

# **How Pilates Can Help Runners Improve Performance And Prevent Injury**

**Penny Thorn, July 2009**

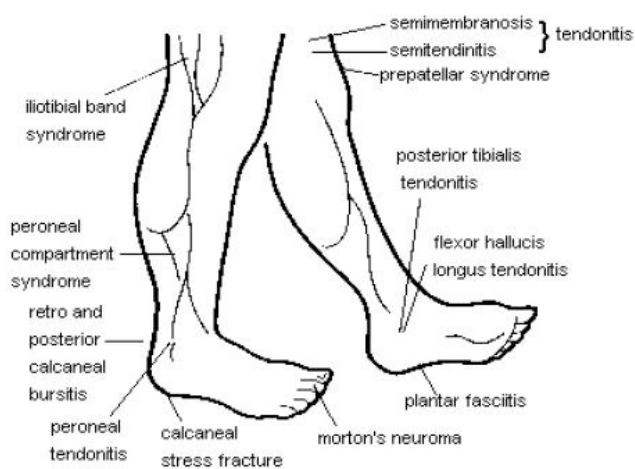
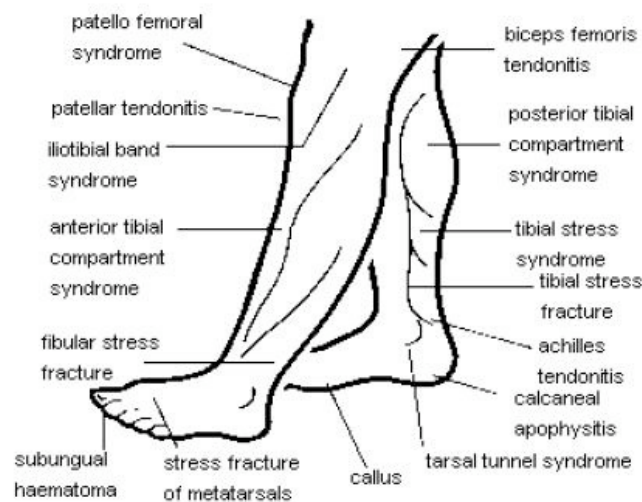
Runners, who display seamless technical excellence, move with efficiency and with ease. To achieve this sense of effortless, the body must: support and direct the forces (the musculoskeletal system); coordinate the timing and sequencing of the movement (neuromuscular system) and balance (sensory, skeletal, neuromuscular system) (Kejonen, 2002 p. 15). It must also focus effort without unnecessary tension (psychological skills), make and use the body's energy systems and have the ability to sustain the movement pattern during the demands of running, i.e., speed, endurance and when feeling fatigued (cardiovascular system) (Elphinston, 2008 p.7).

This essay will review how efficient movement patterns are created and how they can be maintained through Pilates. Interestingly, the essay may convince runners to address weaknesses in their biomechanics, rather than spending more effort training their cardiovascular system to make minor improvements, which may lead to overuse injuries and a plateau in performance. (Elphinston, 2008 p.14) As Albert Einstein said, 'The definition of stupidity is doing the same thing and expecting a different result' (n.d).

Running is 'a group of simple, natural movements combined towards achieving a goal' (Henatsch and Langer 1985). It is primarily a sagittal and transverse plane movement, which requires the body to absorb continuous impact forces from a series of coordinated, alternating, hops from left to right leg (Biomechanics of running, 2009). As the foot touches down, the femur and tibia internally rotates, the sub-talar joint pronates and the foot transforms into a rigid stable lever to support several times the body weight of the runner (Miliron & Cavanagh, cited in Hughes 2008). Simultaneously, a continuous rotation and counter rotation occurs. As the left foot moves forward, the pelvis on the left moves forward. The spine counter rotates against the pelvis enabling the chest to move forward on the right side bringing with it the

shoulder. The degree and speed of pelvic and shoulder rotation are among the factors that have been linked to running economy (Anderson, T cited in Elphinston 2008 p.19). Commonly, if there is no counter rotation the body will try and move in the coronal plane. Often the shoulders, hips and head, rock from side to side in response to leg movement, which disperses energy sideways, so unnecessarily compromising stability. (Ryan, 2008). This places stress on connective tissues throughout the body, especially the lower limbs causing muscle tension and likelihood of musculoskeletal injury. 50-70% of all running injuries (van Mechelen, 1992 cited in McGrath, Finch, 1996 p.10) are musculoskeletal, with 70-80% occurring at the knees and below.

