Pre-bike fit screening

Nick Dinsdale **explains why it pays to study how the rider stands** and walks before bringing the bike into the equation

As the cycling world embraces the concept of bike fitting, it's been suggested that cyclists and bike fitters alike are neglecting or undervaluing the importance of a prior biomechanical and anatomical screening. This pre-screening — potentially followed by treatment off the bike — is where the process should begin if the best overall outcome is to be achieved, says Nick Dinsdale of the NJD Sports Injury Clinic.

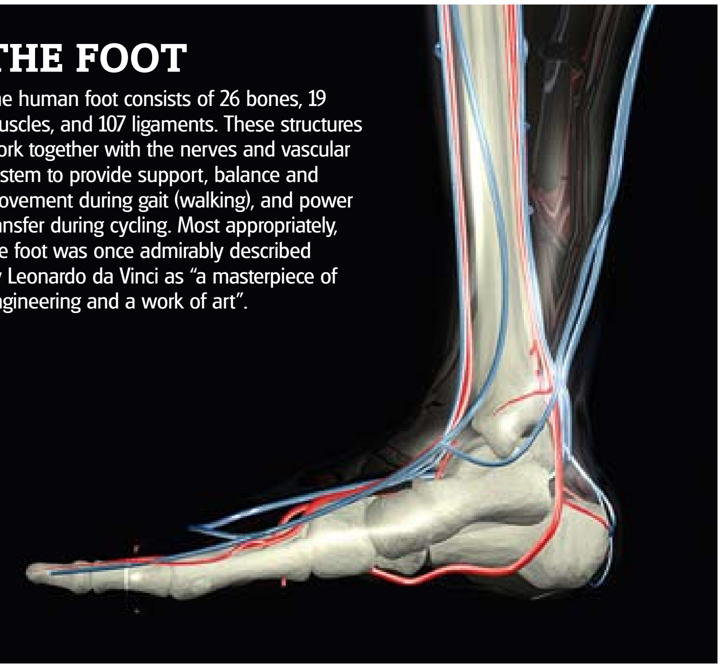
The purpose of pre-screening is to identify potential biomechanical/anatomical problems in standing and walking (gait) that lead to foot dysfunction. If the foot isn't providing a stable platform in day-to-day movements off the bike, and pronatory forces in gait are left uncontrolled, it's likely that you're taking problems onto the bike and, ultimately, compromising the corrective measures taken in bike fitting. Although it's widely accepted that the foot/pedal interface is the cornerstone to effective bike fit, it's rarely reported in the cycling literature that for an optimum outcome, findings from the screening process should impact upon the bike fit package. Failure to undergo effective screening by a qualified clinician may deprive the cyclist of the opportunity to optimise bike fit.

Club riders are the most likely beneficiaries

Club-level cyclists and older riders stand to benefit the most from pre-screening and subsequent adjustments at the foot. Senior cyclists especially are more likely to have not only lower-limb/foot malalignment problems, but also degenerative changes in lower-limb joints, which can disrupt normal pedalling. Previous fractures of the leg and even factors such as hip replacements in older cyclists commonly alter leg-lengths. In turn, these disrupt normal pedalling biomechanics. Chronic pelvic and low back problems are often associated with poor foot mechanics.

THE FOOT

The human foot consists of 26 bones, 19 muscles, and 107 ligaments. These structures work together with the nerves and vascular system to provide support, balance and movement during gait (walking), and power transfer during cycling. Most appropriately, the foot was once admirably described by Leonardo da Vinci as "a masterpiece of engineering and a work of art".



SCREENING PROCESS

In order to treat something, we must first identify and diagnose it. As with any profession, this requires specialist knowledge and differential diagnostic tests.

