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Before Bikefit
Addressing Foot/Pedal Asymmetry: Part 1

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Graduate Sports Therapists Nick and Nicola Dinsdale, father and daughter team, run NJD Sports Injury Clinic in Clitheroe, Lancs. UK. The family clinic is recognised for its strong evidence-based approach to the management of sports related musculoskeletal injuries and its keen interest in working with competitive cyclists. Patients include professional cyclists from across the various disciplines, in addition to British Cycling officials.

Nick specialises in foot dysfunction and how it impacts on cycling performance. This article contains unique findings taken from his own research recently carried out at Manchester Metropolitan University. Nick has worked with The Great Britain Cycling team both domestically and overseas and is a past National Cyclo-Cross Series winner.


Nick Dinsdale


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Introduction

BGN INT XTP MSR MTB

This two-part article will hopefully provide race cyclists with an opportunity to acquire the all too elusive extra-edge. This concept was admirably described by Brailsford [1] "marginal-gains can represent the difference between success and failure". Part 1 of this article will focus on the benefits of screening competitive cyclists, from a clinician's perspective, especially prior to Bikefit. Clinical screening is an area often neglected, undervalued, or misunderstood. Both parts of this article will examine the foot/pedal interface - considered to be the most common source of pedalling asymmetry. Part 2 will investigate ways of addressing common anatomical / biomechanical abnormalities that arise following comprehensive screening, which if left, may lead to pedalling asymmetry. Different approaches for addressing foot/pedal interface issues will be considered, i.e. the emotional topic of Varus Wedges (shims) versus Musculoskeletal Rehabilitation strategies; and the controversial issue of In-Shoe Wedges versus Cleat Wedges. Where possible, research literature will support the respective claims.

Here, in Part 1 of this article, we explain why competitive cyclists in search of marginal-gains should consider comprehensive anatomical and biomechanical clinical screening, especially prior to Bikefit. While many Bikefit organisations offer some degree of screening prior to Bikefit, unfortunately some fall short of offering a true clinical approach.

Rationale

Efficient, injury free cycling relies on rider symmetry throughout the entire pedal revolution. Strength and balance in the muscles situated in and around the pelvis are prerequisite to symmetry and paramount to efficient cycling, whether road, track or mountain biking. Symmetry represents a stable, level pelvis, with minimal pelvic motion (no rocking) and sound core stability. Similarly, there should be minimal sideways movement of the knee when pedalling (Figure 1a). Excessive aberrant motion of the knee means it must travel further than is necessary through each pedal revolution (Figure 1b). This extra, but unwanted knee motion constitutes wasted energy and is potentially destructive on the structures of the kinetic-chain (foot, ankle, knee, hip, pelvis, lower back and neck).

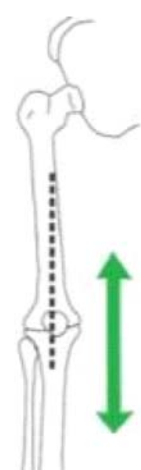
Figure 1a

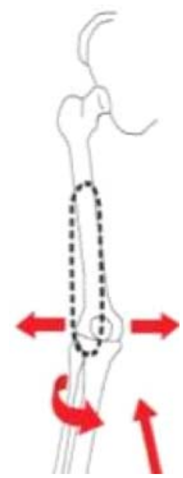
Figure 1b

What is the cause of asymmetry?

The foot/pedal interface is the mechanical link between the leg and the cycle, and consequently, the point at which asymmetry most often arises. Less than (<) 10% of the population have a neutral foot [2-5]. When translated into cycling terms, < 10% of cyclists have a perfect foot position when placed on the pedal [5,6]. Reduced cycling performance and overuse injuries, particularly knee related, are frequently linked to the anatomic structure of the foot (i.e. excessive pronation). This is because the structure and function of the foot dictate how effectively pedal forces are transmitted via the foot/pedal interface down to the cranks, and potentially, how deleterious forces are transmitted up the kinetic-chain – impacting on the knee, hip, pelvis, lower back and neck. 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 anatomic, biomechanical or mechanically related, creates asymmetry – which often leads to overuse injury and impaired performance. In support of these claims, studies demonstrate excessive foot pronation can compromise core and pelvic stability and/or create postural issues [7-14]. Leg-length differences (LLD) which can be either anatomic or functional, restricted hip motion, incorrect cleat position, and some pedal systems are amongst other contributory factors linked to asymmetry. Studies have demonstrated the prevalence of anatomic LLD affect approximately 90% of the population [15,16]. Although prevalent, the mean LLD is small, and considered unlikely to be significant.

The deleterious effects of excessive pronation
What is pronation?