### Running injuries of the lower limb



(Larkins, 1990 used in McGrath, Finch 1996 p.20)

When the musculoskeletal system cannot meet the demands of training, compensation and poor technique creep in, creating instability and potential overuse injuries (such as tendonitis), as the body attempts to cope with the weakness or control the problem. Compensation initially helps the runner perform, however, over time performance plateaus, until the compensatory patterns are addressed (Elphinston 2008 p.24). Obvious signs may include clenched hands, face or jaw, which may be compensation for lack of stability elsewhere in the body (Elphinston 2008 p.72-74). Pilates helps identify the correct muscles and how to recruit them at the right time and in the right order so that compensation strategies are addressed. Once patterned into the neuromuscular pathway, it increases the potential for running stronger, faster and for longer, with more efficiency, ease and power.

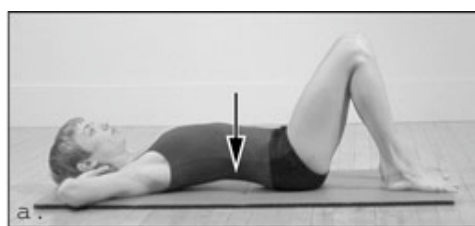
To increase biomechanical efficiency, improve balance, control and minimise musculo-skeletal stress, the body needs to work from a stable base to safely manage the dynamic forces it places upon itself (vertical landing forces are two to three times body weight) as well as withstanding environmental forces (the ground as the runner pushes up to propel forward) (Jamison S, 2008 p. 2).

Controlled movement patterns require a firm foundation from the local stabilisers, which create a cylinder and provide muscular support in the centre of the body. The cylinder is made up of the transversus abdominus (TrA), the multifidus and the posterior psoas major all of which control segmental displacement in the lower spine. The cylinder requires a top and bottom to increase internal pressure, known as intra-abdominal pressure. Forming the top of the cylinder is the diaphragm, whilst the pelvic floor creates the bottom of the cylinder. The thoracolumbar fascia creates a stabilising corset, forming a 'hoop' around the abdomen. It attaches to the internal obliques and TrA, providing support and stability to the lumbar spine. (Scott, Comerford, Mottram, May 2006).

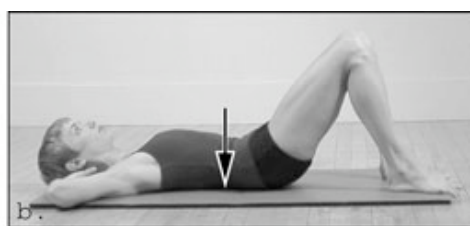
Local stabilisers support a neutral spinal position, which follows the gentle inward curve of the cervical and lumbar regions. This is the most natural position for proper body movement to take place. The mechanical importance of neutral is that the curves share the vertical load across many joints

dissipating forces around the body and decreasing the pressure on the vertebral discs (Webster, 2009). It establishes a 'central longitudinal axis' down the middle of the body (a central reference point which supports movement of the torso and limbs), which is necessary for efficient rotational movement (Elphinston p.17). Runners with poor local stabilisers have difficulty controlling the neutral spine and struggle to gain optimal technique and posture. In Pilates many exercises are performed with a neutral spine to help maintain the natural curves as we move (Elphinston 2008 p.42). Pelvic rocks help to find the neutral position of the pelvis, which then helps to establish a neutral spine. The neutral pelvis is the mid way point between an anterior and posterior pelvic tilt. It is important to find neutral alignment whilst standing, in 4 point kneeling and sitting, so it can be remembered during functional movement, including running.

