- (Part one)
11. The role of the core in middle and long distance running

Introduction

For middle and long-distance runners whose events involve balanced and powerful movements of the body propelling itself forward and catching itself in complex motor patterns a strong foundation of muscular balance is essential. In many runners, however, even those at an Olympic level, the core musculature is not fully developed. Weakness or lack of sufficient coordination in the core musculature can lead to less-efficient movements, compensatory movement patterns, strain, overuse, and injury. This article briefly discusses the theory behind core training for injury prevention as well as for improving a distance runner's efficiency and performance. It then details a systematic progression of core exercises that can be incorporated easily into every runner's training programme.

The role of the core

The core musculature is composed of 29 pairs of muscles that support the lumbopelvic-hip complex. These muscles help to stabilise the spine, pelvis, and kinetic chain during functional movements. When the system works efficiently, the result is appropriate distribution of forces; optimal control and efficiency of movement; adequate absorption of ground-impact forces; and an absence of excessive compressive, translation, or shearing forces on the joints of the kinetic chain.

The first stage in developing a stable core is to develop the abdominal muscles. Richardson et al have discovered that there are two different types of muscles fibres (slow-twitch and fast-twitch) that make up the abdominal muscles, and that because of this different fibre composition, different exercise regimens are required to properly train these muscles. Slow-twitch fibres primarily make up the local muscle system-the muscles of the deeper abdominal muscle layers. These muscles are closer to the centre of rotation of the spinal segments and, with their shorter muscle lengths, are ideal for controlling intersegmental motion, maintaining mechanical stiffness of the spine, and are best suited to respond to changes in posture and extrinsic loads. The key muscles of this system include the transversus abdominus, multifidi, internal oblique, deep transversospinalis, and pelvic floor muscles. Co-contraction of these muscles produces force via the thoracolumbar fascia and the intra-abdominal pressure mechanism stabilises and resists forces acting on the lumbar spine.

Fast-twitch fibres, on the other hand, primarily make up the global muscle system, which includes the superficial or outer-layer muscles. These muscles possess long levers and large moment arms that are capable of producing high outputs of torque, with an emphasis on speed, power, and larger arcs of movement. The main muscles in this layer are the erector spinae, external oblique, and rectus abdominis muscles-the muscles that are strengthened by traditional back and abdominal exercises and that assist with gross spinal movements.

Interestingly, Hodges and Richardson have shown that it is not simply that

deep-layer abdominal muscles are recruited during stabilisation of the spine, but it is how they are recruited that is important. The transverse abdominus and the multifidi are considered "stabilising muscles" (muscles that are continually modulated by the central nervous system and provide feedback about joint position), while the global and larger torque-producing muscles control acceleration and deceleration. The authors found that the co-contraction of the deeper-layer transverse abdominus and multifidi muscle groups occurs prior to any movement of the limbs, and believe that this neuromuscular pre-activation is critical in stabilising the spine prior to any movement.

The core programme

Stability work should be started only after the athlete has achieved good mobility, as adequate muscle length and extensibility are crucial to proper joint function and efficiency. Although beyond the scope of this article, a thorough evaluation of the muscular system should include an assessment of the muscles for over-activity, shortening, weakness, inhibition, and quality of motion. This is best accomplished by a skilled physician or therapist using muscle-length tests, strength tests, and tests for the efficiency of basic movement patterns and neuromuscular control. A thorough postural observation and video taping of the athlete's running gait will help in assessing and identifying any movement imbalances.

Preliminary stretches for shortened muscles should include proprioceptive neuromuscular facilitation (PNF) type or contract-relax stretches that strive for isometric contraction, followed by end-range stretching. These are effective techniques for maintaining muscle length and joint mobility. Active Release Techniques@ (a specialised method for soft tissue mobilisation) when used in conjunction with stretching techniques, have shown great promise in restoring muscle length and soft-tissue extensibility. Athletes can also do their own self-mobilisation with use of a foam roll.

