

# The Foundation of Injury Prevention, Optimum Health and Superior Performance for the Endurance Athlete

## Part 1 - What Causes Injury?

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Approximately 50% multi-sport endurance athletes and 85% of running athletes will experience an injury on a yearly basis. The severity of these injuries range from performance limiting aches and pains to season ending injuries with possible long term consequences; most if not all of these injuries can be avoided with appropriate prevention and performance strategies. Thankfully, steps taken to ensure optimal health and performance are consistent with those of injury prevention. Unfortunately, very few people employ these principles, primarily due to a lack of knowledge and understanding.

This series of articles highlights the key points outlined in the presentation titled, “The Foundation of Injury Prevention and Superior Performance in the Endurance Athlete”, and aims to answer the following question:

***Are you training to promote optimal health, prevent chronic degenerative disease, and achieve superior performance? Or are you guaranteeing the onset of an injury and poor performance?***

In part 1, I will outline the fundamental principles of how injuries occur in the endurance athlete and the factors that cause them. In part two, I will outline a six step plan for preventing injuries and enhancing performance, and in part three, I will discuss how proper running technique can reduce your risk of injury, improve efficiency and speed.

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Injuries common in the endurance athlete are non-traumatic and commonly referred to as cumulative trauma disorders or repetitive strain injuries. The causes of these injuries are multi-factorial and include both extrinsic and intrinsic risk factors. Extrinsic risk factors being those that are imposed on you by the environment or training and intrinsic risk factors are intrinsic to you, such as your anatomy and physiology.

Your training plan can be a significant extrinsic risk factor for injury. Specifically, training programs that don't allow adequate recovery time or inappropriately progress training volume and/or intensity, are a major risk for injury. Simply stated, you need to avoid the terrible too's: doing too much, too soon, too often, too fast, too hard, combined with too little rest and too little attention paid to pain. Most coaches and many athletes are aware that weekly training volume should not be increased by more than 10% per week to allow for adaptation of the muscles, tendons, ligaments, bone and nervous system. This concept could be expanded to include training load such that weekly volume time's intensity should not be increased by more than 10% per week. This rule may at times fluctuate in the elite athlete, but for us average folk the 10% rule is a good one to follow. Keep in mind that a continual

and progressive increase in training load without time for recovery and adaptation, such as that taken in unloading weeks, can also lead to overtraining.

Other factors related to training plans include exercise selection and technique, to be discussed in more detail in part 2 of this article.

**Extrinsic Risk Factors**

- Inappropriate training (rest, recovery, progression, exercise selection & technique)
- Bicycle and shoe fit
- Training surface (unforgiving, cambered, unstable)

**Intrinsic Risk Factors**

- Biomechanical Imbalance (muscle weakness or inhibition, tight or overactive muscles, scar tissue and adhesions, joint dysfunction)
- Postural Imbalance
- Genetic and developmental factors
- Technique
- Previous injury

**Table 1: Risk factors for injury**

For cyclists, bicycle fit is an important factor in both injury prevention and performance. An improper bicycle fit will lead to discomfort, poor biomechanics, declined performance and injury, while a proper bicycle fit will promote ideal biomechanics and support injury free performance.

The counterpart to bicycle fit in running would be wearing appropriate shoes. It is essential that you train and race in shoes that fit you properly, including length, width and shape, with an overall structure that supports your biomechanics and ability. Whether your feet are hyper-mobile (i.e. move too much) and potentially over pronate, or are hypo-mobile (i.e. move too little) and poor shock absorbers, the shoe should function accordingly. A complete discussion of shoe selection and mechanics is beyond the scope of this article and will be featured in a future article devoted to this topic.

Other extrinsic factors that may contribute to injury include surface issues, such as running on a surface that is unforgiving or unstable, running on a cambered surface, and running or cycling on a slippery surface.



Figure 1: Polar bear slipping on ice

Intrinsic risk factors that contribute to injury include biomechanical and postural imbalance. Biomechanical imbalance would include things such as weak or inhibited muscles, tight or overactive muscles, scar tissue and adhesions, joint dysfunction, and any combination of joint hypo-mobility - meaning moving too little - and joint hyper-mobility - meaning moving too much. A postural imbalance would include things such as a thoracic kyphosis, spinal scoliosis, protracted and winged shoulder blades, and many others. Postural imbalances are significant because they almost always correspond with biomechanical inefficiencies known to cause injuries.

Your genetic make-up and the way you developed may also be a contributing factor to injury. For example, some people develop with femurs (thigh bone) that rotate excessively inward. This is referred to as an anteverted femur and will place a much higher demand on the muscles responsible for controlling the pelvis and hip during the stance phase of running or walking gait. This will lead to increased risk of overuse injuries at the pelvis, hip, knee, ankle and foot. There are many other variants of anatomy and physiology that may predispose you to injury, but keep in mind that their significance can be minimized if their accompanying biomechanics are considered and controlled for. In the case of an anteverted femur, extra strength and conditioning of the hip stabilizers can counteract the increased demand placed on them during activity, and effectively reduce the risk of injury.

