



Running Tips and Techniques

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RUNNING STATISTICS

- ✦ Up to 60% of runners experience a running related injury severe enough to curtail their activity at some time.
- ✦ The average runner strikes his or her foot to the ground 500 to 600 times per kilometre (5 – 6000 times in a 10km race)
- ✦ Every running injury should be viewed as a failure of training technique.
- ✦ The only animals suffering from stress reactions and stress fractures are greyhounds, racehorses and humans. No horse ever rode itself to death until a rider was put on its back. For the human, this “rider” is usually one’s own ego and aspirations.
- ✦ Accepted guidelines for cardiovascular fitness – any rhythmic exercise that uses large muscle groups at least three days per weeks for 15 – 60 minutes per session and at an intensity that gives an age-adjusted heart rate of 60 – 90 percent of maximum. To calculate this number, use the following formula:

$$\begin{aligned} & \text{✦ } (220 - \text{age}) \times 0.6 = \text{(low end of range)} \\ & \text{✦ } (220 - \text{age}) \times 0.9 = \text{(high end of range)} \end{aligned}$$

- ✦ Picture a 150-pound person who runs for 1 km. Assuming he / she takes approximately 600 steps, and assuming that they must dissipate an initial ground reaction force of 250 % of body weight per foot strike, 225 000 pounds of energy must be dissipated through each foot – for each kilometre!

THE BIOMECHANICAL FORCES OF RUNNING

- ✦ Initial vertical force is equal to 2 – 3 times your body weight.
- ✦ Forward shear 50 percent of body weight.
- ✦ These forces must be dissipated in one-third the time that is available when walking.
- ✦ Peak impact forces generally occur 20 – 30 milliseconds after initial foot contact. This means that contrary to common belief, the heel is not the area of the foot that receives the greatest impact force. Rather, it is the midfoot that must absorb the peak force of each stride. This is the reason that the midsole of a shoe is so important, and not coincidentally why this part of a shoe is the first to wear out.

Rates of Decrease in Shoe Shock Absorption Properties³

- 25% loss after 100 km.
- 33% loss after 150 – 250 km.
- 40% loss after 400 – 800 km.

OVERTRAINING AND STALENESS

If an athlete continues to push onward with training despite continuing symptoms of overtraining, within a few weeks a sort of physiological and psychological breakdown can occur. This marks the onset of *long-term overtraining*, or simply *staleness*. It is defined as a combination of (1) inability to train or race at an acceptable level, (2) an extended period of fatigue, and (3) often an increased occurrence of sickness. This represents a complex combination of psycho physiological signs and symptoms of a more far-reaching nature than simple fatigue. It suggests a trend toward actual cellular injury, profound fuel exhaustion, breakdown of the body's defence mechanisms, neurological and endocrine disturbances, or perhaps all of these together. Decrements in performance that before were occasional are now chronic and large. Along with increased risk of injury, illness occurs with increasing frequency. Altered mood states, altered hormonal patterns, and other metabolic changes can occur, and these can vary enormously among individuals. A very long time will be required for recovery to restore performance abilities; weeks, months, or even a year!

In other words, the development of long term overtraining or staleness should be avoided by runners like the plague, because it could spell the end of a competitive season or even a career!!

THE MAJOR WARNING SIGNS OF OVERTRAINING AND STALENESS

Training related

- Unusual muscle soreness the day after a training session
- Progressive increase in soreness with continued training
- Performance plateau or decrement despite increased training
- Inability to complete previously manageable training load
- Elevated effort sense; delay in recovery from training

Lifestyle Related

- Increased tension, depression, anger, fatigue, confusion
- Inability to relax
- Reduced vigour in completing daily activities
- Things once pleasurable are not now
- Poor sleep quality

Health Related

- Swelling of lymph nodes
- Constipation, diarrhea
- Increased incidence of illness (fever, head colds, etc.)
- Increased blood pressure; increased morning pulse
- Loss of weight; loss of appetite

