A LETTER FROM

LONDON, UK

Throw away the needles and orthotics, teach them to run…

– Written by Andrew Franklyn-Miller, UK

While I write this in London it is below 0°C and going out for a run barefoot on the frozen ground in the wood surrounding our home is the last thing on my mind, but it certainly does not deter a great number of people. Barefoot or minimalist running is certainly the 'latest thing' and we are seeing increasing numbers of proponents in our clinics, either in VFFs (Vibram five finger shoes) or a Nike free or Vivo barefoot shoe. Throwing away the concept that cushioned or anti-pronation shoes are the answer to their running problems, or even if they have never suffered from exercise-induced running pain, many are turning to the phenomenon. In theory it should be unmarketable as it does not require any special equipment and as such the 'Gait analysis' performed in running shoe shops the world over have no reason to promote it, but they have found a way.

As I have blogged and tweeted, being faced with a patient being 'prescribed' shoes by a 'gait analysis' expert in a shoe shop is one of my biggest bugbears. Typically the runner hops on a treadmill and tries on a few shoes after being grouped into a category as over pronator, heavy lander, flat footer or other such nonsense. They are then recommended an expensive cure-all shoe, without any regard for the higher motor patterns or the actual running muscle recruitment. It is rarely about strength or weakness, more about timing!

It is not about the shoe, it is about what the muscles of the leg are doing to control the absorption of force and generate force and how they are doing this. No shoe, or orthotic for that matter is going to do that. But you as the clinician can.

> ***It is not about the shoe, it is about what the muscles of the leg are doing***

Barefoot running is fascinating. This is partly because of the evangelical support of its believers and also because it has made such a big impact in the running press. Today manufacturers are all racing to produce minimal and near to barefoot running shoes and runners are adapting to this new technology.

Many point to reading the book 'Born to Run', by Christopher MacDougall. It traces the story of the Tarahumara Indians whose running ability is legendary and who run shod but almost barefoot. The book charts the success of the author from non-runner to ultra-distance running using many of the same principles.

Chris was seeking a 'cure' for his Achilles tendinopathy. After having shots of cortisone and multiple other therapies, adjustments and 'guru' treatments, he found no improvement until he chanced upon the Tarahumura. He adapted their 'barefoot' style along with many other variables such as dietary change, volume running and enjoyment! He does not mention whether his Achilles still gave him pain but given the volume of running he manages, it appears it did not. His story is not only inspirational but important. It suggests towards something that is obvious when you look at it and similar threads are picked up by Matt Fitzgerald in 'Iron War' the story of Dave Scott and Matt Allen and also in Richard Moore in 'The Dirtiest Race in History', where high level athletes comment on how we are not taught to run as a developing child.

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Injury rates have not changed much in recent decades, with the often-quoted 37 to 56% of runners sustaining an injury in every 12-month period[1]. As such, any intervention which may affect this number is a good one and worth examining, particularly since it coexists nicely with the theory that changing the pattern, speed and sequence of muscle activity in force attenuation and generation is reproducible.

There has been much debate about this at recent conferences. At the 2011 American College of Sports Medicine Annual Meeting, a symposium on barefoot running was led by Dr Irene Davis and Professor Daniel Lieberman. Both are active researchers in running biomechanics and evolutionary development respectively, and the debate continued in London at UKSEM 2011 between Prof Daniel Howell (an anatomy professor from Liberty, USA, who actually lives barefoot), Simon Barthold, Prof Benno Nigg, Dr Mathias Marquard and Prof Daniel Lieberman, evolutionary biologist from Harvard . The debate itself has been covered very well by Dr Ross Tucker[2] who chaired the latter debate, but outside the debate whether barefoot is best, the real question is: can we take gait changes and biomechanical changes from it and adapt this to retrain injury?

Conventionally, the definition of exertional lower limb injury (ELLI) includes, among other things, medial tibial stress syndrome, tibial and fibula stress fractures, anterior knee pain and patellofemoral pain, Achilles tendinopathy and plantar fasciitis along with that of chronic exertional compartment syndrome.