Proprioceptive: *Relating to stimuli that are produced and perceived by the body. especially those connected with position and movement.*

Specific exercises for the runner should progress from mobility to stability, to reflexive motor patterning, to acquiring the skills of fundamental movement patterns, and finally, to progressive strengthening. These sequences may not be applicable to all athletes; therefore, the key is to analyse the individual in each exercise category and then to tailor an exercise regimen that will best suit that runner's needs. For example, it has been shown that runners prone to iliotibial band syndrome often have weakness in their hip abductors that predisposes them to increased stress on the iliotibial bands. Thus, a preventative training programme for runners with this syndrome must target the hip abductors, particularly the posterior aspect of the gluteus medius that assists external rotation or in decelerating internal rotation of the hip. Other muscles that prove weak or inhibited on evaluation should also be strengthened on a case-by-case basis.

The purpose of basic core stabilisation exercises is not only to increase stability,

but more importantly it is to gain co-ordination and timing of the deep abdominal-wall musculature. It is extremely important to do these basic exercises correctly. as they are the foundation of all other core exercises and movement patterns. These basic exercises emphasise maintaining the lumbar spine in a neutral position (which is the midrange position between lumbar extension and flexion.), allowing for the natural curvature of the spine.

This first stage of core stability training begins with the athlete learning to stabilise the abdominal wall. Proper activation of these muscles is considered crucial in the first stages of a core stability programme, before progressing to more dynamic and multi-planar activities.

We recommend the technique as described by McGill. This involves a sub-maximal isometric contraction of the three layers of the abdominal wall (rectus, obliques, and transverse) producing a true muscular girdle around the spine to buttress against buckling and shear instability.

Fundamental lumbo-pelvic stability

The exercise programme should progress sequentially through the fundamental movements as detailed below. The following exercises are to be performed three times per week to maximise results. The athlete begins with one to two sets of 15 repetitions and progresses to three sets of 15-20 repetitions. These exercises are taught initially in either a supine, hook-lying position, or all-fours quadruped position. The athlete can progress to the more functional standing exercises, as control is developed. Important concepts taught at this stage include not tilting the pelvis or flattening the spine. We also emphasise normal rhythmic breathing.

SUPINE BENT-KNEE RAISES

This is a fundamental exercise for recruiting the deep abdominal muscles and for lumbopelvic control.

The athlete lies on her back, with knees bent and feet flat on the floor. She then braces the abdominal wall, holding the lumbar spine in a neutral position, and slowly raises one foot 15-30cm off the ground with alternate legs. Common errors when performing this exercise include rocking the pelvis, abdominal protrusion, or an inability to maintain the neutral (midrange) lumbar curve. If this happens, discontinue the exercise for a rest period. Quality more than quantity is stressed.

Progression: The exercise can progress to alternately extending the legs and lowering to the ground. Once the athlete can maintain stability with alternate leg lifts. She can add alternate, overhead arm raises for greater challenge. The arm raises should be performed slowly, while maintaining lower abdominal bracing.

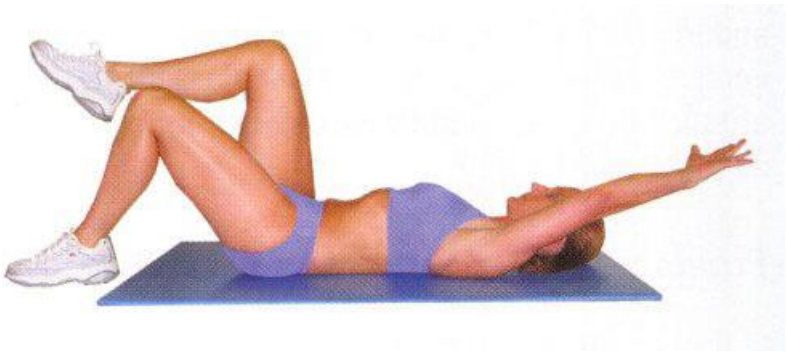

Figure 1: Supine Bent-Knee Raises

QUADRUPED WITH ALTERNATE ARM/LEG RAISES

This exercise prepares the athlete for the proprioceptively more challenging, more dynamic exercises of the trunk. It specifically engages the multifidi-the deep transverse spine stabiliser and extensor of the lumbar spine.