### The Neutral Position of the Pelvis and Spine



a. Too much curve (anterior pelvic tilt)...



b. not enough curve (posterior pelvic tilt)...



c. and just right (neutral pelvis).

(Dummies.com 2009)

Low-level recruitment of the TrA and multifidus in the range of 20 - 30% of maximum (Robinson et al, 2002 p.11) produces a 'corset effect' around the lumbar spine. With its extensive attachments, TrA is able to disperse force across a large surface area, thereby decreasing load on more isolated limbs and creating a foundation for the strong leg muscles to pull from. TrA and multifidus are activated prior to arm and leg movement and anticipate dynamic forces, which act on the spine. Studies by Hodges and Richardson in 1997 (Elphinston 2008 p.34) show that the local stabilisers remain activated during trunk movements, regardless of movement direction. By contrast, the

global stabilisers, which provide control of the moving parts throughout motion and in producing force (e.g. external obliques, gluteus maximus) and global mobilisers, which produce movement (rectus femoris, rectus abdominus, hamstrings and erector spinae) switch on and off, depending on the direction of movement.

Pilates is associated with training low-level recruitment of the deepest stabilising layer prior to and during movement and to activate it as part of a neuromuscular pattern. To do this, imagine a narrowing of the waist and a hollowing in the front of the pelvis. This is the action of the TrA. There will be a subtle sensation of the waist and front of the body drawing or collecting inward without visible movement of the pelvis. Exercises to activate TrA include; leg slides, heel and toe raises, bent knee fall out and knee floats. These low load exercises aim to keep the pelvis stable and in neutral, whilst the limbs produce small movements, stimulating two-way communication between the brain and the muscles (Robinson et al, 2002 p.38). Physioballs and foam rollers can be used to add challenges to balance and to enhance proprioception.

To maximise the effect of low-level recruitment, it is imperative to do the exercises exactly as described without rushing (Webster 2009), or loading the body too heavily, forcing it to revert to incorrect, old stability activation patterns. Imagery, verbal, tactile and visual cues are vital to retrain movement from being 'soft-wired' (they remain a conscious effort), to gradually 'hard-wired' into the neuromuscular system, so they become subconscious and automatically deployed (Clinical Pilates, 2009).

Once the deepest core musculature is functioning correctly, intermediate exercises can be layered to challenge first the endurance of the local stabilisers, then ensure the correct neuromuscular patterning of the global stabilisers and finally recruit the mobilisers. Appropriate intermediate exercises may include: hundreds, hip rolls, roll up, single leg stretch, double leg stretch, criss cross and hamstring stretch, which performed with precision and control creates the correct muscle recruitment pattern for segmental spinal control. (Webster 2009)

Another important running muscle is the quadratus lumborum (QL), which is responsible for minimising displacement of the axis in the coronal plane and maintaining pelvic control. If the pelvis tips from side to side during running due to weaknesses in the muscles in the hip, the spine will bend sideways to compensate and help to balance (Elphinston 2008 p.44). Single leg balance and single leg knee bends are exercises to help strengthen this muscle.

With the QL, the gluteus medius (GMed) is probably the most important active component in the achievement of a biomechanically efficient running technique. It works with the gluteus minimus, adductor muscles of the inner thigh and tensor fascia lata (TFL) to keep the pelvis level when weight bearing on one leg. If GMed is weak the TFL becomes more active which causes tightness in the iliotibial band, causing potential knee problems and nerve compression round the head of the fibular. The piriformis can become overactive with GMed weakness interrupting normal pelvic and lower back mechanics causing sciatica and lower back pain, sacroiliac joint and knee problems. These muscles all work to balance the trunk vertically, preventing coronal plane movement, which impairs athletic performance and increases foot contact time, as the hip collapses on each foot strike (Elphinston 2008 p.51 - 52).

