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Stabilization Exercise for the Management of Low Back Pain

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1. Introduction

Lumbopelvic stabilization model

The lumbopelvic stabilization model is an active approach to low back pain, as proposed by Waddell (Waddell et al., 1997), based on a motor control exercises program. The main aim of this program is to reestablish the impairment or deficit in motor control around the neutral zone of the spinal motion segment by restoring the normal function of the local stabilizer muscles.

Stabilization exercise program has become the most popular treatment method in spinal rehabilitation since it has shown its effectiveness in some aspects related to pain and disability. However, some studies have reported that specific exercise program reduces pain and disability in chronic but not in acute low back pain, although it can be helpful in the treatment of acute low back pain by reducing recurrence rate (Ferreira et al., 2006).

Studies comparing Stability programs and others

Despite stabilization exercises have become a major focus in spinal rehabilitation as well as in prophylactic care such as sports injury prevention (Zazulak et al., 2008), the therapeutic evidences in terms of postural control variables have not been well documented. Some randomized controlled trials have comprehensively reported the effects of stability exercises versus conventional physiotherapy treatment regimes on pain characteristics, recurrence and disability scores in chronic low back pain patients emphasizing patient centered outcomes (Dankaerts et al., 2006; Liddle et al., 2007). These studies have addressed the need of homogenous chronic low back pain group for better clinical outcomes. Evaluating postural control parameters such as centre of pressure displacements, moments and forces following interventions, particularly stability exercises, may provide insight into how this surrogate outcomes are mediated by different subgroups or heterogeneous chronic low back pain patients and identifying subgroups of chronic low back pain patients who are most likely to benefit after particular intervention (Muthukrishnan et al., 2010).

The core stability exercises cannot be superior to conventional physiotherapy exercises in terms of reducing pain and disability. However, core stability exercise demonstrates

significant improvements in: distribution of ground reaction forces, use of optimized postural adjustments in the direction of perturbation, 20% absolute risk reduction of flare-up during intervention and 40% absolute risk reduction for resolution of back pain after core instability exercises (Muthukrishnan et al., 2010).

Core stability exercise is an evolving process, and refinement of the clinical rehabilitation strategies is ongoing. Further work is required, however, to refine and validate the approach, particularly with reference to contemporary understanding of the neurobiology of chronic pain (Hodges, 2003).

Related to the comparison between Pilates method and stabilization programs, Pilates method did not improve functionality and pain in patients who have low back pain when compared with control and lumbar stabilization exercise groups (Pereira et al., 2011).

To contrast the efficacy of two exercise programs, segmental stabilization and strengthening of abdominal and trunk muscles, on pain, functional disability, and activation of the transversus abdominis (TrA) muscle, in individuals with chronic low back pain. Both techniques lessened pain and reduced disability. Segmental stabilization is superior to superficial strengthening for all variables. Superficial strengthening does not improve TrA activation capacity (Franca et al., 2011).

Comparing traditional exercise program and core stabilization program one group of Soldiers (N = 2616) between 18 and 35 years of age were randomized to receive a traditional exercise program (TEP) with sit-ups or Core Stabilization exercise program (CSEP). CSEP did not have a detrimental impact on sit-up performance or overall fitness scores or pass rates. There was a small but significantly greater increase in sit-up pass rate in the CSEP (5.6%) versus the TEP group (3.9%) (Childs et al., 2009).

Who is suitable for getting benefits from a stabilization program?

This sort of program has shown to produce short-term improvements in global impression of recovery and activity for people with chronic low back pain, maintaining the results after 6 and 12 months (Costa et al., 2009), as well as be superior to minimal intervention at long term follow-up (Macedo et al., 2009; Kriese, 2010). Improvements in pain intensity and functional disability were also demonstrated in groups of patients with low back pain suffering from a spondylolysis or a spondylolisthesis (O'Sullivan, 2000) and a significant decrease of symptoms in people with hypermobility (Fritz et al., 2005).

However, before approaching this model, for better understanding the theory basis some of the crucial terms will be described.

Neutral Position

"The posture of the spine in which the overall internal stresses in the spinal column and muscular effort to hold the posture are minimal" (Panjabi, 1992b)

Neutral Zone

"That part of the physiological intervertebral motion, measured from the neutral position, within which the spinal motion is produced with a minimal internal resistance. It is the zone of high flexibility or laxity" (Panjabi, 1992b).