HEAT ACCLIMATION

Heat production is a measure of efficiency. The more efficient a machine is, the less heat (which is a by-product of mechanical work) is created. A machine that is 100% efficient would generate no heat, as all of the energy produced would be transformed to work, rather than heat. The same concept holds true for our bodies. The more efficient we are when running, the more of our finite amount of energy is used as work, and less is transformed to heat. Unfortunately, as well designed as the body is, even the most efficient athlete is only about 30% efficient. That means that for each kilocalorie of energy that we have on board at a given time, only 30% of that is used to propel us forward when we run. The other 70% is used to maintain bodily functions and / or is lost as heat. An exercising athlete will produce 70 times the heat they would normally produce at rest, due to muscular contraction. Dissipating this heat is of the utmost importance. Fortunately, our body is quite efficient at getting rid of this heat, to the extent that up to 4 litres of sweat can be produced per hour by an athlete.

COLD ACCLIMATION

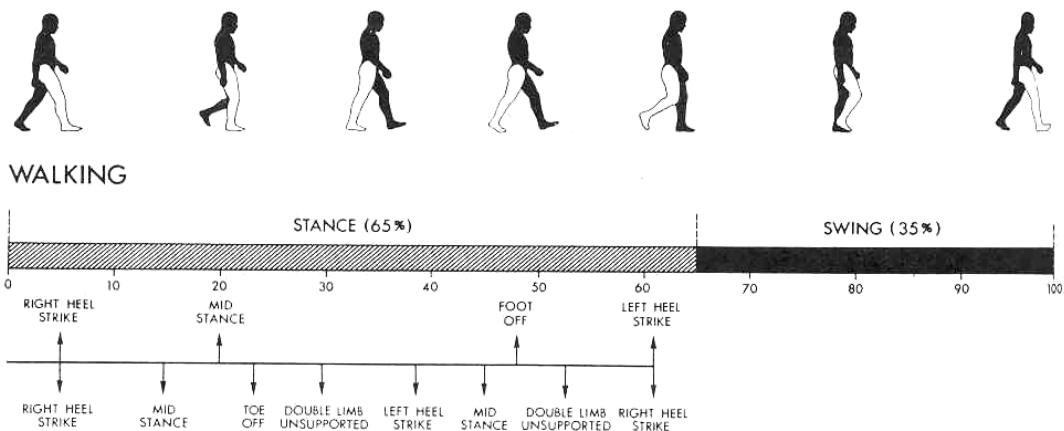
Just as heat production is a measure of efficiency, retention of heat is a measure of preparedness. A disproportionately large percentage of body heat is lost through the head, hands and feet. Running with proper headwear and gloves is common sense, and will enhance your performance by allowing you to thermo regulate more efficiently. Choose gloves and headgear that “breathe” while retaining heat. In this way, moisture next to the skin (a major source of heat loss) will be minimized. When it gets extremely cold outside, a mask may be beneficial to help decrease the risk of frostbite, but don't worry about your lungs. Cold air is warmed sufficiently as you draw breathe in, and your lung tissue is not at risk of injury from freezing, even when running in freezing conditions. Common sense prevails when dealing with cold weather exercise, and running on a treadmill may be a wise substitute in certain climates. Furthermore, as with all running, pay close attention to what your body is trying to tell you. You *will* run slower, your tissues *will* be less pliable, and you *will* need more time to warm up when the temperature plummets.

RUNNING SPECIFIC INJURIES

Running is one of the most injury-producing sports. This is due to the cumulative effects of training, and the repetitive nature of the sport. In fact, lower limb repetitive trauma injuries from running account for a large percentage of conditions that present in my clinic. The most important factor in the etiology of running injuries is ground impact force, which is on the order of 150-300% of the athlete's body weight per stride. Using the example of a 150 pound runner who runs 10 km in 1 hour, this athlete will be making 12 000 heel strikes per hour and will have to endure 2.25 million pounds of pressure through each foot. Nearly 2/3 of runners report being significantly injured each year. Most of these injuries occur from the hips down. It is truly a testament to the design of the body that it can withstand such incredible forces over 1 hour of activity. In fact, over a lifetime, it has been estimated that the average person walks 184 000 km by foot⁴ – not including running (and we all know that runners are not average)!