Hip and pelvic stability can be assessed by doing a standing knee lift (Elphinston 2008 p.91). With the feet together and arms out at the side, one knee should be lifted to shoulder height. The pelvis should remain level. If the stance leg moves out to one side and the pelvis drops, it signifies a weak GMed. During a single leg lunge, if the knee moves inwards or the pelvis tips sideways, a weak GMed is indicated. The GMed can be recruited during side lying clams and single side leg lifts, whilst palpating the GMed for activation. Once functioning, GMed should be activated in standing by balancing on one leg and maintaining a level pelvis. Another simple exercise is the single leg knee bend; the trunk position remains vertical and the knee bends forward past the toes, maintaining, knee and hip alignment.

The gluteus maximus (GMax) is a key mobilising muscle with pelvic attachments that control the relationship between the thigh, pelvis and trunk. When the foot is fixed and the pelvis moves, GMax propels the body forward

over the fixed foot. With the GMed, GMax controls the vertical alignment of the knee and controls thigh rotation ensuring movement in one plane. It also works with the erector spinae and hamstrings. If the GMax is weakened or inactive, the neuromuscular patterning fires the muscles in the wrong sequence and can cause tight hamstrings, a dropped pelvis, or insufficient forward and upward power production from the legs. If only one GMax is firing, one side of the body will be better balanced and there will be an increase in use of the latissimus dorsi on the opposite side, which pulls the shoulders down (Elphinston 2008 p.50).

Having a strong GMax is essential for running. Simple exercises can trigger the muscle; whilst standing or sitting, the gluteals can be tensed and held for 3 seconds ensuring the hamstrings do not fire before GMax. Whilst lying prone, bend one knee to 90 degrees then lift it using the GMax. Variations include bending the leg to 90 degrees and straightening, or bending and rotating the leg to one side. For intermediates, starfish, swimming, paddling and heel beats can be performed. Lunges, one leg balances and squats are functional dynamic exercises, which challenge the stability, balance and coordination from the centre.

The key to improving gluteal strength is to ensure the connection and movement between the spine and the pelvis. Ab Prep 1 restores mobility between the spine and the pelvis, unlocks tight back muscles, promotes flexibility and stability throughout the length of the spine and helps discover the relationship with the GMax (Robinson et al, 2002 p.45). Many runners who use the back muscles to fix their pelvic position and maintain stability, make it very difficult to activate GMax. Ab Prep 1 and lumbar stability in low/high bridge position improves the dissociative ability, which can help recruit the GMax.

A strong upright stance is one of the most important aspects of running. As Kevin Kortan (2009) states 'Posture is not a static position. It is a dynamic activity.' Good posture ensures that the body moves forward as one unit with all the muscles working together. Maximum power is generated from the muscles, reducing the effort required to run at any pace. Injury is less likely because of better alignment reduction in extraneous motions, so the muscles

and tendons spend less time correcting biomechanical inefficiencies (Galloway 2009).

To improve posture whilst running, visualisation can be practiced. Envisage being suspended by a string attached to the top of the head then imagine gravity efficiently aligning the head, torso and pelvis and then the feet lightly touching down as the legs go through their smooth running cycle. Puppet visualisation helps correct upright posture to conserve energy and to run more efficiently (Galloway 2009).

Finally, 'breathing is a primary principle of Pilates and a seemingly innate component of exercise' (Webster 2008). Correct breathing is when the lower ribs expand in an outward and upward direction without lifting the shoulders, or excessive billowing of the whole abdomen. This enhances stability, inhibits the use of the external obliques as stabilisers and helps maintain the thorax in a tall position (Clinical Pilates, 2009). Evidence supports using breath patterns to activate the TrA, particularly during exhalation (Robinson et al, 2002, p.22). Inspiration also aids in tensioning the diaphragm, which increases intra-abdominal pressure and immediately activates the TrA. Good breath work is crucial in building control throughout the running cycle, assisting in stability, providing oxygenated air to the muscles as well helping to relieve neck and shoulders tension.