Spinal instability. Panjabi's Hypotheses

Can be defined as "a significant decrease in the capacity of the stabilizing system of the spine to maintain the intervertebral neutral zones within the physiological limits so that there is no neurological dysfunction, no major deformity, and no incapacitating pain" (Panjabi, 1992b). Therefore, an unstable spinal segment might not be able to maintain the correct vertebral alignment. The excessive movement in an unstable spine may either stretch or compress pain sensitive structures, leading to inflammation (Panjabi, 1992a).

It is also necessary to differentiate between instability and hypermobility because in both cases the range of motion is greater than normal. The main difference is that hypermobility might be asymptomatic, however, instability exists when dysfunctions, which can induce pain while performing active physiological movements (Paris, 1985).

1.1 The stabilization system of the spine

Panjabi conceptualized the basis of the stabilization system of the spine, subdividing it into three different subsystems: the active subsystem, the passive subsystem and the control subsystem.

The Passive subsystem consists on the ligamentous system and does not generate or produce itself any motion at the spine. It produces reactive forces by the end of the ranges of motion but its prime assignment is to work as a signals transducer to the neural subsystem and to send any sense of vertebral position or motion, especially those produced by the vicinity of the neutral zone (Panjabi, 1992a).

The Active subsystem is composed of muscles and tendons which generate forces to supply the stability to the spine (Panjabi, 1992a). Poor postural control can leave the spine vulnerable to injury by placing excessive stress on the body tissues (Kendall et al., 1993). In the lumbar spine, the trunk muscles protect spinal tissues from excessive motion. To do this, however, the muscle surrounding the trunk must be able to co-contract isometrically when appropriate (Richardson, 1990). The synergistic interaction between various trunk muscles is complex: some muscles act as primary movers to create the gross movements of the trunk, whereas others function as stabilizers (fixators) and neutralizers to support the spinal structures and control unwanted movements. Rehabilitation through active lumbar stabilization not only deals with the torque-producing capacity of muscles, as it is true for many traditional programs, but also seeks to enable a person to unconsciously and consistently coordinate an optimal pattern of muscle activity (Jull&Richardson, 1994a).

The Neural Control subsystem. Its function is to receive all the sensory feedback from the transducers of the passive system, determine the stability requirements and make the active system to achieve those stability goals. It also has an important role in measuring the forces generated in each muscle through the transducers located inside the tendons (Panjabi, 1992).

In a normal situation, the stabilization system provides the stability required to fulfill the demands of the constantly changing stability provoked by variations in posture and static and dynamic loads. To meet all those needs, the three subsystems must work together in harmony. However, dysfunction of any of these three components might incite a fail in the whole system, leading, over time, to chronic dysfunction and pain (Panjabi, 1992a).

Each of these three interrelated systems has its own role in maintaining the spinal stability. Inert tissues (in particular ligaments) provide passive support; contractile tissues give active support; and neural control centers links the passive and active systems, receives information about the position and direction of the movements and coordinates and control the muscles ability to contract and maintain stability (i.e., to increase stiffness and reduce the size of the neutral zone). This will depend on the speed and accuracy with which the information is relayed. The vital aspects of neural system development are therefore accuracy of movement and speed of reaction. Thus, the stabilization program emphasizes accuracy of movements early on; speed comes later.

Generally speaking, the main strategy of the stabilization model is to reduce the size of the neutral zone by increasing stiffness offered by muscles contraction (Norris, 2008)

Following with the Stabilization model, we are focusing now on the active support system. In this concept we must avoid *muscle imbalance* that occurs when one muscle, the “agonist”, is stronger than the opposite, the “antagonist”, or when one or the other is abnormally shortened or lengthened.

1.2 Types of muscles

We can categorize muscles into two groups: stabilizers or “postural muscles” and mobilizers or “task muscles” (Janda&Schmid, 1980; Richardson, 1990).