Foot screening

We believe the foot should be screened for activities on and off the cycle, as the aim is to control excessive pronation for all activities. Although not well documented in cycling literature, excessive pronation is a common cause of pelvic, sacroiliac joint and chronic low back pain. Any disruption or imbalance caused by gait activities (walking and running) may be taken onto the bike. Excessive foot pronation during walking and/or at the foot/pedal interface when cycling transmits harmful forces up the kinetic chain into the pelvis and lower back. These harmful forces generate excessive pelvic motion in the frontal plane and transverse plane. Excessive pelvic motion › is very disruptive, and can lead to pelvic muscle imbalance and sacroiliac joint problems. To compensate, the cyclist adopts an asymmetrical riding position, indicative of sitting to one side of the saddle and pushing more through one leg. Uneven wear patterns on the saddle are indicative of postural asymmetry.

Tsai et al (2006) demonstrated that good posture during gait relies on foot stability during mid-stance. Mid-stance is when all your body weight is on one foot. Rothbart (2006) demonstrated that foot pronation displaces the body's line of gravity forwards through forward pelvic rotation, while Cobb et al (2004 and 2006) found that levels of forefoot varus greater than 7° can cause core and pelvic instability. The above studies demonstrate that the foot, through walking and running, can cause core and pelvic problems which, if not addressed, can be taken onto the cycle, even after a comprehensive bike fit.

Screening for leg length difference (LLD)

Legs should be checked for differences in length However, without the use of x-rays, leg-length differences (LLD) can be difficult to diagnose and more difficult to measure accurately with any confidence. LLD can be classified into two main categories: anatomical and functional. Consequently, great care is required when attempting to establish the amount of LLD, and whether the difference is anatomical or functional, or a combination of both. Anatomical differences, which are true LLDs, result from an actual anatomic shortening of one or more of the bones of the lower extremity.

Whereas functional LLD is not a true leg-length difference, but usually occurs as a result of muscle contractions, muscle weakness or inflexibility among other reasons. Knutson (2005) reports that 90 per cent of the population have anatomic LLD — but not many need corrective shimming.

We have had cyclists visit our clinic where anatomic LLD has been mistaken for functional

Nick begins with a visual assessment of forefoot tilt

LLD. Inadvertently, compensatory packing shims have been fitted to the cyclist's shoe unnecessarily, further exacerbating their problem.

In the absence of x-rays, and because there is no one stand-alone test to determine LLD, we strongly recommend that a series of tests be employed in order to arrive at a reliable hypothesis. Problems associated with LLD clearly highlight the importance of a thorough clinical assessment.

We have used packing shims equating to a 20mm stack for one extreme example belonging to a 40-year-old female cyclist with an estimated LLD of 25mm following a hip replacement. We are currently customising a male cyclist's shoe with a similar leg-length difference following a fractured leg.

> **"During one hour of cycling, a rider may average up to 5,000 pedal revolutions"**

Screening lower limb alignment

The vast majority of the population have tibial varum — in other words, bow-leggedness. Excessive tibial varum is considered the main cause of pronation and often leads to forefoot varus (tilt). Tibial varum is the natural bowing of the lower third of the tibia represented as a norm of a 3-4° angle. Some cyclists have tibial varum of 5-6°, and in these cases more corrective wedging is usually warranted. When the foot is unloaded (open chain) the inside aspect (big toe) of the foot is elevated in relationship to the outside of the foot. When the foot is loaded (closed chain) the inside of the entire foot must roll inwards (pronates) to make contact with the pedal platform.

Caveat emptor often applies when treating foot pronation. Cycling and gait activities are very different and require different remedies. External cleat wedges are effective for treating tibial varum for cycling activities, while separate foot orthotics may be required when walking.

The foot/pedal interface

The foot/pedal interface is the most common source of pedalling asymmetry, and represents the mechanical link between leg and cycle. According to many authors, including Paul Swift, Bikefit.com, the foot/pedal interface is the foundation for an effective bike fit. This is because the structure and function of the foot and lower-limb alignment dictate how effectively pedal forces are transferred via the foot/pedal interface down to the cranks; and potentially, how harmful forces are transferred up the kinetic chain. During one hour of cycling, a rider may average up to 5,000 pedal revolutions. The smallest amount of malalignment at the foot/pedal interface — whether anatomical, biomechanical or mechanically related — creates pedalling asymmetry.

