercise effect. Previous studies have demonstrated a significant low recurrence rate. On the other hand, previous strengthening exercise studies suggested the exercise effect tends to diminish if that patients discontinue the exercise.

In summary, considering the evidence level and long-term exercise effect, the segmental stabilization exercise seems to be more effective for patients with chronically symptomatic spondylolysis and/or spondylolisthesis. However, it does not necessarily indicate the lesser effectiveness of the strengthening exercise.

Methodological improvement would provide an opportunity to enhance the level of evidence. In order to demonstrate a high level of evidence, future strengthening exercise studies should consider the methodological strategy.

Although this study endorses the high quality of the segmental stabilization exercise studies, some caution is still needed. First, further study is necessary to demonstrate the effectiveness of the segmental stabilization exercise in other CLBP populations, otherwise the clinical application of the segmental stabilization exercise may be too limited. In order to demonstrate the superiority of the exercise, more studies that directly compare the segmental stabilization exercise and other treatments are necessary. Especially, comparisons with other specific exercise program, including the strengthening exercise, are important to demonstrate the superiority of the segmental stabilization exercise. This is a future challenge for segmental exercise study.

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