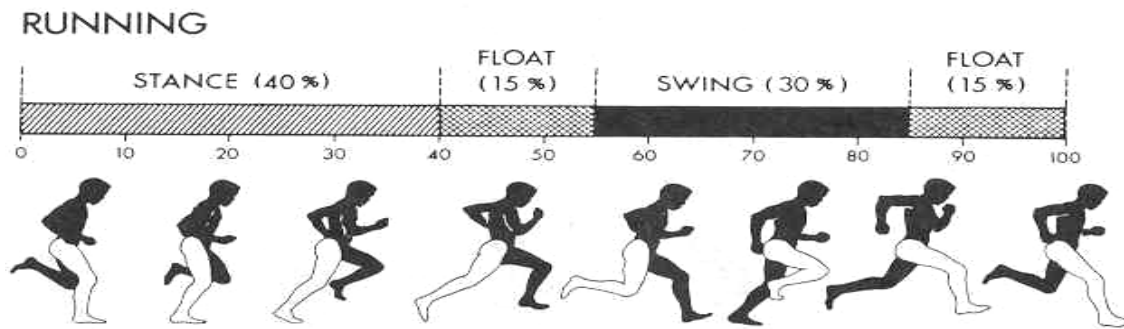
- The biomechanical factors that predispose a runner to patellar tracking problems are multiple, but the most common trend is excessively tight lateral compartment thigh muscles and iliotibial band, both of which attach to the lateral aspect of the kneecap and act to pull the kneecap laterally. Compounding this problem is a tendency toward weakness of the medial thigh musculature (specifically a muscle called the vastus medialis oblique). This small muscle is responsible for doing 80% of the work to pull the kneecap medially. When placed in a “tug of war” with a group of large, overly tight lateral thigh muscles, this muscle becomes easily overworked. The end result of this muscular imbalance is poor tracking of the patella, pressure on the underside of the kneecap and resultant sharp pain⁶.
- The treatment of this condition revolves around correcting the muscular imbalance through a regimen of strengthening the medial thigh musculature and stretching the lateral thigh muscles and iliotibial band. Myofascial release therapy, of which Active Release ® is a form, is a very effective way of minimizing small adhesions between and within tight and / or overworked muscles that accumulate with repetitive trauma and act to impair the contractility of muscle tissue. Chiropractic Spinal Manipulation of the lower back has been proven to cause “reflex inhibition” of the anterior thigh muscles¹². This can help to relax the tone of the tight leg muscles. Knee mobilizations can also help to decrease pain and improve functionality.

RUNNING BIOMECHANICS¹



There is a continuum from walking to running when considering the mechanics that are involved. Running involves a more complex series of events than walking. Running requires that the foot be stable yet able to absorb shock when necessary. The foot must also be able to become a rigid lever for use in push-off. The design of the foot is adequate for daily use, but some inadequacies arise with repetitive running over long distances. Both walking and running are characterized by specific phases. The most obvious difference between the two is the presence of a float phase when running – that period of time where the body is unsupported and not in contact with the ground. This elevation above the ground is responsible for the increased vertical impact force associated with running. Certain running techniques lend themselves to a larger impact force than others. Runners who are seen to “bob” up and down with every stride are wasting valuable energy toward forward motion by moving up and down instead. The higher a person “bobs”, the more forceful their landing is, and more likely is their risk of

injury. Furthermore, these inefficient runners must deal with an increased ground reaction force upon every stride. This means that they must work harder with each stride to maintain their speed. Conservation of energy is a very simple concept that is imperative to fast, injury free running.



As the velocity of gait increases, the duration of the cycle decreases. The stance phase shortens considerably during running, with the balance of time spent between the swing phase (only slightly less than while walking) and the float phase (absent when walking).

Muscles, joints, ligaments and bones are the four main structures involved with the generation of movement for running. The intricacies of gait mechanics are unnecessarily complex for the scope of this paper, and will not be detailed here. In short, hip rotation generates the torque necessary to develop the progression from lateral heel strike to medial toe off during the stance phase. The progression of force loading from outside to inside of the foot allows the foot to act first as a cushion to absorb the various impact forces (both vertical and sheer forces), and then as a rigid lever for effective muscular contraction and forceful toe-off. These changes take place in shortened time span of the running stance phase (0.2 seconds while running vs. 0.6 seconds while walking). The fact that the same amount of work needs to be done in 1/3 of the time makes it easy to see how running places incredible demands on the structures of the foot and leg. The shin in particular must disperse some of the force of impact, accelerate the foot via concentric muscular contraction and decelerate the foot via eccentric muscular contraction. This constant barrage of forces can quickly lead to an overuse / stress injury to the shin (tibia or less often fibula) or any of the muscles and / or soft tissues in the lower leg.



