Issue 4: February 2020

TRAINSMARTER

PART 1: RUNNING RELATED INJURIES

INTRODUCTION

Despite advances in technology, running shoe research and compression garments, running related injuries (RRI) remain very high when compared to other sports. In fact, 68% of triathlon injuries are from the running event and there is also greater risk of injury from running than weightlifting, martial arts and gymnastics. Also worthy of note was a study on recreational runners which found that 25% of runners experienced RRI during an 8 week training period. So why are injuries so common amongst runners? This 2-part article aims to help understand the factors associated with running related injuries and present some strategies to help prevent them. Specifically, we shall have a look at the biomechanics and movement patterns required for running, how our body adapts to forces placed on it (including pain) and then part 2 will consider the evidence for stretching, strength training and plyometric exercises in the prevention of game changing injuries.

The onset of injury can be narrowed down to one of two reasons (or a combination): Training errors and Personal characteristics. First, let's get a bit "sports sciency" – and have a look at the training variables that we need to consider when setting about a training routine. Table 1 outlines the four modifiable factors that we can consider when designing a training plan:

1.	Volume	Total distance per week
2.	Intensity	How hard you train (Minutes per mile)
3.	Frequency	How often
4.	Type	Type of session: Speed, hills, LSD (etc)

Table 1: Training variables

These training variables all lead to load or accumulation of stress and strain on the body. When we run, the force is equivalent to 2.5 – 3 times our body weight. Our bodies are capable of amazing feats and will adapt to manage this load if we allow adequate recovery between runs. It is when the load (application of training variables) exceeds our body's ability to adapt and tissues become overloaded when we get injured. Tendons, muscle, joint and even bone will all adapt and strengthen in response to load. However, inadequate training will not promote significant change and t**oo much load** will lead to pain and injury. So, with the right training and recovery your body will adapt to manage the load and you will get fitter, stronger, faster and avoid injury. This can be illustrated using the envelope of function (see diagram 1).

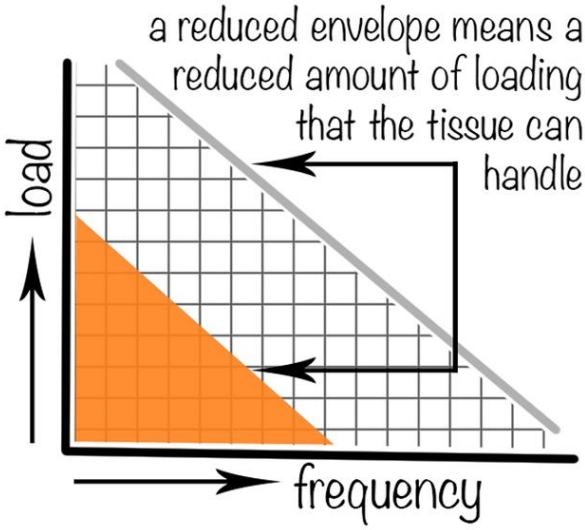


Diagram 1: The envelope of function

This diagram highlights that when you increase load, you need to keep the frequency low or if you increase the frequency of training, you need to adjust the load. This way you will stay within your envelope of function (the orange bit) and reduce your chances of overload and injury.

WHAT IS PAIN?

If you were to train outside of your envelope of function, you are more likely to overload tissue and experience pain. Pain affects us all in different ways and we all have different methods to cope with it. It is far beyond the scope of this article to delve into the complexity of pain science, however, it is important to understand that pain does not necessarily mean that there is tissue damage. It can behave more like an early warning, signalling that something is wrong or a reaction to excessive loading informing you to take action! The solution in this case would be to reduce the load, allow recovery and then find a balance within the envelope of function. If pain is ignored it can lead to further overload and subsequent tissue damage. Pain can be very unreliable and often a lagging indicator of dysfunction - including poor running technique, inadequate mobility, strength or biomechanics. Upon injury, identification of the factors that led to our pain is critical for you to not only to get back to running, but to improve your performance and avoid further injury. Movement screening is used in the prevention of running related injury to identify movement errors early and set in place a preventative program to keep you injury free.