The causes of lower limb injury are recognised as multi-factorial and not well-understood in terms of prospective risk, but abnormal biomechanics are recognised as a key element. It has been suggested that causation can be grouped into three general categories: training, anatomical and biomechanical. While training-related factors such as high weekly mileage and sudden changes in intensity and distance, along with the running surface, have all been well-demonstrated as causative of lower limb injury, these are difficult to control in the recreational or professional runner who is struggling to increase mileage or meet training demands. In the military recruit it is also true they may have little control over the progression of their training load and an un-modifiable variable.

Intrinsic factors such as the magnitude of impact, the spike of impact and force of toe off along with rapid rate of pronation have been suggested as contributory to injury, although there has been little quantitative prospective data. Other studies have suggested biomechanical abnormalities associated with exertional lower limb injury. Attempts to correlate anatomical morphology including Q angle, limb lengths and knee extension flexion angle with injury in a cohort of US Army infantry recruits found significant associations between some of the variables. While biomechanical abnormalities such as pes planus or pes cavus were associated with increased overuse lower limb injury, little work to date has looked at the timing or ability of the lower limb to control proximally what occurs distally and newer studies are emerging which are beginning to show promise.

Patellofemoral pain is an extremely common running-related overuse injury. Over the past decade or two, extensive work on patella taping and quadriceps muscle timing has shown to be partially effective but focused less on the role of the gluteal muscles, which act as a resistor of femoral rotation under stance and then a strong hip extensor. Almost 75% of runners make initial foot contact with the heel. The result of this is a significant loading force spike which Davis[3] has demonstrated can be significantly reduced by changing to a midfoot or forefoot initial contact by up to 30% and the tibial deceleration forces reduced by up to 50%. Significant as a stand-alone fact, but combined with the similar reduction in peak knee flexion moment may contribute to reduced patellofemoral joint forces.

Cheung[4] has shown in a small case series that 90% of runners with patellofemoral pain were able to maintain a midfoot landing. They followed a re-training programme of eight sessions over 2 weeks, focused on moving from a rearfoot to midfoot strike to maintain a midfoot strike and similarly showed a reduction in peak ground reaction force between 10 and 35%, along with a reduction of pain scores and improved running performance. This is important

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as many runners question their ability not only to change the way they run but also to maintain it. The reduction in ground reaction force is clearly important but also the recruitment of the hip stabilisers, the gluteals, which can more effectively engage to produce drive.

Chronic exertional compartment syndrome (CECS) was first described in the mid 1950s but much is assumed about the pathological physiology. An assumption is made that elevated sub-fascial or intramuscular pressure during exercise causes tissue hypoxia and ischaemic pain due to decreased blood flow but to date, no conclusive evidence exists to demonstrate either hypoxic damage or decreased capillary perfusion. Further supposition is made regarding muscle hypertrophy, reduced compartment volume due to a decreased fascial compliance and shorter periods of muscle relaxation as the underlying pathophysiology of CECS.

While working at the Centre for Human Performance and Rehabilitation at the UK Ministry of Defence, we were referred large numbers of military patients with suspected CECS and hence conducted large numbers of intra-compartmental pressure measurements. It was during discussion with consultant colleagues, researchers and specialist physiotherapists that we began to doubt the mechanism and underlying pathology. We also recently questioned the reliability and validity of the published diagnostic criteria for CECS[5]. We believe that, in patients with exertional leg pain referred to as chronic exertional compartment syndrome, we are observing a common condition seen in other patient groups, that of muscle overload. As the aetiology in these patients is biomechanical, we have described their condition as a 'biomechanical overload syndrome'[6].

Muscle overuse syndromes are not new. They are well-described in the literature, significantly in musicians and office workers. There is often a clear synergy with the predisposing factors in repetitive exercise: increasing frequency and the intensity or load of work and practice. Altered limb biomechanics alongside limited interventions is also a factor.