Technique is also an extremely important intrinsic risk factor for injury in the endurance athlete and will be discussed in future articles.

Of all these risk factors, perhaps the most significant risk for injury is a previous injury, especially if not properly rehabilitated. However, an injury can be a positive thing and potentially protect you against future injury if it leads you to re-evaluate your training plan, a thorough functional sports assessment, and a comprehensive approach to injury prevention, as I will outline in part two of this article.

Whether intrinsic or extrinsic risk factors are to blame, it is important to understand that in repetitive strain injuries the onset of pain or discomfort will occur weeks to months or thousands of repetitions after the onset of dysfunction. Pain is never the first sign. If you recall I previously mentioned that you should pay attention to pain. Well, this is certainly a valid point but I believe we can do better than that. I think we can be a little more objective and sensitive to what is going on in our body and in many cases prevent the injury

or onset of pain to begin with. In fact, if you consider the categorization of overuse injuries based on their stage and severity, you will find that in stage 0 there is no pain present before, during, or after activity, and minor discomfort is experienced at times of higher training load. In stage 1 you will have mild pain or stiffness after activity and the pain is usually gone by the next day. In stage 2 mild discomfort is experienced before activity that goes away or diminishes soon after exercise is commenced. Pain returns later in the training session or after the exercise is completed and lasts up to 24 hours. Stage 3 is characterized by pain that has progressed to being moderate and present before and during activity. At this point the pain is an annoyance which will alter biomechanics, cut training sessions short and force you to decrease the intensity of training to avoid further irritation. It is at this point that the athlete will typically seek help for their problem, and if they do not, they run the risk of progressing to stages 4 and 5 leading to increased severity of the injury, delayed return to activity, and the potential for complete resolution of the injury worsens. This disease plagues even the most intelligent athlete, as their motivation and courage overstep their ability to recognize the obvious.

If you can intervene at stage 0, complete and speedy recovery is assured. But wouldn't it be nice to prevent stage 0 from ever developing? Essentially, an injury begins with a biomechanical overload of a specific tissue (i.e. muscle, tendon, bone, etc.) that leads to an imbalance between tissue regeneration and tissue breakdown. In other words, the stress is too great and the recovery too little, which will eventually lead to injury.

Let me put this into a different perspective...

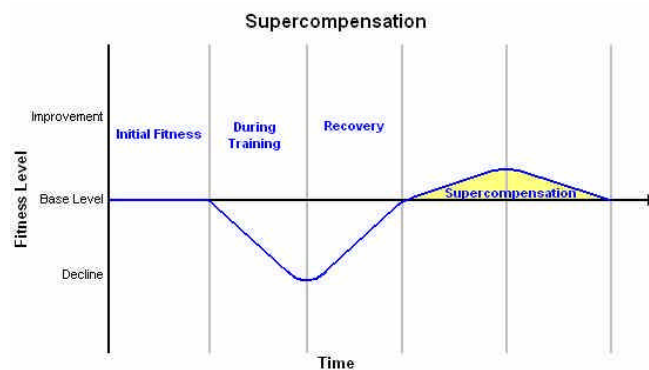
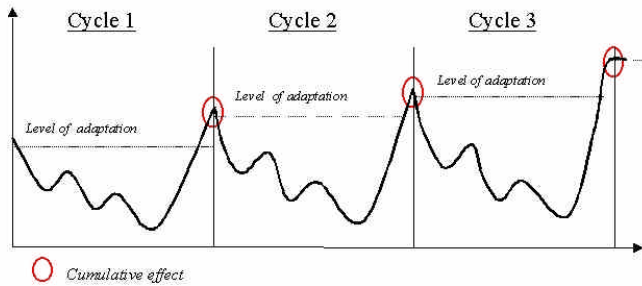


Figure 2: Supercompensation cycle

The supercompensation cycle is used to describe the effect training has on physiology and fitness. It describes how upon the application of a stress or training stimulus there is a temporary decrease in fitness, which if followed by recovery leads to supercompensation and increased fitness.

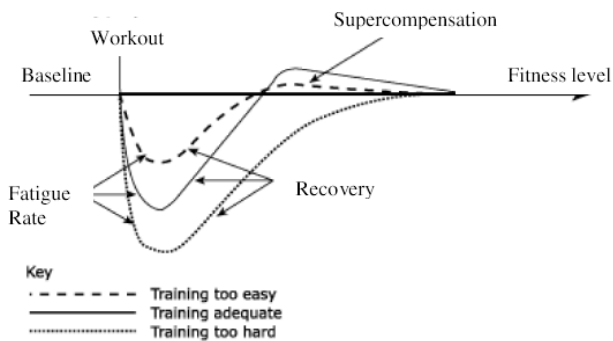
When we think of the supercompensation cycle we most often think of a systemic adaptation to a training stimulus leading to increased fitness. This adaptation is incurred in the cardiovascular, pulmonary, nervous, and musculoskeletal systems, leading to increased capacity of each respective system based on the training stimulus. Indeed, this cycle of adaptation occurs in every stressed tissue and cell in the body. Your tendons, ligaments and

bone all respond to a training stress leading to increased production of collagen and other essential components of these tissues, with the end result being a stronger more resilient structure. With repeated cycles of supercompensation the body adapts to a training load that is within physiological limits by activating genes and producing proteins related to an increased capacity of that tissue or system, resulting in things such as increased V02 max, improved lactate threshold, muscular endurance and strength.



