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# Spinal Instability in Myogenic Low Back Pain: Stabilization Exercise Approach

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**ABSTRACT**

Spinal instability can be caused by various conditions including an illness, trauma, and degenerative processes affecting one or more of the three spinal subsystems. These three subsystems are the spine and ligaments, back muscles, and the nervous system work synergistically to maintain spinal stability. Until now it is still difficult to identify spinal instability. Low back pain (LBP) affects 60-80% of the world's population and in the United States causes losses of around $15-50 billion each year. For several decades, a muscle training program has been the main program that recommended to solve LBP, based on the premise that the muscle subsystem is a subsystem that can be repaired and improved, a muscle training program is developed and applied in the management of NPB. This literature review focuses on aspects of stabilization exercises in the management of low back pain with and without spinal instability

## 1. Introduction

Pope and Panjabi defined instability, from a biomechanical perspective, as a loss of stiffness in the spine. Stiffness was defined as the amount of motion within a system relative to a load applied to the structure.[1,2] To ensure balance and stability, three subsystems function synergistically - the bones and ligaments of the spine, the muscles, and the nerves that coordinate muscle activation.[3–6] These three subsystems work collaboratively to ensure that the center of gravity (CoM) and base of support (BoS) are maintained in their correct orientation. Spine stability is the basic requirement to protect nervous structures and prevent the early deterioration of spinal components. Any disorder, trauma or degenerative lesion, affecting any of the three subsystems can result in some degree of spinal instability.[3,5] Meanwhile, the lack of standard operational definitions makes it difficult to quantify the incidence of spinal instability. Regardless, mechanical instability refers to disruption of the passive stabilizers and decreased structural integrity while functional instability refers to a lack of neuromuscular control of the joint during activities.[1]

The loss of stiffness was thought to allow increased motion to occur at each vertebral segment, which is associated with the occurrence of back pain. Spinal instability is considered to represent one of the potential conditions causing nonspecific LBP.[3] Conversely, the occurrence of SL in subjects with LBP has been considered one of the most obvious manifestations of SI

## 2. Myogenic Low Back Pain

Myogenic low back pain ranks second as the cause of LBP in general. It is estimated that as many as 60-80% of the population will experience lower back pain (LBP) at some point in their lives, with the prevalence of LBP estimated at 49-90%. Furthermore, approximately 25% of patients seeking treatment for LBP will experience a recurrence of the condition within a year. Research conducted by Fatoye et al. reports the prevalence and incidence of LBP to be 1.4-20% and 0.024-7.0%, respectively, with males being more commonly affected than females.[7,8] The most common age prevalence is between 55-64 years.[5,6] In industrialized societies, LBP can be classified as an occupational disease, with an estimated annual cost to the United States of between $15 and $50 billion.[7]

### 2.1. Definition

Based on the definition of pain and its location, low back pain (LBP) is an unpleasant sensory and emotional experience originating from the area between the 12th thoracic vertebra to the lower pelvis.[9,10]

Myogenic low back pain occurs due to stress or strain on the muscles, tendons, and ligaments of the back. Addressing this type of pain is crucial since it can result in issues like lost work time and decreased work productivity. Conditions included in myogenic or musculoskeletal LBP are acute and chronic lumbar strain, mechanical LBP, myofascial pain syndrome, fibromyalgia, tension myalgia at the pelvic base, LBP in abnormal posture, and LBP in pregnancy.[8,10]

Sinaki and Mokri state that mechanical low back pain is a non-discogenic back pain (without the involvement of the intervertebral disc) caused by physical activity and reduced by rest. This pain is associated with stress/strain of the back muscles, tendons, and ligaments which usually occurs when performing excessive physical activities, prolonged sitting or standing, or lifting heavy objects.[10] Half of the subjects developed their LBP condition secondary to a single event injury while the other half developed LBP gradually in relation to multiple minor traumatic incidents.[3]

The pain is dull, with varying intensity and often becomes chronic, can be localized or spread to the gluteal area. This pain is not accompanied by neurological deficits. For example, if there is provocation such as coughing or sneezing there is no radiation of pain to the legs.[10]

### 2.2. Etiology

Mechanical pain refers to any type of back pain caused by abnormal stress and strain on the muscles of the vertebral column, usually associated with deconditioning and decompensation conditions with unknown onset, weakness of the back and abdominal muscles, obesity, and chronic improper activity. Patients may fail to perform or maintain complex body movements. The factors contributing to lower back pain can be divided into two categories: static and dynamic.[5,6,10]

Static factors refer to deviations in body posture or attitude that lead to an increase in the lumbosacral angle or lumbar lordotic curve over time, resulting in a shift in body weight center (center of gravity or CoG). This shift causes stretching of the ligaments and contraction of the muscles, leading to sprains or strains in the ligaments or muscles of the lower back, which then cause pain.[5,6,10]