The athlete should position herself on all fours. She then braces the abdominal wall as described above. While maintaining a midrange/neutral curve of the lumbar spine, the athlete should raise the right arm and the left leg (opposite upper and lower limbs) into a line with the trunk, while preventing any rocking of the pelvis or spine (excessive transverse or coronal-plane motion). If it helps to maintain alignment, the athlete may use an object, such as a foam roller or wooden dowel, placed along the spine, for added tactile feedback. The leg should be raised only to the height at which athlete can control any excessive motion of the jumbo-pelvic region. She then performs the exercise raising the left arm with the right leg.

Progression: A Physioball underneath the trunk can provide significantly more proprioceptive challenge owing to its unstable surface. The goal once again is for the athlete to maintain lumbar stability while the opposite arm and leg are raised slowly.

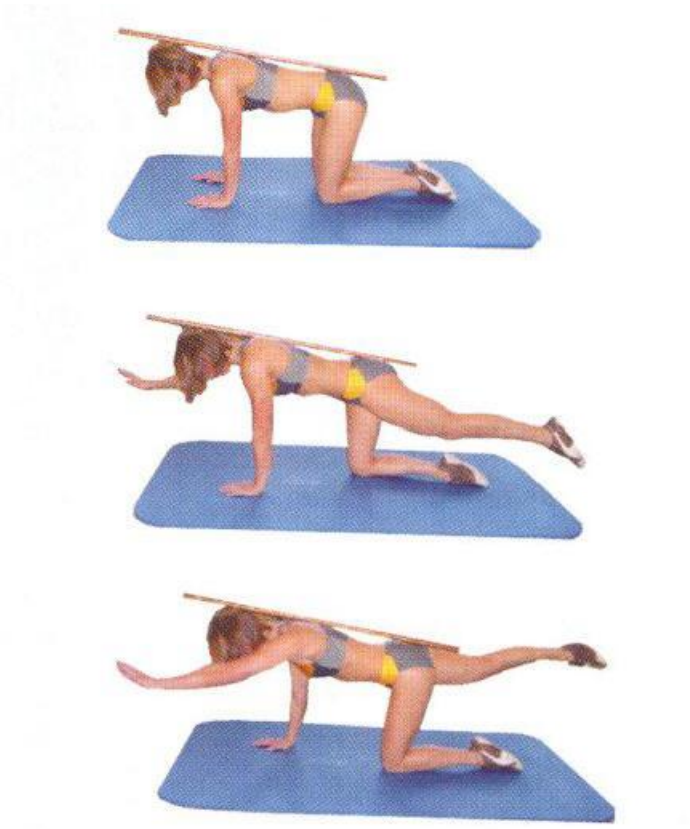

Figure 2: Quadruped with Alternate Arm/Leg Raises

BRIDGING

Bridging is a fundamental core-stability and gluteal-strengthening exercise.

The athlete begins the exercise on her back, in a hook-lying position, with arms resting at her sides. She activates the abdominals and squeezes the gluteal cheeks prior to initiating the movement. The athlete lifts the pelvis and hips off the ground while maintaining neutral lumbar alignment. There should be no rotation of the pelvis. The hips should be aligned with the knees and shoulders in a straight line. The athlete should hold the position for 10sec and then slowly lower the pelvis to the floor.

Progression: In the lifted-bridge position, while maintaining neutral lumbar and pelvic alignment. the athlete can lift one foot off the ground and extend the leg. By placing her arms across her chest, she can increase the challenge of stabilising the lumbo-pelvic region. To progress further, the athlete can raise both arms up to the ceiling and then move one arm out to the side. She should bring the arm back to the centre and repeat with the other side.

Figure 3: Bridging

PRONE PLANK

This is a fundamental, static core-stability exercise.

The athlete supports herself with her forearms resting on the mat, elbows bent at 90°, and the toes resting on the mat. The athlete maintains the spine in a neutral position, recruits the gluteal muscles, and keeps the head level with the floor. She is instructed to breath normally throughout the exercise, while maintaining the abdominal brace. We suggest holding the position for 20sec, working up to one minute for two to three repetitions. No compensatory motion, such as increased lumbar lordosis or sag, should be seen.