Stabilizers or postural muscles: stabilize a joint and approximate the joint surfaces. Tend to be more deeply placed in the body and are usually monoarticular muscles. Stabilizers can be subdivided into primary and secondary types (Jull&Richardson, 1994). Many of these smaller muscles have an important proprioceptive functions. For example, the intertransversarii muscles of the lumbar spine and the interspinalis muscles both have a dense concentration of muscle spindles indicating a significant proprioceptive function (Adams et al., 2002). Intertransversarii muscles and interspinalis muscles have demonstrated their influence over low back pain. The secondary stabilizers are the main torque producers, being large monoarticular muscles attaching via extensive aponeurosis.

Despite there is no actual evidence whether pain or motor control impairments come first, Panjabi (1992a) suggested that changes in the active support system might lead to a poor control of the joints and repeated microtrauma and pain. Supporting this idea, many research works have been conducted to explain all those fails in controlling the stability of the spine. According to this, changes in automatic control of TrA have been found in people with low back pain (Ferreira et al., 2004), a delayed onset of its contraction (Hodges&Richardson, 1996) and a loss of its tonic and preadjusting function (Hodges, 1999), what indicates a motor control deficit and is hypothesized to result in inefficient muscular stabilization of the spine (Hodges, 1996, 1999). The activation of the other stabilizer muscles also appears delayed, but to a lesser extent (Hodges, 1999).

On the other hand, there are many research papers about the changes that occur in other stabilizers as a consequence of or associated to chronic low back pain. Some of these changes are: a reduction in the cross-sectional areas of multifidus, psoas, and quadratus lumborum (Kamaz et al., 2007), asymmetric atrophy between both side of the symptomatic level (Hides et al., 2006) and fat infiltrations in multifidus muscles (Kjaer et al., 2006; Mengiardi et al.,

2006). Nevertheless, it has been reported some good results in recovering these changes with a specific stabilization program (Hides et al., 1996; Hides et al., 2008).

Mobilizers: are superficial and are often biarticular (two-joint) muscles. They can develop angular rotation more effectively than the stabilizers. This group of muscles acts as stabilizers only in conditions of extreme need. When they do, the precision of movement is often lost, creating and observable movement dysfunction.

In table 1 we can see stabilizers and mobilizers characteristics (Norris, 2008).

Stabilizers and Mobilizers Characteristics		
Stabilizers	<p>Primary stabilizers:</p> <ul style="list-style-type: none"> • Deep, close to joint • Slow twitch • Usually monoarticular (1joint) • No significant torque • Short fibers <p>Secondary stabilizers:</p> <ul style="list-style-type: none"> • Intermediate depth • Slow twitch • Usually monoarticular • Primary source of torque • Attachments are multipennate 	<ul style="list-style-type: none"> • Build tension slowly, more fatigue resistant • Better activated at low levels of resistance • More effective in closed chain movement • In muscle imbalance, tend to weaken and lenghten
Mobilizers	<ul style="list-style-type: none"> • Superficial • Fast twitch • Often biarticular (2 joints) • Secondary source of torque 	<ul style="list-style-type: none"> • Build tension rapidly, fatigue quickly • Better activated at high levels of resistance • More effective in open chain movements • In muscle imbalance, tend to tighten and shorten

Table 1. Stabilizers and mobilizers characteristics.

In this table, stabilizer and mobilizer muscles that affect the low back are presented. Muscles with (*) can work in different ways.

STABILIZERS		MOBILIZERS
Primary	Secondary	
Multifidus	Gluteus maximus	Iliopsoas * Rectus femoris
Transversus abdominis	Quadriceps	Hamstrings
Internal oblique	Iliopsoas *	Tensor fasciae lata
Gluteus medius	Subscapularis	Hip adductors
Vastusmedialis	Infraspinatus	Piriformis
Serratus anterior	Upper trapezius	Rectus abdominis External oblique Quadratus lumborum *
Lower trapezius	Quadratus lumborum *	Erector spinae
Deep neck flexors		Upper trapezius Levator scapulae
		Sternomastoid Scalenes
		Rhomboids Pectoralis minor Pectoralis major

Table 2. Stabilizer and mobilizer muscles that affect the low back

2. Diagnosis in lumbopelvic stabilization model

The main purpose of our diagnosis is to identify the abnormal segmental control of a motion segment. For that assessment, passive intervertebral manual pressures directly applied on the spinous process can be utilized in the search of an excessive or uncontrolled segmental translation. Usually, the application of that force on an affected or unstable segment may provoke pain or reproduce the symptoms. Multifidus muscles atrophy at any level could be another sign to detect a dysfunctional spinal segment. This can be assessed by palpation at both sides of the spinous process of every level and might be either unilateral or bilateral (figure 12).