This led to a close look at the biomechanical use of the lower limb muscle. During walking gait, tibialis anterior dorsiflexes the ankle concentrically to provide foot clearance during swing phase and isometrically (with lengthening of the tendon) to control the lowering of the forefoot during the first part of stance. This is assisted by the long toe extensors (extensor hallucis longus, extensor digitorum longus) and peroneus tertius. During running gait, both the tibialis anterior and gastrocnemius have a high degree of pre-activation prior to foot strike. During the weight-bearing phase the conjoint tendon of soleus and gastrocnemius undergoes an eccentric, then concentric, loading phase through a range of angular load greater than any other muscle tendon interface. Tibialis anterior activity decreases rapidly during running-induced metabolic fatigue compared with the gastrocnemius.

A change in muscle activation between walking and running gait may explain the differences in rearfoot pronation. In running, certain muscles are more active on foot contact to limit rearfoot pronation. It has been proposed that tibialis posterior, soleus, medial and lateral gastrocnemius all act to limit rearfoot pronation. EMG studies have shown that the major peak of soleus, gastrocnemius lateralis, and gastrocnemius medialis is on foot contact/early stance in running as opposed to mid-late stance in walking. The preloading of the peroneal muscles may be active during early stance to increase joint stiffness on initial contact - this in turn can reduce the tibial torque. The major peak of peroneus longus has been shown to shift from mid-late stance in walking to early stance in running. This is relevant as it gives the potential mechanism for change of gait pattern, but the focus is on sequential gluteal activation through hip flexion and extension, resisting femoral rotation

Crowell and Davies[3] looked at reducing peak positive acceleration of the tibia and vertical peak ground reaction force using similar gait retraining concepts and reduced tibial acceleration by 50%. This has been implicated in stress fracture, again utilising only one feature of gait retraining but demonstrates a possible use in stress fracture prevention.

We have developed, along with colleagues, a 'running re-education programme', which focuses on many of the perceived benefits of barefoot running technique but assessing the patient's current running style, it is not about the shoe or indeed the feel or selling an assessment or orthotic, it is about reducing the ground reaction force and improving running economy. By reducing the ground reaction force we can improve running economy, by reducing ground contact we

reduce the stretch contract phase of the posterior calf muscles and subsequently the load cycle on the Achilles. In some patients, by preloading the lateral compartment muscles of the shank, we can alter the initial contact position and offset loading of the foot. However the most important feature is the position of the centre of mass and enabling the gluteal muscles to function as the primary drive train, reducing the load on muscles further down the chain. This in turn reduces the femoral rotation, making it useful in patellofemoral pain. We have begun to use the technique in patients suffering from Achilles tendinopathy as an adjunct to maintain exercise. With a reduced stretch contract phase following a high volume stripping of the fascia, we can maintain running throughout treatment.

In any other sporting activity where an athlete has suboptimal technique or performance we look at form and coach the skill. Running efficiently is no less of a proficiency than a tennis serve, but it is very rarely emphasised in injury prevention. Errors in timing, posture and muscular control while running reduce efficiency of movement and predispose the athlete to injury.

So, where does this leave the orthotic? Well although ground reaction forces are measured at the foot, much modification is higher up the chain. Unless we are generating and absorbing load efficiently with the large muscle groups, we cannot expect small tweaking to make a significant difference. My view on this has changed appreciably since my Ph.D. studies into orthotic use in the Military as an injury prevention tool and pressure plate analysis of running gait[7]. We do utilise temporary inserts as targeting and gait retraining tools occasionally, but not for more than 2 weeks and find we use them less and less. Of course this is hotly contested, but we find more often it is a control and timing problem rather than inherent abnormality.

Beyond all, we use running as a treatment rather than the goal and gait retraining offers much in the way of sports physician, physiotherapist and athletic trainer 'hands on' therapy. It is not a style of running such as ChiRunning or Pose Running which are more for the uninjured runner looking for a different challenge, but utilising gait retraining as a treatment allows for a cost effective, successful and rewarding intervention in the clinic.

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