Progression: In this position, the athlete can add leg lifts for more difficulty: one leg can be lifted off the mat, held for five seconds, and then repeated on the opposite side.

Figure 4: Prone Plank

SIDE PLANK

This is a fundamental, static core-stability exercise designed to challenge the athlete's body against gravity in the coronal/frontal plane and is an ideal exercise to train the quadratus lumborum.

The athlete is lying on her right side with the right arm extended in a straight line up from the shoulder, with the forearm resting on the mat. She then raises the pelvis from the floor and holds it in a straight-line "plank" position. The hips should not be allowed to sag toward the floor. We suggest holding the position for 20sec, working up to one minute holds for two to three repetitions.

Progression: The top foot can be raised to increasingly challenge the core and gluteal musculature.

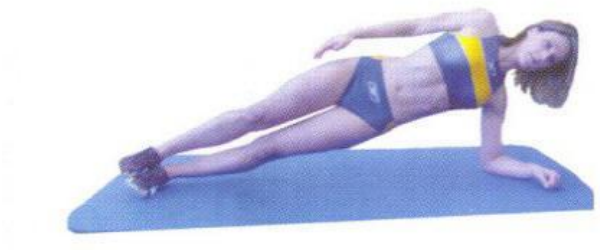

Figure 5: Side Plank

Advanced lumbo-pelvic stability

Once the athlete demonstrates good stability with all static core exercises, they can be replaced with more advanced exercises on the Physioball detailed below. These exercises should be performed at least two times per week to maximise results. The athlete progresses to two sets of 10-15 repetitions. Quality is more important than quantity; the athlete must maintain lumbar neutral and keep the spine in perfect alignment throughout the exercises.

SEATED MARCHING ON A PHYSIOBALL

This exercise is more difficult because the athlete positions her body against gravity in a seated position on an unstable surface.

The athlete begins by sitting upright on a Physioball, with the lumbar spine in a neutral position (midrange). She places her feet hip-width apart While bracing the abdominal muscles, she lifts one leg and foot off the ground. (The limb does not need to be lifted very high, just enough to be off the ground approximately 5cm to start) The athlete should focus on controlling the weight shifting to the weight-bearing limb while maintaining lumbo-pelvic stability.

Progression: Once lumbo-pelvic stability can be maintained with alternate leg lifts, the athlete can add opposite arm lifts.

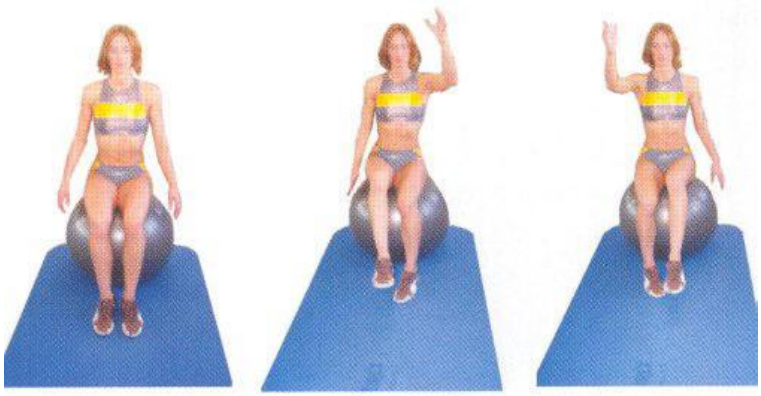

Figure 6: Seated Marching on a Physioball

SPINAL FLEXION ON PHYSIOBALL

The athlete pre-activates her abdominal brace in the starting position and maintains this as she rolls back into spinal extension. She then slowly raises the body, focusing the rotation in the thoracic spine. Picture the head and neck as a

rigid block on the thoracic spine to prevent flexing the cervical spine. The athlete concentrates on attempting to touch the bottom of her ribs to her pelvis (ASIS). The hands can be placed over the ears to eliminate pulling on the neck.

Progression: The athlete holds a 2.0 to 4.0kg medicine ball in front of the chest with the arms extended (see Figure 7b).