Dynamic factors, on the other hand, result from stress or abnormal mechanical loads on the tissue structures in the lower back area during movement. These factors can lead to disturbances in the lumbar pelvic rhythm, causing musculoskeletal lower back pain. Movements that have the potential to cause this type of pain are those involving combination movements, particularly flexion and rotation, and repetitive movements, particularly when accompanied by a load, such as lifting a heavy object.[5,6,10]

### 2.3. Related Factors of Low Back Pain

The main factors associated with low back pain are those related to work and those related to the individual.[10]

a) Work-related factors:

More than 60% of low back pain patients attribute their pain to rough and heavy work. In addition, activities such as lifting, pulling, pushing, twisting, slipping, and sitting for extended periods, whether alone or in combination, can also contribute to low back pain.[10]

b) Patient-related factors:

The risk of developing low back pain increases gradually until around age 55. Factors that may increase the risk of low back pain include obesity, tall stature, postural changes such as scoliosis, kyphosis, excessive or reduced lumbar lordosis, leg discrepancy, restricted range of motion of the lumbar spine, weakened abdominal and spinal muscles, and smoking. Psychological factors such as depression, anxiety, hypochondria, hysteria, alcoholism, divorce, and chronic headaches have also been linked to a higher frequency of low back pain.[5,11]

## 3. Management of LBP

While there is a lack of consensus on the best exercise treatment and numerous studies are underway, exercise therapy has been advocated as an effective treatment for chronic low back pain.[7]

Exercises for low back pain have evolved over the period of time with a specific emphasis on maintaining spinal stability.[12] The three subsystems work synergistically in maintaining spinal stability, the spinal musculature is the major source of spinal stability and is the component that can be enhanced in a rehabilitation approach.[3]

### 3.1. Stabilization Exercise

Over the last few decades, exercise programs have been a commonly used intervention to treat low back pain. Its primary goals are to improve back flexibility, strength, and endurance, reduce the intensity of pain, and decrease back pain-related disability by reducing excessive fear and worry about back pain.[12,13] Lumbar stabilization exercises, also known as "core" stabilization exercises, are currently a popular intervention and are widely prescribed for patients with mechanical low back pain.[8,14]

In 2004, Rainville et al conducted a meta-analysis study to compare various studies on the effect of stabilization exercise on the recurrence of low back pain in different conditions. The study discovered no proof that exercise raised the chance of further back pain episodes or work incapacity in those with acute, subacute, or chronic low back pain. But given the current medical situation, it's crucial to carefully study and assess the kind of activity.[15]

Due to the rationale that disturbance to any of the stabilizing components causes some instability, and that the spinal musculature is the major component of stability, stabilization exercises have been widely used in the management of patients with segmental instability, clinical instability, and chronic pain. Although there are some variations in exercise programs, the theoretical foundations and principles of stabilization exercises remain the same. These exercises are based on the anatomical-biomechanical model of trunk muscle function presented by Bergmark and the idea of spinal dysfunction put out by Panjabi. The global muscle system and the local muscle system are the two primary muscle systems that regulate movement and stability in the spine, according to Bergmark's paradigm.[15,16]

Primary spinal movers such as the rectus abdominus, external oblique, and iliocostalis lumborum comprise the global muscle system. These muscles do not directly link to the lumbar spine; instead, they move the trunk. Conversely, the lumbar multifidus, internal oblique, transverse abdominis, quadratus lumborum, lumbar component of the lumbar iliocostalis lumborum, and psoas major are among the tonic, postural, and stabilizing spinal muscles that make up the local muscle system. These muscles are nearer the axis of rotation and have a shorter length. They can offer stability because they are directly attached to the spine.[15,16]

Panjabi and Bergmark's theory was combined with research on spinal stability and control and motor learning theory to develop a progressive intervention model, including core stabilization or dynamic lumbar stabilization.[15,16]

Stabilization exercises aim to restore active and passive control of the trunk by focusing on specific local stabilizing muscles such as the transverse abdominus, internal oblique, and lumbar multifidus. This program, which is widely used, emphasizes the training of stabilizing muscles using isometric co-contraction and progression based on a motor learning paradigm.[3,17]

The stabilization exercise program involves three stages. In the first stage, patients are taught to consciously and deliberately activate local muscles in isolation. In the second stage, patients are taught to co-contract local muscles while performing limb movements. In the third and final stage, patients learn to integrate the activation of local muscle systems with daily activities.[16,18–20]