In this section, we shall have a look at training errors and personal characteristics, both of which may lead to tissue overload and injury.

TRAINING ERRORS

Table 2 identifies some of the factors that may be considered as training errors leading to biomechanical overload and injury.

Rapid increase in load
Change in technique / shoes / terrain
Early return to running after injury (incomplete rehab). *Consider sports teams!*
Inadequate rest
Poor recovery / sleep
Inadequate strength
Movement dysfunction

Table 2 Common training errors

When looking for a reason why we are injured, we can often identify something from this table that may have played a part in your injury. Novice runners or those setting about a program after a period of inactivity are at greater risk of injury due to the unaccustomed increased in activity. Changing the terrain or adding more hills is also a common reason for injury and should be carefully considered when planning your training.

The return to running after injury too early or without adequate rehabilitation is a very common training error that needs consideration. Have a look at sports teams for example: an injured player would undergo comprehensive rehabilitation, vigorous screening for fitness and testing before a graded return to play. However, many runners seem to stop running when injured, rest, recover and then restart without implementation of preventative strategies or any consideration of why they were injured in the first place. Movement screening and identification of factors leading to overload and injury should be addressed if you are to avoid reinjury.

To avoid training errors, consider these top tips:

- Plan your training – think about the training week or month and not just the individual run.
- Keep a training log and record your mileage, progressions and recovery.
- Incorporate mobility and strength training in your weekly schedule.
- Listen to your body and plan rest days. Fatigue and irritability are signs of over training and lead increased risk of injury, colds and illness.
- Observe good sleep hygiene, water intake and diet.

PERSONAL CHARACTERISTICS

This considers our individual style of running, body shape, physiological make up, previous injuries (the list goes on…). Effective running requires good range of movement at the whole body, strength to be able to absorb landing forces and then propel forwards and good technique (remember, running is a skill). Let's have a closer look at running.

There are several differences in our gait pattern when progressing from walking to running. Our arm swing increases, our step width narrows and our pelvis tilts forward to increase the biomechanical efficiency of running. One of the biggest differences between walking and running is the addition of the float or flight phase which is the time during the gait cycle when there is no foot contact with the ground. This increases the impact of the foot with the ground on each step and can exceed 2.5 times your body weight. This is called the **Ground Reaction Force (GRF)** and needs to be absorbed to maintain efficient running and avoid injury. The human leg is mode of from 3 segments. (Hip, knee and ankle joints which combine to produce the overall biomechanics needed to run. Each of these joints has the ability to absorb energy and meet the stress demands of the GRF and avoid injury. The interaction between these 3 segments (along with the trunk) and the muscles controlling them will determine the distribution of the stresses of the GRF. Therefore, a joint with a poor capacity to absorb forces may place increased demands upon structures elsewhere, conversely, a strong body segment can help reduce excessive stress on the whole system and minimize the effects of injury on the whole system. This is the key to avoiding injury and increase running efficiency.

Strength & mobility training should be incorporated into your weekly training plan in order to maintain optimal joint movements, absorb the forces of running and propel you forwards. Joint stiffness and muscle weakness can lead to abnormal or compensatory movement patterns resulting in overload to the tissues ultimately leading to injury.

Joint mobility required in running

Optimal mobility at each joint will ensure that you are able to distribute forces across the lower limb efficiently and avoid overloading structures. The picture below shows *optimal* ranges of movement for the joints of the lower limb.

Diagram 2: Optimal joint ranges (Novacheck, 1998)

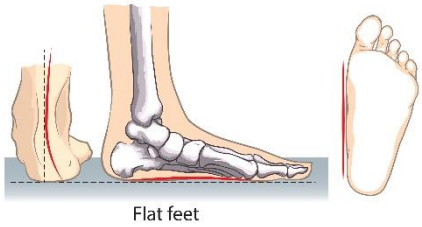
So far, we have discussed mobility and strength training. However, one factor often overlooked is movement patterns or control of movement.

Identification of abnormal movement patterns and why they are occurring (i.e. as a result of poor joint mobility, lack of strength or poor motor control) is vital in the successful rehabilitation after injury but also in identifying potential causes of injury which will assist in reducing injury recurrence. This section will focus on four commonly occurring movement pattern dysfunctions that lead to inefficient running style and subsequent injury. Click on the link below to watch a video explaining this further.