When running, the leg muscles act to:

1. Stabilize the trunk and pelvis and accelerate the limb against gravity and the running surface
2. Decelerate the rapid motion of the swinging leg.
3. Control the rotations down the length of the limb.

ORTHOTICS – APPROPRIATENESS OF USE



Foot orthotics are devices prescribed by chiropractors, physicians and pedorthists. They are worn in shoes to improve inefficient mechanics of the feet, ankles, and legs. The use of orthotics can reduce or eliminate discomfort and pain in these areas as well as in the hips and back. Orthotics are also prescribed to accommodate a variety of uncomfortable “wear and tear” foot conditions. These conditions, causing symptoms ranging from general aches and fatigue to painful bone and foot problems including excess callus formation, bone spurs, plantar fasciitis and soft tissue degeneration. Collapsed or flattened arches and / or improper foot alignment cause these problems. Custom foot orthotics help realign the joints of the foot and act as an arch support to eliminate discomfort and pain.

There are a number of uses of custom-made orthotics. These include:

- Shock Absorption / Stress Reduction
- Motion Control and Alignment
- Immobilization and Support
- Correction of Deformity

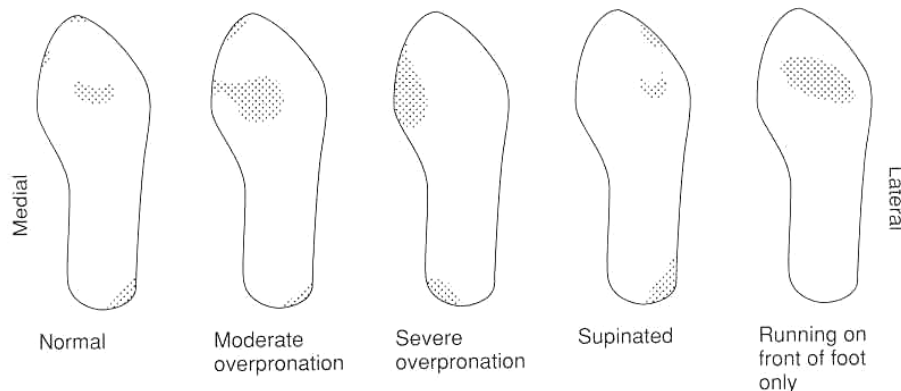
It is important to remember that treating a foot problem with orthotics is only part of the picture. While orthotics may play a significant role in reducing or eliminating the symptoms, properly designed and expertly fitted footwear is crucial to optimize the success of treatment. Poorly constructed, non-supportive footwear do not provide a strong, stable, supportive base for orthotics. When purchasing footwear be sure to receive service from a salesperson who is experienced in fitting orthotic users. The other obvious component when dealing with orthotic use is to ensure that you have adequate muscular strength in both the intrinsic and extrinsic muscles of the foot, ankle and lower leg. A sports chiropractor or sport physician can determine the strength, balance and integrity of these muscles and provide specific treatment and advice⁹.

Because custom orthotics alter your base of support, it is common to experience a transitional period during which you may experience mild aches and pains. This is perfectly normal, as it takes the body some time to adapt to change. This may be most evident in the feet, ankles, legs, hips, or even in the low back¹⁰. However, this will soon disappear as your body adjusts to the orthotics. Because your body needs to adapt to a completely new mechanical foundation, it is essential to have a gradual break-in period.

Finally, the effective life of orthotics is 4 - 6 years for most adults. Children and adolescents orthotics can generally accommodate growth of 2 shoe sizes before needing replacement.

