

## Muscular Imbalance: An Update

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New work from Chris Norris has advanced our knowledge about how to restore muscle imbalance. In particular, new tests of a muscle's inner holding endurance have been presented. Also, a revised understanding of the classification of muscles into those which tend to lengthen versus those which tend to shorten has been presented. Much of this work was previously eluded to in his excellent series of papers:

1. Norris CM. Spinal stabilisation. 1. Active lumbar stabilisation - concepts. *Physiotherapy* 1995;81(2):61-4.
2. Norris CM. Spinal stabilisation. 2. Limiting factors to end-range motion in the lumbar spine. *Physiotherapy* 1995; 81(2):64-72.
3. Norris CM. Spinal stabilisation. 3. Stabilisation mechanisms of the lumbar spine. *Physiotherapy* 1995;81(2):72-9.
4. Norris CM. Spinal stabilisation. 4. Muscle imbalance and the low back. *Physiotherapy* 1995;81(3):127-38.
5. Norris CM. Spinal stabilisation. 5. An exercise program to enhance lumbar stabilisation. *Physiotherapy* 1995; 81(3):138-46.

However, Norris has expanded this information in an upcoming, as yet unpublished manuscript on spinal stabilization for human kinetics (scheduled publication: 2000). Another book he has written on sports injuries presents many of these concepts (Norris C. *Sports Injuries: Diagnosis and Management*, 2nd edition. London: Butterworth Heinemann, 1998).

The most difficult area of rehabilitation is facilitation of the weak link. This requires compliance, motivation, concentration and effort. A shortcut is sensory motor training. Economic constraints make mobilization much more "user friendly" than stabilization. Manipulation is quick, whereas therapeutic exercise training can be time consuming. Issues of motivation, compliance and adherence further cloud the achievement of rehabilitation goals. In order to overcome these inherent problems in the successful integration of rehabilitation into musculoskeletal practice, a model has been worked out for improving the efficiency of the delivery of rehabilitation services.

It is essential to link the rehabilitation prescription to the patient's symptoms, diagnosis and activity intolerances. First, identify the relationship between biomechanical overload and the injured tissues. Second, find the kinetic chain dysfunction (pathomechanics) responsible for the biomechanical overload. Third, address the key functional pathologies utilizing the continuum of care. Fourth, follow the basic progressions described below to facilitate the "weak link."

A major stumbling block in delivering rehabilitation services in a chiropractic setting is identifying the appropriate rehabilitation goal. According to Lewit, "Disturbed movement patterns are the most important cause of blockage, and remedial exercise is the therapy of choice." Obviously, improving faulty movement patterns is the major goal of spinal rehabilitation. However, as Lewit

says, "Remedial exercise is always time consuming, and time should not be wasted ... We should not attempt to teach patients ideal locomotor patterns, but only correct the fault that is causing the trouble."

For chiropractors to find added value in rehabilitation for their practices, they must learn how to identify realistic rehabilitation goals. Additionally, they must learn specific methods of progressing patients and facilitating the "weak link" (see Table I). Patients generally do not perform exercises perfectly. As Lewit says, "The inventiveness of patients to make mistakes with exercise has no bounds." Therefore, appropriate goal setting and a methodological approach to progressing patients is necessary for managing the rehabilitation of spine patients.

[Table I: Basic progressions to facilitate the "weak link" and improve motor control.]

1. Train awareness of postural (neutral range joint) control during activities.
2. Prescribe beginner ("no brainer") exercises.
3. Progress to more challenging exercises (i.e., labile surfaces, whole body exercises).
4. Transition to activity-specific exercises (i.e., with tubing).
5. Transition to health club exercise options.

Successful training is contingent on a number of factors. First and foremost is identification of the underlying muscle imbalance. Muscles have different functions. Most muscles function to produce movement, such as rotation around a joint fulcrum. Others function to stabilize a joint during such movements. The VMO is an example of a stabilizer, while the quadriceps is an example of a mobilizer. The function of stabilizers and mobilizers is summarized in Table II.

[Table II: Functions of stabilizers and mobilizers.]