3.1.1. The First Step

During Stage 1 training for patients with recurrent or chronic LBP, The goal is to raise their level of conscious knowledge regarding proper local muscle activation and the neutral lumbar position. Patients with lower back pain (LBP) may find it difficult to move their pelvis independently of their hips and thoracic spine, thus pelvic motion independence is first taught to them. After achieving independence in pelvic motion, patients are instructed to shift their pelvis in order to bring their lumbar spine into a neutral posture. However, based on each patient's unique pathophysiology, the neutral position may differ. For example, a patient whose lumbar spine is hyperextended could need to adopt a minor posterior pelvic tilt, whereas a patient whose lower lumbar spine is flattened might need to adopt a slight anterior tilt.[16]

The therapist's goal is to engage the local stabilizing muscles, such as the lumbar multifidus and transverse abdominus, after the patient is in the neutral position. In order to co-contract the lumbar multifidus and activate the transverse abdominus, the patient is instructed to execute the abdominal drawing-in maneuver (ADIM). The therapist uses ultrasound imaging, pressure feedback devices, or palpation of the relevant muscles to offer feedback. Every day, the patient spends at least ten to fifteen minutes practicing this approach. The patient can move on to Stage 2 of the training after the co-contraction can be maintained for 60 seconds. Table 1 shows the important points in the first stage of stabilization training.[16,18,19]

**Table 1. The first stage of stabilization exercises**[16]

| Activity | Important point |
|---|---|
| Neutral lumbar position | ● Forming independent pelvic movements<br>● Finding and maintaining a neutral lumbar vertebral position |
| Diaphragmatic breathing | ● Proper breathing technique without the use of accessories respiratory muscles |
| Transversus abdominis activation | ● Abdominal drawing-in maneuver (ADIM)<br>● Bending position with hands down and then continuing with the prone position<br>● Monitoring with palpation or with pressure feedback tools<br>● The patient is in the prone position with a pressure feedback device pumped up to 70 mmHg; the patient should be able to lower the pressure from 6 to 10 mmHg |

| | |
|---|---|
| | and hold for 10 seconds. |
| Co-contraction of the lumbar multifidus with the transversus abdominis | ● Strengthens lumbar multifidus contractions<br>● Monitoring by palpation; Feel the formation of pressure on multifidus<br>● No pressure under the finger indicates that the patient is unable to activate the multifidus; Rapidly emerging pressure indicates that substitution has occurred contractions with erector spinae |
| Maintain co-contraction | ● Maintain co-contraction of local muscles for a long time with activity<br>● Please proceed to the second stage when the duration of contractions has reached a length of 60 seconds |

3.1.2. Second Step

During the second stage, patients are taught how to maintain the co-contraction of the transverse abdominus and lumbar multifidus while performing various movements and activities. Patients can undertake heel slides, leg lifts, bridging, standing, and walking while using the Abdominal Drawing-In Maneuver (ADIM) to strengthen their transverse abdominus further. The exercise known as the "horizontal side support" (Figure 1) can help strengthen the quadratus lumborum, another crucial lumbar spine stabilizer. This exercise works the abdominal obliques and the quadratus lumborum without placing significant compressive pressure on the lumbar spine. Patients can practice opposite arm and leg lifts in quadruped pose to strengthen the erector spinae and lumbar multifidus.[8,16,20]

When creating exercise programs for patients with low back pain, it is important to consider the endurance of trunk muscles rather than just strengthening. Therefore, exercises should be performed daily, with low loads and high repetitions. Additionally, this stage should include some form of aerobic training. Lastly, patients should identify movements and activities that cause pain and practice performing them with local muscle co-contraction. Component movement training can be helpful for more complex activities. For example, if a patient experiences pain while rising from sitting, they should attempt to maintain the neutral position of the lumbar spine and local muscle co-contraction while sitting, shifting weight anteriorly, and extending the hips and knees. Practicing local muscle co-contraction during functional activities should help reduce pain levels and improve function in daily activities. Once patients are able to maintain local muscle co-contraction during transitional movements and activities of daily living, they can move on to Stage 3.[16,18–20] Table 2 shows the second stage of stabilization exercises.

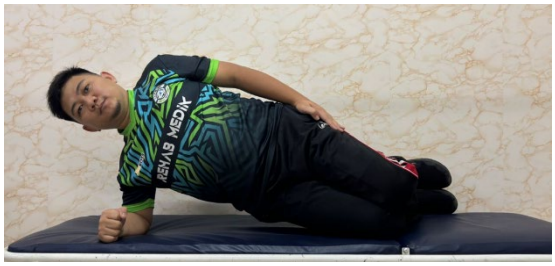

**Figure 1. Horizontal side support exercise with abdominal draw-in maneuver**

**Table 2. The second stage of stabilization exercises**[16]

| Activity | Important point |
|---|---|
| Range of motion exercises for the trunk | • Lumbar flexion and extension in quadruped position |
| Hip flexibility exercises | • Adequate hip flexibility reduces stress on the lumbar spine and allows the patient to more easily maintain a neutral position |
| Aerobic exercise | • Aerobic exercise to increase muscle endurance |
| ADIM Maneuver : | |
| - *Supine heel slide* | • Supinated position with hip and knee flexion<br>• Shift one heel outward and inward, repeat on the other foot<br>• The progression of both heels moves simultaneously |
| - *Supine leg lifts* | • Supinated position with hip and knee flexion<br>• Extend one leg so that the tip of the foot is on the edge of the table |