Referring movement impairment changes in body segment alignment and the degree of segmental control (the ability to move one body segment without moving any others) form the basis of the movement impairment tests.

On the other hand, tightness and weakness in muscle imbalance alters body segment alignment and changes the equilibrium point of a point. If the muscles on one side of a joint are tight and the opposing muscles are lax, the joint will be pulled out alignment toward the tight muscle. This alteration in alignment throws weight-bearing stress out a smaller region of the joint surface, increasing pressure per unit area. Furthermore, the inert tissues on the shortened (closed) side of the joint will contract over time.

The combination of stiffness (hypoflexibility) in one body segment and laxity (hyperflexibility) in an adjacent segment leads to the development of relative flexibility (White&Sahrmann, 1994).

In contrast, radiologists have tried to determine the intervertebral instability using imaging techniques to assess both normal and abnormal ranges of movements. Most common techniques used to measure those intervertebral ranges of movements are neutral radiographs and functional in both flexion and extension taken in sagittal plane (Alam, 2002; Leone et al, 2007). Some of the measurements taken by many authors in different studies are shown in the table below.

Author	Spinal Level	Translation (mm)	Rotation (degrees)
Hayes et al.	L1-5	2-3	7-13
	L5-S1	3	14
White et al.	L1-5	3	13
	L5-S1	3	20
Froming & Frohman	L1-5	3	9
	L5-S1	3	17
Kanayama et al.	L1-5	4	10

Table 3. The upper limits of motion in a normal spine as seen on functional radiography.

According to White and Panjabi (1978), the radiographic criteria established as spinal instability are the following:

Flexion-extension radiographs

- Sagittal plane translation > 4.5 mm or 15%
- Sagittal plane rotation

15° at L1-2, L2-3, and L3-4

20° at L4-5

25° at L5-S1

Resting radiographs

- Sagittal plane displacement >4.5 mm or 15%
- Relative sagittal plane angulation >22°

Despite these measurement techniques are commonly used in taking care of some spinal pathologies, especially degenerative disorders, are not really relevant in clinical practice

when talking about stabilization exercise program and its used as an instability evaluation technique has not been reported in any of the stabilization research papers.

Now some examples of different tests related to tight muscles, lax muscles and movement impaired are presented.

2.1 Tight muscles tests

2.1.1 Thomas test

Goal: to assess the length of the hip flexors.

The patient begins in supine position on the examination table. He/she is told to lift both knees up to his/her chest, keeping his/her back flattened to a point where the sacrum just begins to lift away from the examination table surface, but not further. As he holds on leg close to his chest in order to maintain the pelvic position, the opposite lower limb is gradually extended until it rests on the table. An increase of lumbar lordosis or the impossibility to complete the knee extension (figure 3b) indicates shortened hip flexors (iliopsoas mainly).

The same procedure with the examined leg out of the table (figure 3c) elucidates a shortened rectus femoris. Optimal alignment occurs with the femur horizontal and aligned with the sagittal plane (no abduction) and with the subject's shoulder, hip, and knee more or less in line. A positive test is indicated when the tibia loses their vertical position due to knee extension. The test is negative when the tibia remains vertical.



Fig. 3(a). Thomas test (no shortness).



Fig. 3(b) Thomas test (iliopsoas shortened).



Fig. 3(c). Modified Thomas test (rectus femoris shortened).

2.1.2 Ober Test

Goal: to assess the length of tensor fasciae lata muscle.

The patient adopts a side-lying position with the pelvis in neutral. Contralateral knee is bent in order to improve overall body stability while the examiner stabilizes the pelvis to avoid lateral pelvic dipping. Patient abducts the homolateral leg to 15° above the horizontal and then extends his hip about 15° . While maintaining extension patient is then told to adduct his/her leg. Optimal muscle length would be confirmed if he/she is able to lower the homolateral leg to the level of the table.