BIOLOGY BEHIND TECHNOLOGY

Modern equipment's influence

Again, not something often referred to in literature, but it's highly likely that modern cycling technology — in particular, the advent of carbon — exacerbates the problem of foot dysfunction. While frames, wheels, cranks, pedals, shoes and so on have all advanced and become significantly stiffer, the human foot remains unchanged. Consequently, in a system that has very little flex for energy to dissipate, pressure on the foot increases considerably. While these rapid technological advancements, and ever-improving rider fitness/strength, provide for more efficient power transfer, they come at the expense of increased forefoot pressures. These cause the foot to collapse inwards, and can be responsible for forefoot problems and increased pronation.

THE EXPERTS

Father and Daughter duo Nick and Nicola Dinsdale, both graduate sports therapists, together run the NJD Sports Injury Clinic in Clitheroe, Lancashire.

Aside from running his own practice, Nick has raced at a high level, and regularly presents seminars plus has written several articles pertaining to foot mechanics' association with pedalling biomechanics in the UK and US cycling press. Nicola takes a primary role in running the clinic, and is the sport therapist for Blackburn Rugby Union team.

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The harmful effects of excessive pronation

Pronation is when the foot rolls inwards and is considered a normal and necessary movement for efficient gait. Excessive pronation, in both cycling and gait, can be described as when the foot rolls in too much, creating abnormal knee motion. Excessive knee motion means the knee must travel further than is necessary through each pedal revolution. This additional, unwanted knee motion constitutes wasted energy, and is potentially destructive to many parts of the kinetic chain (foot, ankle, knee, hip, pelvis, lower back and neck).

Excessive pronation is very common

In a study to examine different foot types, Garbalosa et al (1994) found that 87 per cent of the sample population had forefoot varus (excessive pronation) in one foot or both, nine per cent had forefoot valgus, and four per cent had a neutral forefoot-rearfoot relationship. Conventional or standard pedal systems are designed for the cyclist to be positioned on the pedal flat-footed, and, therefore, are only ideally suited to four per cent of the cycling population. Incidentally, Dr. Andy Pruitt of Boulder Center for Sports Medicine used the Garbalosa findings in the development of the Specialized Body Geometry (BG) shoes, footbeds, and wedges.

When translated into cycling terms, less than 10 per cent of cyclists have a perfect foot position on the pedal. Therefore, the high number of cyclists with forefoot varus (87 per cent) clearly highlights the need for screening and subsequent adjustments at the foot/pedal interface. Forefoot varus is sometimes referred to in cycling literature as forefoot tilt.

Conventional screening

Conventional screening for normal function of ankles, knees, hips and spine should be routine. History of lower-limb trauma, training loads, pedal systems, cleat positions, etc, are taken into consideration. Muscles in and around the pelvic region often become affected. Typically, the quadratus lumborum, piriformis, tensor lata fascia/ilio-tibial band, psoas and adductors become imbalanced, tight and sensitive to the touch. Older riders may have some degeneration in their joints (osteoarthritis), particularly in the hip. Altered biomechanics is a contributing factor in accelerating degenerative changes in the lower-limb joints. Personalised musculoskeletal rehabilitation plans, complimented with manual therapy, are often prescribed to restore function.

Comprehensive bike fit package

We believe that biomechanical and anatomical screening before bike fit is an area often neglected, undervalued, or misunderstood. Although many sources offer some degree of screening prior to bike fit, some fall short of offering a clinical approach. Ideally, a complete bike fit package should include pre-screening and, when necessary, advice and /or corrective measures implemented to control excessive pronation during gait activities. In cases where muscle or joint problems exist, a personalised musculoskeletal rehabilitation plan accompanied with manual therapy may also be required.