Wear Pattern Analysis

The following is a simplified approach to assess your running mechanics by looking at the wear pattern of your shoes. There is a wide range of variability in the wear pattern of different runners shoes, depending upon which portion of their foot absorbs the most force. Pronation is synonymous with “Flat feet”, while supination is akin to having a “high arch”. Pronation and supination are both normal components of every step we take. When assessing for orthotic need, your doctor may use terms like over-pronation or excessive supination. With every stride, our feet go through a natural progression from supination to pronation and back to supination. Natural variation does exist in the way runners contact the ground. 60 to 70% of all runners utilize the classic heel to toe transition, while 10 to 20% of runners are “foot slapper’s” (those who contact the ground with a large part of their foot at once). 5 to 10% of the running population will exhibit a propensity to forefoot contact and toe-off. This latter group of runners will have wear patterns similar to the diagram on the far right. With insufficient muscular strength or ligamentous integrity, these motions can become exaggerated and eventually cause symptoms of foot, ankle and / or leg pain. Use the diagrams below to inspect your own shoes, paying close attention to the wear patterns. If they look suspicious at all, take them to your doctor (chiropractor, sports physician or pedorthist) on your next appointment.



RUNNING TECHNIQUE

Much has been written on proper running technique. The Running Room publishes excellent articles on running form, written by Jeff Galloway. As a chiropractor and a runner, it is my primary focus when analyzing the form of a runner to ensure that they are mechanically efficient. A great deal of energy is wasted when we run; proper technique can decrease the amount of waste and increase our efficiency. Of course, conserving more energy during a run / race will allow us to run longer AND faster, with less risk of injury. The key points are:

- ***RUN TALL*** – By maintaining an upright posture, you are keeping your centre of balance well inside your base of support (the area that your feet occupies). Adopting this posture minimizes excessive muscular firing, stops the tendency to “have you’re bottom half trying to catch up with your top half”, and ensures that you are not increasing your ground reaction forces more than necessary. Furthermore, this posture provides the greatest room for your lungs to work. By running tall, you can use the energy you save to better supply your respiratory muscles (the ones that force air into and out of your lungs during hard effort), thus increasing your ventilation.

- ***DON'T BOUNCE*** – As mentioned above, bouncing (vertical motion) is simply wasted energy that could have been put to better use (namely forward energy). With few notable exceptions (world champion Paula Radcliffe comes to mind), top runners look very smooth. The way to measure this smoothness is to watch a person's head. With truly efficient use of energy, the top of the head travels in a nearly straight line. When running yourself, pay attention to how much your view shakes up and down, and try to modify your technique to minimize this.

- ***LOOK LIKE A LOCOMOTIVE*** – Many runners waste energy by inefficient arm swing and arm carriage. Proper use of your arms can actually benefit your running, both by saving energy and by assisting in “coupled motion” (opposite arm and leg both drive forward simultaneously, giving you increased momentum). Proper use of your arms can even help you get up a steep hill. By driving your arms back forcefully as you ascend a hill, you eccentrically load the muscles on the front of your body, resulting in a stronger “recoil – type” contraction as you bring your arms forward. With normal running, your shoulders should be relaxed, elbows bent to approximately 90 degrees, and hands lightly gripped “as though you are holding onto a potato chip between your thumb and fingers”. The carriage of your arms should be relaxed to the point that your fingernails graze across your shorts at the level of your hip bones during every stride. The purpose of all this imagery is to counter the tendency that runners have of carrying their arms too high, clenching their fists and elevating their shoulders as they fatigue. Furthermore, by keeping your arms relaxed, you improve the ability of your upper body to counteract the rotational forces transmitted through your spine from your pelvis. A good example of this is seen when watching someone who carries their arms very high; they have a tendency to swing their arms from side to side. This side-to-side motion is counterproductive; it is not forward motion, and is in fact a waste of energy. By driving your arms forward and back, you ensure that most of your energy is being used in the correct plane of motion (i.e. forward). This front to back arm swing resembles an old-style steam locomotive.

- ***RELAX YOUR FACE*** – This is another form of energy loss that can be better appreciated by watching other runners. The muscles of your jaw are some of the strongest muscles in the body for their size. There are countless wrong ways to express the discomfort of running, the right way is to keep your tongue and jaw relaxed and don't squint. Your jaw should be relaxed to the point that you can feel it bounce just a little bit with every stride. Furthermore, tension in facial muscles is nearly always accompanied by neck and shoulder tension. In fact, it is very common for someone with high arm carriage (as above) to be very tense throughout the entire upper shoulder / neck / face region.