Fig. 4(a). Ober test; started position.



Fig. 4(b). Ober test; ended position.

2.1.3 Straight-leg raise test

Goal: to assess tightness in hamstrings.

The patient lies supine on the examination table, with one leg slightly bent. The patient is told to raise the other leg, keeping it completely straight. The examiner palpates the anterior rim of the pelvis to note the point at which the pelvis begins to posteriorly tilt because of hamstrings tightness. Optimal muscle length will permit degrees of flexion around 60-70°.



Fig. 5. Straight-leg raise test.

2.2 Lax muscles tests

2.2.1 Assessing muscle balance in the gluteus medius

Goal: to determine if the gluteus medius muscle is capable of holding the hip in full inner-range combined abduction and external rotation.



Fig. 6(a). Assessing muscle balance in the gluteus medius; started position.

The action in this test combines hip abduction and slight lateral rotation to emphasize the posterior fibers of the muscle. Patient lies on one side with his knees flexed and feet together. This position will identify where muscle tone is poor. People should rotate their trunk forward until the chest is on the couch and allow the knee to drop over the couch side. From this position they lift the leg as before.



Fig. 6(b). Assessing muscle balance in the gluteus medius; ended position.

2.2.2 Sorensen test (low back fatigue test)

Goal: to determine isometric endurance of trunk extensor muscles.



Fig. 7. Sorensen test.

The test consists in measuring the amount of time a person can hold the unsupported upper body in a horizontal prone position with the lower body fixed to the examining table.

Maximum values:

Healthy women: 171 sec. Healthy men: 239 sec.

Low back pain women: 99 sec. Low back pain men: 109 sec.

2.2.3 Prone abdominal hollowing test using pressure biofeedback

Goal: to assess patient's ability to hold the inner range of the deep abdominals.

With the patient lying prone, a pressure biofeedback unit is placed under his/her abdomen with the upper edge of the device's bladder below his navel. The unit is then inflated to 70 mmHg and patient is instructed to perform the abdominal hollowing maneuver. The aim is to reduce the pressure reading on the biofeedback unit by 6 to 10 mmHg and to maintain this contraction for 10 repetitions of 10 sec. each while breathing normally.



Fig. 8. Prone abdominal hollowing test using pressure biofeedback.

2.3 Movement impaired test

2.3.1 Functional low back movements

Goal: to determine the quality of each movement (flexion, extension, side-bending and rotation).

Patient stands up and is asked to move into flexion, extension, side-bending and rotation. Pelvis and low back is monitored any time in a quantitative and qualitative way.

2.3.2 Kneeling rock-back

Goal: to determine control of the hip relative to the lumbar-pelvic region while kneeling.

Patient is kneeling on a mat on all fours, with his/her hand directly beneath his shoulder and his knee beneath his hip. The test begins with the lumbar spine in a neutral position and then is rocked backward, pulling the hip behind the knees. Examiner should monitor the pelvic tilt angle and lumbar lordosis. Motion should begin at the hip for an optimal segmental control. Once hip flexion passes about 120° (depending on patient's body proportions), his pelvis should posteriorly tilt and his lumbar spine flatten. Examiner should ensure that he moves slowly, and determine whether the sequence is motion at the hip-pelvis-lumbar spine. Poor segmental control will be present if the pelvic tilts and the lumbar spine flattens at the beginning of the rock-back.



Fig. 9(a). Kneeling rock-back; starting position.



Fig. 9(b). Kneeling rock-back; ended position.

2.3.3 One-leg lift

Goal: to assess lumbar-pelvic control during one-leg lifting.

Patient stands side-on to a wall with one hand on the wall for balance if needed. He/she is instructed to slowly lift one leg, with the knee bent. The leg should reach a comfortable position -usually above hip height- and then lower. The examiner monitors the lumbar-pelvic region from the front and the side. In optimal alignment, the pelvis should remain level horizontally as the patient lifts his leg, and the sequence should be hip motion (flexion) followed by pelvic motion (posterior tilt) followed by lumbar motion -lordosis flattens and then reverses-. Poor control exists when the pelvis drops as the leg is lifted, and the lumbar spine flexes during the early stages of the movement.



Fig. 10. One-leg lift.