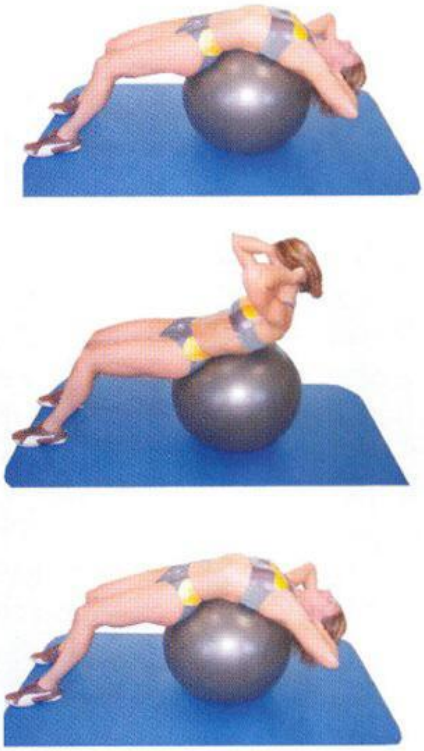

Figure 7a

Figure 7b

ALTERNATE LEG BRIDGE WITH SHOULDERS ON BALL

The athlete starts this exercise sitting on the Physioball and walking forward with his feet on the ground, slowly leaning back until his back rests on the ball. This is called the *bridge position*. The head, neck and shoulder blades should be

supported on the ball. Knees should be bent at a 90° angle, with feet on the ground. While bracing the abdominal muscles, the athlete raises the foot and extends the leg off the ground. The weight will be shifted to one side, and the athlete should focus on maintaining stability of the lumbo-pelvic region. The athlete should strive for stability and balance, while holding this position for 10sec and alternating lower limbs.

Progression: The athlete lifts the arms up in the air or out to the sides.

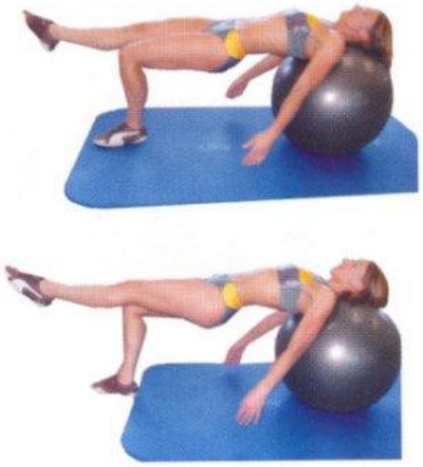

Figure 8: Alternate Leg Bridge with Shoulders on Ball

LEG CURLS ON A PHYSIOBALL

The purpose of this dynamic exercise is to recruit both actions of the hamstrings-hip extension and knee flexion-while maintaining dynamic stability of the lumbar spine.

In a supine position on the floor, the athlete places both feet on the Physioball. (Shoes should be removed to allow increased proprioception from the exteroceptors of the feet) The athlete keeps her arms on the floor at the sides of the body for balance and raises the hips off the ground until the knees, hips, and shoulders create a straight line. She should focus on holding the spine in a neutral midrange position. In this position, the athlete then pushes the ball forward with the feet while maintaining the bridge. The goal is to keep the pelvis elevated (hip extension) as both legs extend and flex at the knees. While the knees extend and flex from this elevated bridge position, the athlete focuses on maintaining lumbo-pelvic stability.

Progression: The athlete can continue with single leg hamstring curls in the same position (see Figure 9b).