## **Conclusion**

This essay has reviewed the biomechanics of running and how efficient movement patterns are created. It demonstrates that by addressing poor biomechanics, compensatory patterns, muscle tightness, bad posture and poor breathing patterns that improvements to running performance can be made (increased speed, endurance, increased resistance to fatigue, better form and technique), as well as injury prevention. By highlighting running specific muscles and how they impact stability and movement patterns, the essay demonstrates exercises, which can help runners target weaknesses. This essay aims to encourage runners of all abilities to understand the benefits of Pilates, as an invaluable aid in performance enhancement, which actively prevents injury.

## References

- Biomechanics of running: From faulty movement patterns come injuries*, viewed 16th July 2009  
<http://www.sportsinjurybulletin.com/archive/biomechanics-running.html>
- Clinical Pilates: The art and science of Pilates as a rehab approach*, viewed 16th July <http://www.sportsinjurybulletin.com/archive/clinical-pilates.html>
- Comerford, M, *Core stability: Priorities in rehabilitation of the athlete*, viewed 16<sup>th</sup> July, *Sportex.net*
- Dynamic Posture™*, viewed 16th July  
<http://www.evolutionaryyoga.com/articles/dynamicposture.htm>
- Elphinston, J, 2008, *Stability, Sport and Performance Movement*, Lotus Publishing, Chichester, UK
- Galloway, J, *Posture Perfect*, viewed 16th July 2009  
[http://www.internetfitness.com/articles/running\\_posture.htm](http://www.internetfitness.com/articles/running_posture.htm)
- Henatsch, H.D, & Langer, H.H, 1985, 'Basic neurophysiology of motor skills in sport: A review', *International Journal of Sports Medicine*, 6, 2-14, viewed 16<sup>th</sup> July [http://www.texasrtrack.com/coaching\\_article\\_5.htm](http://www.texasrtrack.com/coaching_article_5.htm)
- Hughes, D, 2008, *The Art of Running: A Biomechanical Look at Efficiency*, viewed 16<sup>th</sup> July [http://www.texasrtrack.com/coaching\\_article\\_5.htm](http://www.texasrtrack.com/coaching_article_5.htm)
- Jamison, S, 2008, *Determining the correlation between biomechanical loadings indicative of over-use running injuries and core strength and stability*, Undergraduate Honors Thesis, The Ohio State University
- Kejonen, P, 2002, *Body movements during postural stabilization. Measurements with a motion analysis system*, Oulun Ulun Yliopisto, Oulu
- McGrath, A.C, & Finch C. F, 1996, *Running the race against injuries: A review of the literature*, Report No. 104, Monash University Accident Research Centre, Wellington Road, Clayton, Victoria, 3168, Australia
- Noakes, T, 1985, *Lore of Running*, Fourth Edition, Human Kinetics
- Robinson, L, Fisher, H, Knox, J, Thomson, G, 2002, *The Official Body Control Pilates® Manual*, Pan Macmillan Ltd
- Ryan E, 2005, *Running and Core Stability: a biomechanical link*, *SPED Journal & Magazine* viewed 16th July <http://www.sped-online.com/2005/referenced.htm>
- Scott, M, Comerford, M.J, Mottram, S.L, May 2006, *Transversus Training: A waste of time in the gym*, Performance Stability, UK, *Fit Pro Network*

*The Pilates Neutral Spine Position*, viewed 16<sup>th</sup> July 2009,  
<http://www.dummies.com/how-to/content/the-pilates-neutral-spine-position.html>

Webster, O, 2009, Inner Strength, Athletes can use Pilates to build core musculature and improve their game. *Advance for Directors in Rehabilitation*, Vol. 18, Issue 4