2.3.4 Forward bending

Goal: to determine lumbar-pelvic control in bending.

Patient stands with his/her feet shoulder-width apart, facing the seat of a chair. He/she is instructed to bend forward, to touch the chair seat, and to stand back up again. Optimal control occurs when the patient unlocks his/her knees and anteriorly tilts his pelvis, flexing only slightly at the lumbar spine. Poor control will be present when he locks out and hyperextends the knees; he/she should not tilt his pelvis but instead should flex markedly at the lumbar and thoracic spine.



Fig. 11. Forward bending test.

3. Phases of treatment: Lumbopelvic stabilization program

The first consideration before establishing phases of treatment is to determine testing procedures. Many experimental assessment procedures, some of them described before,

give essential information about joint protection mechanisms, especially in the lumbopelvic region.

Lumbopelvic stabilization program needs to involve a problem-solving approach, where clinical tests, reflecting the dysfunction mechanisms, are used to decide the best type of treatment approach for an individual client. In order to achieve this, assessments and their related treatments have been simplified by dividing them into progressive stages, where one stage of assessment and treatment is ideally completed prior to proceeding to the next stage. The segmental approach we have devised develops through three stages of segmental control, with each stage exposing the individual patient to increasing challenges to his/her joint protection mechanisms (Richardson et al., 2004).

- Segmental control over primary stabilizers (mainly TrA, deep multifidus, pelvic floor and diaphragm)
- Exercises in closed chain, with low velocity and low load
- Exercises in open chain, with high velocity and load

3.1 Phase 1

Key: Segmental control over primary stabilizers.

We refer to re-establishing directly the simultaneous contraction of the deep muscle synergy independently of the secondary stabilizers and mobilizers. This simultaneous contraction of the synergy, independent of the global muscles, should occur with the postural cue to “draw in the abdominal wall”. The weight of the body is minimized in order to allow the patient to focus on this specific skill involved in joint protection.

Training local segmental control involves activating and facilitating the local muscle system, while using techniques (e.g. feedback) to reduce the contribution of the global muscles, most particularly the mobilizers. Instructional cues, body position and various feedback techniques (including palpation, electromyography and real-time ultrasound) are used simultaneously to facilitate the local synergy and inhibit or relax the more active global muscles. The ability to hold this pattern through developing specific muscular control, without addition of any load, may serve also to help to restore kinaesthetic awareness and lumbopelvic position sense, usually found to be impaired in the patient with low back pain.

The precise position of the lumbopelvic region may itself be facilitatory for activation of the local synergy muscles. Recent research has shown that better co-activation of the TrA occurs when the pelvic floor is contracted with the lumbar spine placed in a more neutral position (Sapsford et al., 1997b). There is a consensus that local muscles are involved in segmental support and, therefore, contribute to the precise positioning of the lumbosacral curve.

Lumbar multifidus activation

In order to get a suitable activation of lumbar multifidus (LM), a submaximal contraction was elicited with the contralateral arm lift maneuver, while holding a small hand weight, as previously demonstrated to elicit approximately 30% of the maximal voluntary contraction of the LM muscle (Koppenhaver et al., 2011).



Fig. 12. Activation of multifidus in prone position.

Transversus abdominis activation

In order to get a suitable contraction of TrA, we propose to use the hollowing-in maneuver. Performance of the abdominal hollowing maneuver may be difficult, even in healthy subjects. Contraction of the pelvic floor muscles may promote contraction of the TrA during the abdominal hollowing maneuver. Participants were instructed to “take a relaxed breath in and out, hold the breath out and then draw in your lower abdomen without moving your spine.” Alternate cues of “cut off the flow of urine” or “close your rear passage” were sometimes given in an attempt to optimize contraction of the TrA with minimal to no thickening of the internal oblique (IO) muscle (Koppenhaver et al., 2011).



Fig. 13. Abdominal hollowing; activation of transversus abdominis in crook-lying position.