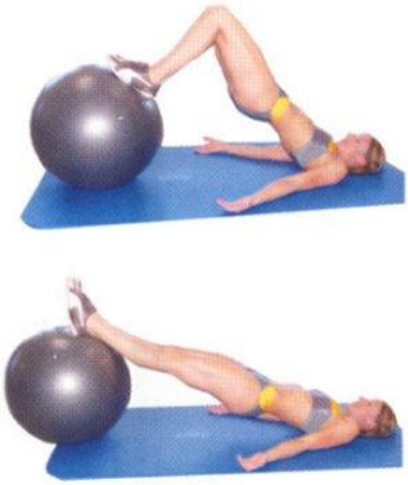

Figure 9a

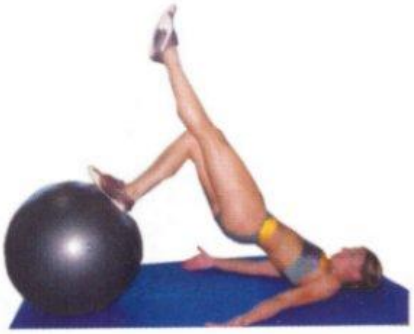

Figure 9b

Figure 9: Leg Curls on a Physioball

Exteroceptor: *A sensory receptor that receives external stimuli.*

ABDOMINAL ROLLOUT

The athlete kneels behind the ball, with both hands on the ball. Keeping the abdominal muscles braced and lower back in a neutral position, she then rolls the ball away from her body a short distance until there is a straight line from the shoulder to hips. While maintaining alignment, she pulls the ball back a short distance, then pushes it away again. The movement should occur only at the shoulders, not the back.

Progression: The athlete can gradually straighten the body until she is up on her toes. There should be a straight line from the back of the head to the knees. Now she can again move the ball away and back toward the body a short distance with the arms.

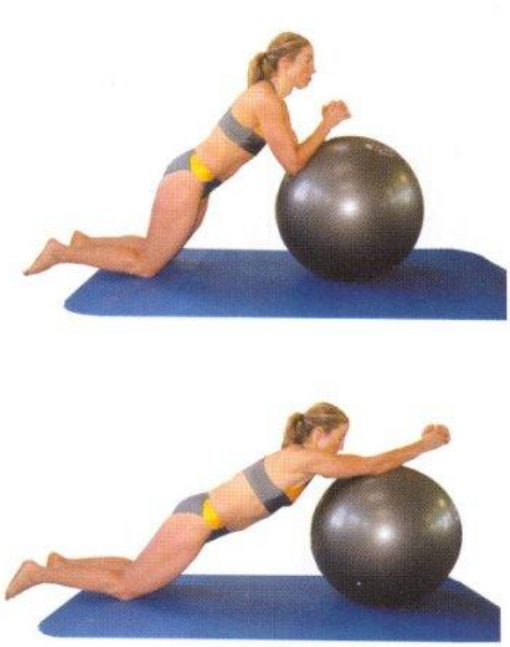

Figure 10: Abdominal Rollout

SQUAT BALL THRUST

Keeping the abdominal muscles braced and lower back and shoulder blades in a neutral position, he athlete uses her abdominal contraction to move the ball forward and back. Keep the spine in neutral alignment throughout the movement. If the exercise shown is too challenging, start with the shins instead of the toes on the ball.

Progression: The athlete can perform the exercise with only one foot on the ball (see Figure 11b).

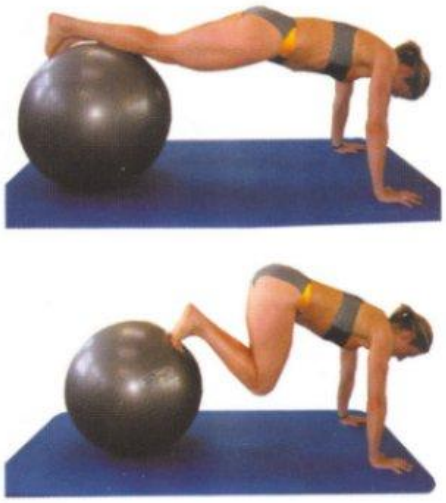

Figure 11a

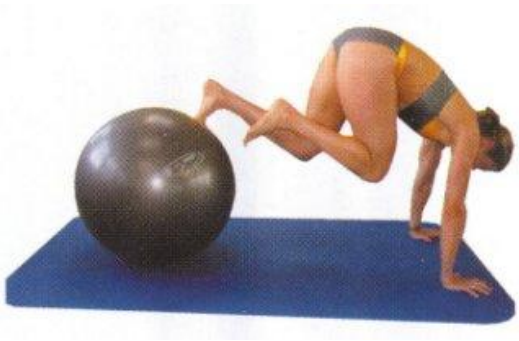

Figure 11b

Figure 11: Squat Ball Thrust