RELATIONSHIP OF STRIDE LENGTH TO ENERGY COST

Research shows that as a runner's speed increases, stride frequency increases, but stride length increases even more¹¹. This is most likely from recruitment of additional muscle fibres. So, although some authorities feel that in order to increase speed, the runner should increase stride frequency, the most efficient stride length and frequency should be what feels to be intuitively natural for them. To put it another way, a runner's most efficient stride length, that is, the stride length that is least energy costly in terms of oxygen (O₂) consumption, typically occurs subconsciously. Oxygen expenditure increases at stride lengths longer and shorter than the optimal value selected by that individual.

The most efficient runners decelerate the least at foot strike, have the least vertical oscillation, and get the maximal forward movement with every stride. Foot strike deceleration tends to increase with over striding (landing in front of the body's centre of mass). This is simply another way to look at correcting your stride length if you are a runner that "bounces" from stride to stride.

It must be remembered that although it is the foot that strikes the ground, the actual pivot point for the lever system that provides movement is really the lumbar spine and pelvis. During the various phases of running, the pelvis tilts forward and backward and the entire trunk rotates in a counterbalancing direction. One of the more common injuries seen in runners continues to be found in the trunk musculature because of inherent weakness in these muscles. Because of the tremendous amount of work required by all the trunk muscles to provide stability and balance when the movements are performed with the arms and legs, the need for these muscles to be healthy and strong becomes even more apparent. Performing strengthening exercises for the abdominals, gluteals, adductors, internal and external hip rotators, and trunk flexor and extensor muscles are an excellent addition to a training program to help runners stay healthy and train successfully⁷.

When an individual runs in a straight line, successive foot placements should be parallel with each other (or nearly so: approximately 10 inches apart) and in the direction of running. This will help to reduce unwanted rotational forces that consume energy and place an excessive stress on the ankles and knees. Below are figures that depict the slight difference between running and walking. Note that with running the lower limbs move beneath the body, thus allowing for more efficient locomotion.

Fig. 4.22 Angle and base of gait

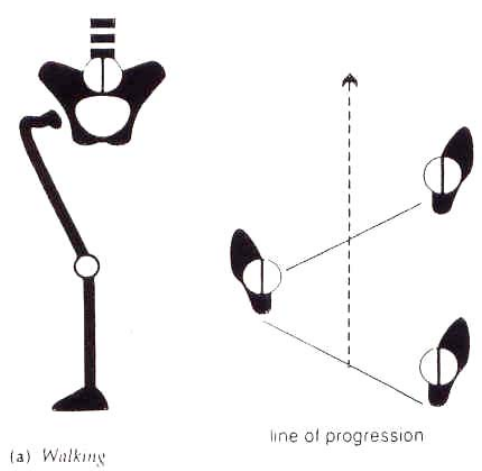
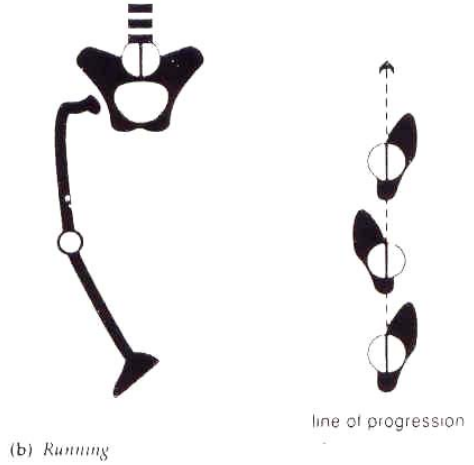


Fig. 4.22 Angle and base of gait (continued)



One of the best ways to improve the mechanics of your running technique is to analyze others. Wherever it may be: sitting in your car at a stoplight, while running or watching people run from a park bench, look at the various aspects of their running technique. By analyzing their arm swing, stride length, facial expressions, chest and head position, you will be better able to examine your own running technique and make changes that will help you perform to the best of your ability.

GOOD LUCK AND GOOD RUNNING!