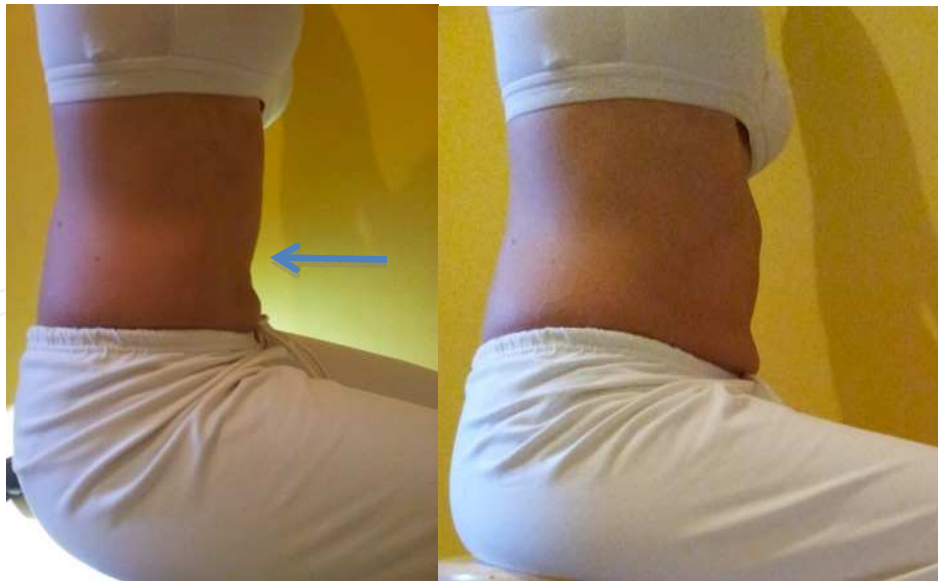


Fig. 14. Abdominal hollowing: activation of transversus abdominis in sitting.



Fig. 15. Abdominal hollowing: activation of transversus abdominis in four point kneeling.



Fig. 16. Activation of multifidus from sitting to lumbar neutral position: looking for neutral position.

3.2 Phase 2

Key: Exercises in closed chain, low velocity and low load.

The purpose is to maintain local muscle synergy contraction, while gradually progressing load cues through the body using weightbearing closed chain exercises. Weightbearing load is added very slowly, ensuring any weightbearing muscle at any kinetic chain segment is activated in order to give effective antigravity support and provide efficient and safe load transfer through the segments of the body. The focus is especially to ensure activation of the local and weightbearing muscles of the lumbar spine and pelvis, and the ability to maintain a static lumbopelvic posture for weightbearing. These muscles are likely to be dysfunctional in patients with low back pain. In addition, lifestyle factors of many individuals, which could have led to a dysfunction in these muscles, need to be addressed, as they may place them at risk of sustaining further low back injury.



Fig. 17. Stand-up position on unstable surface.



Fig. 18. Closed chain lunge exercises, with the addition of hand weights.



Fig. 19. Bridge in prone position



Fig. 20. Bridge in supine position.



Fig. 21. Lateral bridge.

3.3 Phase 3

Key: Exercises in open chain, high velocity and high load.

The aim is to continue to maintain local segmental control while load is added through open kinetic chain movement of adjacent segments. This final step is to direct progression so that all muscles are integrated into functional movement tasks in a formal way.

This third stage allows any loss of local segmental control during high loaded open chain tasks to be detected, as well as ensuring that there is no compensation by the more active (i.e. non-weightbearing) muscles. In addition, loss of range of asymmetry of joints adjacent to the lumbopelvic region needs to be addressed to ensure that loss of movement range does not interfere with the ability of the individual to maintain lumbopelvic stability during movement.



Fig. 22. Lower limb abduction.



Fig. 23. Knee extension in supine position on roller.



Fig. 24. Open chain exercise of upper limb after co-contraction of transversus abdominis and multifidus.

4. Gym ball and foam roller exercises

4.1 Gym ball

We can obtain good levels of stability using exercise with gym balls (also called stability balls or Swiss balls). These exercises require quite complex movements and will help increase the stability already obtained through previous exercises in this book. They can also strengthen stability muscles that otherwise might not be exercised. It is an inexpensive and effective apparatus for back stability. A 26 in. (65 cm) gym ball provides the optimal sitting position for most people although it can be used 21.6 in. (55) cm and 29.5 in. (75 cm). People should be able to sit on the ball with their femurs horizontal and their hips and knees both at 90° to 100° of flexion, so that their knees are slightly below their hips.