Lower limb biomechanics and knee pain

Overpronation.

Your foot is designed to absorb shock, adapt to the surface you are moving on and propel you forwards into the next step. I order to achieve this, the foot moves between pronation into supination with each gait cycle. The intrinsic muscles of the foot, the plantar fascia and the calf muscles work hard to support the foot and allow it to perform this role. Foot posture has a very big role in efficient running and injury prevention. Delayed supination or poor foot mobility can lead to overload of the structures not only within the foot but in joints above as well.



Flat feet

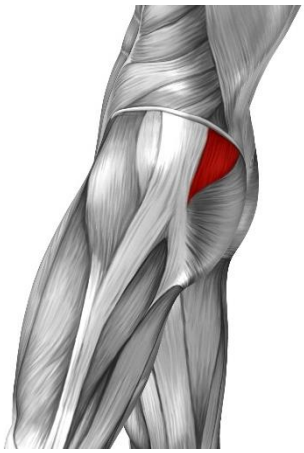
Normal feet

Restricted hip extension.

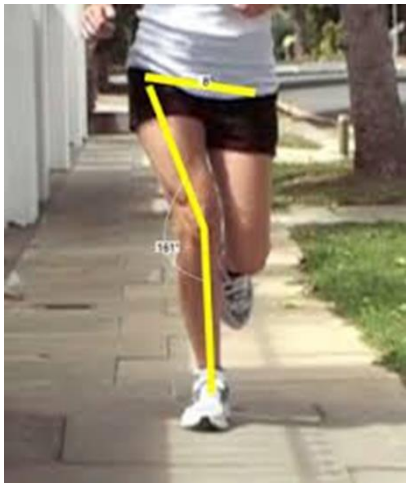
This could be as a result of tight muscles at the front of the hip (Iliopsoas), weak gluteal muscles (Gluteus Maximus) or poor technique. Poor hip extension can lead to overload of other muscles especially the spinal musculature, hip pain, back pain and knee pain. The photo opposite shows a great exercise to mobilize into hip extension.

Excessive hip drop

The inability to control your pelvis whilst walking or running can have widespread consequences. The gluteus medius (highlighted in red in the picture opposite) and minimus are responsible for control of the hip especially whilst standing on one leg. These muscles stabilize the pelvis allowing efficient movements of the hip and spinal joints. Simply strengthening these muscles up may not be the answer. Of course, they do need to be strong, but they also need to perform within a movement pattern to maintain stability throughout single leg activities. Ineffective activation from these muscles contributes to poor movements at the knee joint.



Knee dropping inwards



This could be as a result of inadequate Gluteal activity, over pronating foot posture or poor movement patterns. Poor hip control can lead to increased internal rotation and adduction at the femur (see picture 4) which affects the knee joint biomechanics leading to overloaded tissue and pain. This can also be compounded by tightness in the calf muscles, overpronation or weak core muscles.

Physiotherapy can identify poor movement patterns, weakness or joint stiffness and design exercise programs to correct these dysfunctional movement patterns and get you moving and running effectively.

Considering 8100-foot strikes over a 45 minute run, it stands to reason why inadequate strength, mobility or movement control can lead to musculoskeletal overload and injury. This highlights the importance of including mobility and strength training into your running schedule or more specifically – developing running robustness.

COMMON RUNNING INJURIES

Before we have a look at developing "Running Robustness" lets have a look at some common injuries seen among runners. We can identify injury according to the structure injured (Table 2: muscle, tendon, joint, which includes ligaments and bone), and this will inform healing times and rehabilitation. Regardless of the type of injury, all structures will follow a cascade of events known as tissue repair ultimately leading to scar tissue. Rehabilitation will determine the effectiveness of this scar tissue and your ability to return to pre injury levels. Diagram 3 shows the healing process as a sequence of events (3a) that in reality converge into a seamless flow (3b).