- Repeat on the other side of the leg
- Arm progressions in opposition to leg movements; starts with the leg at the end of the table

**Figure 2. Exercises can be made more dynamically challenging by including a foam roller**

**Table 3. Third stage stabilization exercise**[16]

| Activity | Important point |
|---|---|
| Distracting exercise | ● It is important to maintain muscle co-contraction while performing other activities that might distract from local muscle co-activation |
| Sustain muscle co-contraction for better physical health during work and leisure activities | ● It is essential to maintain local muscle co-contraction even during work or recreational activities |

3.1.3. Third Step

During the Stage 3 training process, the aim is to establish local muscle co-contraction at the subconscious level. To achieve this, training exercises are designed that involve a degree of mental distraction. Exercises involving dynamic challenges, such as catching a ball while standing on a balance board, balancing on foam rollers in the quadruped position while grasping an object, or lying supine over an exercise ball while pulling on elastic tubing, require patients to maintain local muscle co-contraction. Integrating local muscle co-contraction into daily activities and customizing it to the patient's functional demands and goals is the ultimate goal of Stage 3 training.[16]

### 3.2. Core Stability Exercise

Maintaining proper load balance in the spine, pelvis, and kinetic chain is crucial, and core stability plays a significant role in achieving this.[18,21] The core refers to a group of trunk muscles that surround the spine and abdominal cavity, including the abdominal, gluteal, hip girdle, paraspinal, and other muscles that work together to provide spinal stability. Functional limb movements essential in athletics rely on core stability and its motor control.[18] As well as for treatment of back pain in athletes, sports medicine practitioners also use core strengthening techniques to enhance lumbar stabilization to improve performance and prevent injury.[2,18,22]

Muscle spasms and resulting pain can occur due to lower back muscle dysfunction, but core stability exercise promotes vasodilation that increases blood circulation, supplying more nutrients and oxygen, reducing spasms or tension in the injured tissue, and decreasing pain.[1] Besides reducing pain, other benefits of core stability exercise include increasing intra-abdominal pressure due to the contraction of the diaphragm, pelvic floor muscles, and abdominal muscles, maximizing the balance and mobility of extremities, and improving neuromuscular coordination, thus enhancing spinal stability .[8,18,19]

### 3.3. Rhythmic Stabilization exercise (RSE) and Post Isometric Relaxation (PIR) exercises

Rhythmic Stabilization Exercise (RSE) and Post Isometric Relaxation (PIR) exercises are proven exercise therapies that also can effectively alleviate low back pain.[23] Studies on neurophysiology have connected pain in the lumbar spine area to disruptions in mechanoreceptor function and degeneration of the superior proprioception centers. Proprioceptive exercise regimens may be helpful in the treatment of persistent low back pain. Proprioceptive neuromuscular facilitation (PNF) exercises are one such program that improves the response of neuromuscular processes by stimulating proprioceptors. To assist patients in reaching their maximum level of function is the primary objective of PNF treatment.[13,24]

A PNF technique called "rhythmic stabilization" alternates between isometric contractions against resistance without any intention of motion. It's used to relieve pain and restricted range of motion, especially when trying to move. By making manual contact on opposing sides of the body, the therapist delivers multidirectional resistance. The patient maintains the chosen position while resistance is concurrently applied in the other direction.[13]

In 2018, Virny conducted a study that concluded

Rhythmic Stabilization Exercise is a more effective method for improving functional ability in patients with Non-Specific Low Back Pain compared to Post-Isometric Relaxation (PIR). The study revealed that Rhythmic Stabilization Exercise resulted in a greater reduction of the Oswestry Disability Index (ODI) value, by 0.87, as compared to PIR.[23]

## 4. Conclusion

Spinal stability relies on three subsystems functioning synergistically: the bones and ligaments of the spine, the spinal musculature, and control by the nerves. Spinal stability ensures the protection of the nerve structures and the prevention of early deterioration of the spine. Any damage or disruption to any of these sub-systems can cause spinal instability. Based on the reasoning that the musculature is the subsystem that can be enhanced through rehabilitation programs, exercises are widely used in the treatment of LBP with and without spinal instability. The stabilization exercise approach involves three stages: the conscious and isolated activation of local muscles, the co-contraction of local muscles while superimposing limb movements, and the integration of local muscle systems' activation with daily activities.

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