4.1.1 Practical considerations (Norris, 2008)

- Patients should warm up before use them.
- Return to the neutral position when the exercise is complete and keep their abdomens hollowed when stress is imposed on the spine.
- Progression with stability ball exercises: we might start with 8 to 10 repetitions, and then increase to 12 to 15. At first a slow count of 4 to 5 to move into a holding position should be used; hold the designated position for a count of 5, and then use a count of 4 or 5 to move back into the starting position. Patients can progress by adding reps or increasing the holding time.
- Deflate the ball slightly to increase its contact area.
- Begin with simple actions and progress to more complex movements.

4.1.2 Some exercises

- Sitting knee raise on gym ball. Goal: maintain stability in the presence of hip movement on a reduced base of support.



Fig. 25. Sitting knee raise on gym ball.

- Abdominal slide. Goal: control action of the rectus abdominis while moving.



Fig. 26. Abdominal slide.

- Lying trunk curl with leg lift. Goal: strengthen upper and lower abdominals.



Fig. 27. Lying trunk curl with leg lift.

- Basic superman. Goal: strengthen the spinal and hip extensors.



Fig. 28. Basic superman.

- Bridge with therapist pressure. Goal: strengthen hip and trunk stability muscles by challenging stability with continuously variable overload from multiple directions.



Fig. 29. Bridge with therapist pressure.

4.2 Foam roller

Foam rollers are commonly used within physical therapy for rehabilitation and during exercise classes such as Pilates (Norris, 2008). They are normally 3 ft (1 m) long and either 3 or 6 in. (7.6 or 15.2 cm) in diameter. Rollers may be either full rolls (circles) or half rolls (D-shaped), made of polyurethane or similar materials, which are durable and suitable for weight bearing up to 350 lb (150kg) (figures 23, 30, 31 and 32).

Because the rollers are narrow, their contact area with the floor is quite small, making them ideal as an unstable base of support. Because they are firm but forgiving, they are especially useful for exercises that require direct body contact. Foam rollers have the advantage over wooden wobble boards in this feature.

Each exercise should be performed for 10 repetitions or 5 reps to each side (10 in total) if using single-side movements. Because these are balance exercises, they may be progressed through timing and complexity.

4.2.1 Some exercises

Supine-lying leg lift. Goal: to develop back stability in an unstable lying position.



Fig. 30. Supine-lying leg lift.

- Bridge with heel raise on roller. Goal: develop spinal extensor and gluteal muscle endurance on an unstable platform.



Fig. 31. Bridge with heel raise on roller.

- Prone tuck on roller. Goal: to develop whole trunk strength and range of motion.



Fig. 32. Prone tuck on roller.

5. Conclusions

Lumbopelvic stabilization approach seems to be useful for the management of low back pain. Based on a solid biomechanical model (Panjabi's hypotheses), it has demonstrated positive effects over pain and return to activity, but it is not clear the optimal type of exercise, duration or number of repetitions, among other variables. Furthermore there is no strong evidence that conclude whether lumbopelvic stabilization programs provide better

results than other different methods such as Pilates, Yoga, or Aerobics. Further research focusing on these topics is needed.

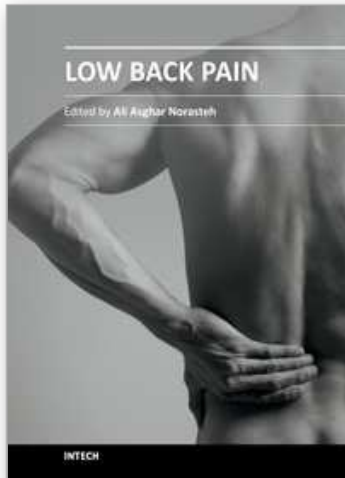
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This book includes two sections. Section one is about basic science, epidemiology, risk factors and evaluation, section two is about clinical science especially different approach in exercise therapy. I envisage that this book will provide helpful information and guidance for all those practitioners involved with managing people with back pain-physiotherapists, osteopaths, chiropractors and doctors of orthopedics, rheumatology, rehabilitation and manual medicine. Likewise for students of movement and those who are involved in re-educating movement-exercise physiologists, Pilates and yoga teachers etc.

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