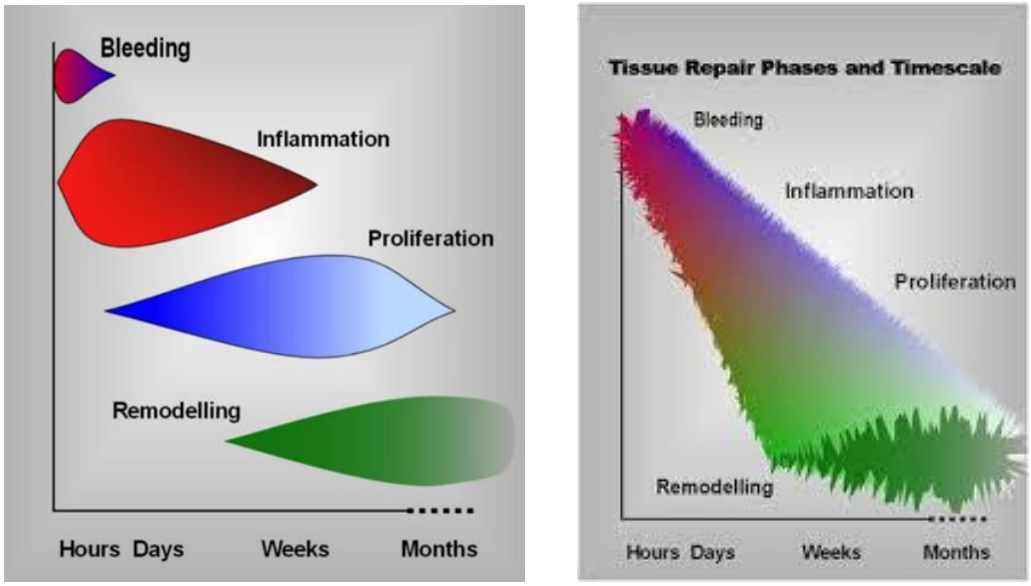


Diagram 3a and b: The healing process. Produced with kind permission from Prof. T. Watson

STRUCTURE	EXAMPLE
Muscle	Hamstring Injuries
Tendon	Iliotibial band syndrome Patella tendinopathy Achilles tendinopathy Plantar fasciopathy
Joint	Patello-femoral pain syndrome
Bone	Shin splints

Table 2: Common running related injuries (RRI)

Muscle injury is characterized by a deep aching pain, bruising and swelling. Usually settles quickly and responds well to ice, compression, elevation and medication. Tendon injuries can take much longer to settle.

Tendon injuries can take a lot longer to settle and require a specific rehabilitation protocol. Symptoms to look out for include pain which subsides on activity which returns on completion. This makes it very dangerous as you can continue activity usually pain free but suffer afterwards. This is often associated with pain the following morning.

Joint pain presents as deep diffuse aching. It may also be associated with instability, giving way or locking. This can often be as a result of trauma or gradual onset suggesting a degenerative condition.

Bone injuries are usually associated with fracture from a trauma; however, repetitive microtrauma can also lead to fracture. An imbalance between loading and recovery can lead to bone injury, the most common being medial tibial stress syndrome (MTSS). This was previously thought to be the soft tissue pulling away from the tibial (shin) bone but advances in imaging technology suggests that MTSS co-exists on a spectrum with stress fractures. CT scans show pockets of reduced bone density in patients with MTSS like that of patients with stress fractures which on recovery from injury, bone density had returned to normal levels.

SUMMARY

Part 1 has identified two important factors (training errors and personal characteristics) that can be modified to reduce risk of running related injury and optimize your running performance. We highlighted the importance of mobility, strength and movement patterns I n the prevention of injury and discussed 4 common biomechanical factors leading to overload. Part 2 will focus upon effective strategies from which to base your mobility, strength and plyometric training around. We will look into the physiological basis of warming up, explore the 2 principles of strength training – specificity and progressive overload in order to help you reach your running goals. We will also have a look at running shoes and tips to help you choose the right ones for you.

For more indepth explanation of running biomechanics, have a look at this article: Biomechanics of Running by Tom Novacheck (1998). Until then, TRAIN SMART!

Access this article with videos at www.niccostiff.co.uk/resourses