**Figure 3: Cumulative training effect**

You can see however, if there is inadequate time for recovery super-compensation will not take place, and the benefit of training will not be appreciated. Repeated cycles of inadequate recovery will lead to declined performance, overtraining, and injury.



**Figure 4: Effect of under-training, over-training, and adequate training**

In figure 4, we can see the result of under and overtraining. If you under-train, the body will not be forced to adapt and your fitness will remain the same or decline. If you over-train the body is unable to adapt to the excess fatigue or inadequate recovery, and depending on the severity of overtraining, your fitness either remains the same or declines. The most common scenario is less than optimal adaptation in the face of less than optimal training and nutrition.

Now imagine that for every tissue in your body we applied a stress, recovery and supercompensation cycle. Your muscles, tendons and joints are all stressed and have to recover in order to respond to training. So, what if you had optimized your training such that you had a perfect balance of training load and recovery, but you had a weak gluteus medius muscle, an important hip stabilizer, leading to poor biomechanics and a relative increase in the stress at the patellofemoral joint and iliotibial band. In this scenario, what would be

adequate recovery for every other tissue and system in the body would now be inadequate for your patellofemoral joint and iliotibial band, eventually leading to overtraining and injury of that tissue. You just implemented a perfect training program but now you are injured and can't train or perform optimally. But was it a perfect training program? Well of course not, it didn't address the weak gluteus medius and associated biomechanical dysfunction which led to an injury and an inability to train or possibly perform. Now I don't know about you, but I think that sucks.

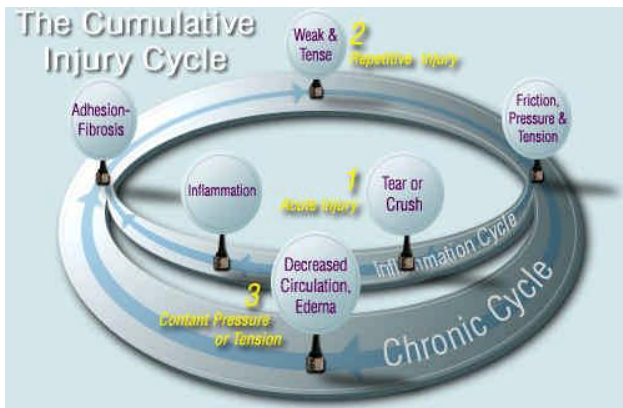


Figure 5: Cumulative Injury Cycle

In the cumulative injury cycle you can see that overwork results in increased tone and weakness of a muscle. Hyper-tonicity and weakness cause increased friction, pressure and tension leading to decreased circulation. Decreased circulation leads to a decrease in oxygen supplied to the tissue, called ischemia, which leads to a process called fibrosis. Fibrosis leads to the formation of scar tissue and fibrous adhesions. Intramuscular fibrosis (i.e. scar tissue formation that is embedded within the muscle) exacerbates the situation creating more tension, weakness, friction, pressure and ischemia, which perpetuates the process leading to additional fibrosis and the formation of more scar tissue and adhesions. Adhesions restrict the natural gliding of the tissue it affects which may include the fascia, muscles, nerves, tendons, and bursa. This restriction will create excess tension and friction on the related structures and again, perpetuate the problem.

In summary, excessive loading of a muscle, tendon or ligament, during physical training is regarded as the main pathological stimulus for fibrosis and degeneration, and there is a greater risk of excessive loading inducing injury in the presence of the previously noted risk factors. The response to repetitive overload beyond the physiological threshold is inflammation, degeneration, or both, with the end result being injury and pain. If present, these factors predispose an athlete to injury and negate optimum performance. Obviously we can't modify our genes or the way we developed but we can modify our posture and biomechanics, the way our bicycle fits, the shoes we wear, and our training programs. With careful evaluation, effective treatment, prevention and performance exercise we can eliminate most extrinsic and intrinsic risk factors and reduce cumulative microtrauma, thus reducing the insult on the tissues and dramatically reducing the risk of injury while increasing your capacity for training, with the end result being optimum health and superior performance.

OK, so we now have a basic understanding of how injuries occur...we have an idea of what goes wrong, but we need a plan. Part 2 coming soon...