Lumbar Spine Stabilization
By
Robert I. Naber, P.T., O.C.S., A.T.,C.

Physical Therapy's approach to back rehabilitation has significantly matured over the past 20 years. Rehabilitation has progressed from a primary emphasis on passive procedures and modalities performed on the patient, to a more active approach of exercises performed by the patient. These exercises include spinal range-of-motion exercises such as Williams' spinal flexion motions and McKenzie's extension press ups and stabilization exercises. In the 16 years since Saal and Saal published their non-operative approach to treating herniated discs in the lumbar spine [8], stabilization exercises have become a mainstay in physical therapy treatment for low back pain. However, these exercises are often prescribed to patients without consideration of what is to be stabilized, which muscles are to be strengthened, or the patient's daily, occupational or recreational needs.

Successful lumbar stabilization exercises require an understanding of how the lumbar spine achieves stability and how it is defined. Webster's New World Dictionary 2nd College edition defines stability as "The state of quality of being firm, steady and not easily thrown off balance." In his 2002 book Low Back Disorders Evidenced Based Prevention and Rehabilitation, McGill describes a continuum of stability with the analogy of a ball in a bowl. The bowls vary by depth and by the height of the walls. The deeper the bowl is and the steeper the walls are, the greater is the stability of the system. The analogy describes the potential energy of the motion segment. The steepness of the walls represent joint stiffness, and the width of the bowl represents joint laxity (Picture 1).

The stiffness of a lumbar motion segment is provided by a balance between osteoligamentous and musculotendinous structures and the motor control system. Injuries, whether traumatic or repetitive, damage the balance of these structures and lead to a state of instability, where an applied force exceeds the stiffness of the motion segment.[2] Flexion and rotation of the intervertebral disc can create annular tears, and excessive vertical compression can damage the cartilaginous endplates resulting in insufficient hydrostatic pressure of the disc. Postural stress can weaken muscle strength, and pain can change the motor control system of the stabilizing muscles such as the Transverse Abdominus.[6,5] Leg length inequality, structural or functional, reduces the spine's stability by moving it from the vertical position of stability and low potential energy to positions deviating from vertical with higher potential energies.

The excessive motion characteristics of an unstable vertebral segment may not be validated by measurements indicating an excessive active range of motion. Rather, given the three degrees of freedom and three planes of translation of the spine, excessive motion characteristics arise from and can be confirmed by a deviation from the normal ratio between the rotation and translation. A patient with spondylolisthesis has excessive translation but may be unable to forward bend and reverse their lumbar lordosis.

Non-operative treatment of lumbar instabilities includes stabilization exercises to increase the stiffness of the motion segment. It is believed this restores the motion characteristics of the vertebral segment. McGill reported that in most people with an undeviated spine, modest levels of coactivation of the paraspinal and abdominal wall muscles will result in sufficient stability of the lumbar spine.[3] However, maintaining this stability to prevent injuries during work and daily activities requires muscle endurance and equal tension of the muscular guide wires rather than the muscle definition of a body builder or high maximum strength. Endurance training has been suggested previously by Biering- Sorensen to reduce the risk of future back troubles.[1]

Endurance testing of the spine muscles from healthy young individuals has been researched isometrically by McGill.[4] The results are listed below in Table 1. The lateral musculature was tested in a side bridge or plank position (Picture 2). The trunk flexors were tested with a sustained sit-up position at 60-degrees (Picture 3) and the back extensors were tested in the Biering-Sorensen position (Picture 4). Other results by McGill indicate the ratio of endurance among the anterior, lateral and posterior musculature is upset once back troubles begin and remains long after the symptoms resolve. The endurance of the extensors is diminished relative to both the flexors and lateral musculature in individuals with a history of back disorders even when they are asymptomatic. Results are listed below in Table 2. Though this type of endurance testing is reliable and easy to do, it does not speak to the primarily eccentric function of the spine muscles and should be carefully applied according to the specific needs of individual patients.

Table: 1 Mean Endurance Time in seconds and ratios normalized to extensor endurance test scores of healthy 21 year-olds (men:n=92; women:n=137).

	Men		Women		All	
Task	Mean	Ratio	Mean	Ratio	Mean	Ratio
Extension	161	1.0	185	1.0	173	1.0
Flexion	136	0.84	134	0.72	134	0.77
Right SB	95	0.59	75	0.40	83	0.48
Left SB	99	0.61	78	0.42	86	0.50
Flexion/Extension	0.84		0.72		0.77	
RSB/LSB	0.96		0.96		0.96	
RSB/Extension	0.58		0.40		0.48	
LSB/ Extension	0.61		0.42		0.50	

Table: 2 Mean Endurance Time in seconds and ratios normalized to extensor endurance test scores of normal workers and those who had back disorders but where asymptomatic at the time. Mean age: 34 y.o. (Never had back troubles: n=24; Lost work due to LBD: n=26).

	No Back Troubles		**History of Back Troubles**	
Task	**Mean**	**Ratio**	**Mean**	**Ratio**
Extension	103	1.0	90	1.0
Flexion*	**66**	0.64	**84**	0.94
Right SB	54	0.52	58	0.64
Left SB	54	0.52	65	0.72
Flexion/Extension*	**0.71**		**1.15**	
RSB/LSB*	**1.05**		**0.93**	
RSB/Extension*	**0.57**		**0.97**	
LSB/ Extension*	**0.58**		**1.03**	

* Significantly different between groups.

The stability of the spine is achieved primarily from the function of muscle support and motor control. The muscles act as guide wires to support the spine. The endurance of the trunk muscles appears to be of greater importance than their strength: the balance between the muscles on all four sides of the spine plays the most important role in stabilizing the spine. Given the many directions the spine is capable of moving, muscle endurance in the transverse plane and non-cardinal planes are also important, as are the different muscle contractions needed for each patient's own daily, occupational and recreational activities.

<u>References</u>:

1. Biering-Sorensen F. Physical measurements as risk indicators for low back trouble over a one year period. *Spine*, 9:106-119, 1984.

2. McGill, S., page 140 (2002) Low Back Disorders- Evidence Based Prevention and Rehabilitation. Champaign, Illinois.

3. McGill, S., page 143 (2002) Low Back Disorders- Evidence Based Prevention and Rehabilitation. Champaign, Illinois.

4. McGill, S., page 227 (2002) Low Back Disorders- Evidence Based Prevention and Rehabilitation. Champaign, Illinois.

5. O'Sullivan, P., Twomey, L.T., and Allison, G.T., Altered pattern of abdominal muscle activation in chronic back pain patients. *Australian Journal of Physiotherapy*, 43:91-98, 1997.

6. Richardson, C., Jull, G., Hodges, P., and Hides, J., (1999) Therapeutic exercises for the spinal segmental stabilization in low back pain. Edinburgh, Scotland; Churchill Livingstone.

8. Saal, JA. and Saal JS. Non-operative treatment of herniated lumbar intervertebral disc with radiculopathy. An outcome study. *Spine* 14:431-7. 1989.