Stabilizer	Mobilizer
1. establish joint congruence	1. produce angular rotation
2. greater sensory role	2. smaller sensory role
3. anti-gravity/postural	3. torque producers
4. tonic activity	4. phasic activity
5. isometric, eccentric	5. concentric
6. fatigue resistant	6. fatigable
7. often deeper muscles	7. often more superficial muscles

Examples of muscles which function primarily as stabilizers are the following:

#### Stabilizer Muscles

- VMO
- Gluteus medius
- Transverse abdominus
- Gluteus maximus
- Internal oblique
- Lower trapezius
- Multifidus
- Serratus anterior

- QL
- Deep neck flexors

Many of these muscles have a tendency to lengthen as a result of deconditioning. As a result, their synergists become overworked and their antagonists shorten. For instance:

#### Lengthened or Underactive Stabilizer

1. Gluteus medius
2. Gluteus maximus
3. Transverse abdominus
4. Lower trapezius
5. Deep neck flexors
6. Serratus anterior

#### Overactive Synergist

1. TFL
2. Iliocostalis lumborum and hamstrings
3. Rectus abdominus
4. Levator scapulae/upper trapezius
5. SCM
6. Pectoralis minor

#### Shortened Antagonist

1. Adductors
2. Iliopsoas, rectus femoris
3. Iliocostalis lumborum
4. Pectoralis major
5. Suboccipitals
6. Rhomboids

A number of tests can be used to assess muscle imbalance, such as postural inspection, muscle length tests, movement patterns and inner holding endurance times. Posture is valuable because it provides a quick screen.

Muscle	Sign of Lengthening or Inhibition
Transverse abdominus	Navel out
Serratus anterior	Winging scapulae
Lower trapezius	Elevated shoulder girdle
Deep neck flexors	Chin poking
Gluteus medius	Unlevel pelvis with one leg standing
Gluteus maximus	Sagging buttock

Muscle length evaluation often shows shortening of the following muscles:

- Gastrosoleus
- Iliocostalis lumborum
- Hamstrings
- Upper trapezius
- Adductors

- Levator scapulae
- Iliopsoas
- Suboccipitals
- Rectus femoris
- Pectoralis major and minor

Movement pattern evaluation is essential to determining the change in the center of rotation (CR) of a movement fulcrum from primary to secondary joints. It also illustrates whether repetitive strain is occurring in the kinetic chain at a particular point. This is often the result of a relatively hypomobile area, due to muscle shortening, being compensated for by a relatively hypermobile area, due to an overactive synergist. Finally, reaction times of various synergistic muscles can be observed. The following tests are commonly performed:

- hip extension
- hip abduction
- trunk curl
- arm abduction
- trunk lowering from a pushup
- neck flexion

Finally, tests of a muscle's inner holding isometric endurance can be performed. This is performed on muscles which have a tendency to lengthen in order to assess their ability to maintain joint alignment in a neutral zone. Usually, a lengthened muscle has lost endurance when tested in a shortened position. This can be tested by passively repositioning the muscle in a shortened position and assessing the duration of time that the patient can hold the muscle in the shortened position. Ten repetitions of 10-second holds is one option. Another is a single 30-second hold. If the patient cannot hold the position actively the moment the passive repositioning is released, it is a sign of antagonist muscle shortening.

Tests of a muscle's inner holding isometric endurance:

- Dead bug
- Hip extension
- Neck curl
- Lower trapezius
- Iliopsoas
- QL
- Squat
- Sorensen (neutral, not inner holding)
- Balance - one leg standing (neutral)

Training should ensure that the stabilizers are isolated; that the center of rotation is around the primary joint fulcrum; and that hypermobility in secondary joints does not occur as a result of compensation for hypomobility at a primary joint. This is the case with both stretching and strengthening. If appropriate isolation and coordination are not maintained, muscle imbalance is increased by exercise.

Key components of an exercise routine are coordination and endurance:

Coordination

- reaction time

- synergist substitution
- agonist-antagonist relationship
- center of rotation

#### Endurance

- holding time (inner)

Training follows these steps:

- Treat key sources of dysfunction such as fixed joints, trigger points or stuck fascia;
- Identify the key muscle imbalances;
- Train agonist/antagonist muscle endurance in the inner range; and
- Avoid improper movement patterns.

Stretching is required if the antagonist shortening interferes with agonist isolation (i.e., iliopsoas/gluteus maximus) or if peripheral muscle inflexibilities make it hard to control spinal posture during exercise (i.e., gastrosoleus/lumbosacral).

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