Pronation is when the foot rolls inwards and is considered a normal and necessary motion for efficient gait. Excessive pronation is when the foot rolls in too much, which can result in knee problems [17-22], pelvic and core problems [7-14], and reduced cycling performance [23-26]. Excessive pronation can be unilateral (one foot) or bilateral (both feet). Forefoot varus and tibial varum are considered the most common cause of excessive pronation in cyclists. In gait, forefoot varus, tibial varum and ankle equinus are the main culprits of excessive pronation. Forefoot varus is a forefoot-rearfoot alignment problem (Figure 2); the 1st MTP joint (big toe) is elevated from the pedal with the rearfoot in a neutral position. This means the foot must roll inwards to enable effective contact with the pedal surface.

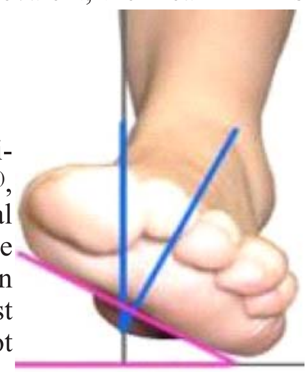

Figure 2

Prevalence of forefoot varus

In a study to examine different foot types, Garbalosa et al [6] found that 87% of the sample population had forefoot varus unilaterally or bilaterally, 9% had forefoot valgus, and 4% had a neutral forefoot-rearfoot relationship. Moreover, conventional or standard pedal systems are designed for the cyclist to be positioned on the pedal flat-footed, and are therefore, only ideally suited to the 4% of the cycling population [5]. The high prevalence of forefoot varus (87%) clearly highlights the need for screening. 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.

The effects of excessive pronation combined with cycling intensity

During the downstroke of pedalling the forces are at their greatest, and in many cases, these forces cause the foot to roll inwards too much, creating excessive pronation, thereby allowing the forefoot to become parallel with the pedal at the foot/pedal interface. As power output increases during high intensity cycling, so does the amount of pronation [26], with corresponding amounts of malalignment at the foot/pedal interface. Furthermore, forefoot varus is known to exaggerate the amount of foot pronation [21]. More interestingly, a recent study found that increasing levels of forefoot varus strongly correlate with increasing power loss [27]. Although no studies provide direct evidence, increasing levels of forefoot varus are likely to correspond with increasing deleterious forces transmitted up the kinetic-chain. Figure 3 shows the effects of excessive foot pronation impacting on the kinetic-chain.

Figure 3

Pelvic issues

While the impact of excessive pronation on cycling performance and knee injuries is well documented, less information exists on how excessive pronation impacts on the pelvic region. Strength and balance in the muscles situated in and around the pelvis and core is prerequisite to symmetry and paramount for efficient cycling, whether this involves road, track or mountain biking [28, 29]. As highlighted above, excessive foot pronation is responsible for transmitting deleterious forces up the kinetic-chain generating excessive pelvic motion primarily in the frontal plane (Figure 4a) and transverse plane (Figure 4b). Excessive pelvic motion can be very disruptive – creating pelvic and core instability, pelvic muscle imbalance,

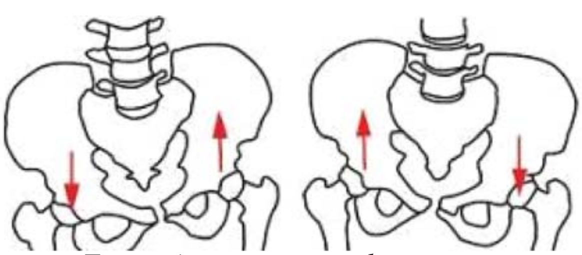

Figure 4a - excessive pelvic motion in the frontal plane

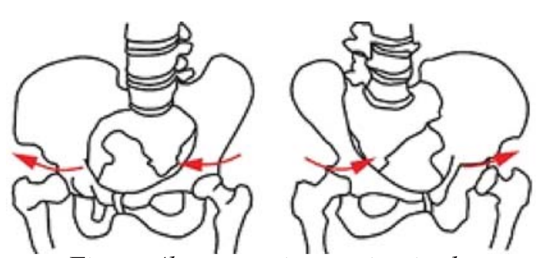

Figure 4b - excessive motion in the transverse plane sacro-iliac joint dysfunction (rotated innominate), and lower back pain. As a result, postural asymmetry can arise and the rider must compensate by sitting to one side of the saddle and pushing more through one leg. Uneven wear patterns on the saddle are indicative of postural asymmetry.

Screening is essential, but should extend beyond cycling activities

Failing to identify important anatomical and biomechanical abnormalities can result in problems being taken onto the bike unknowingly. When excessive pronation exists, the role of the foot should be examined from both a cycling and gait perspective. The reason for this is simple; the role and function of the foot are different with respect to each activity and often necessitate different corrective interventions. Most gait activities revolve around rearfoot control, whereas cycling is reliant on forefoot control. Thus, failure to address excessive foot pronation for both gait and cycling may lead to postural asymmetry being taken onto the bike. The rider then has to adopt an asymmetrical riding position to compensate.

Key areas for screening

In order to treat something, we must first be able to recognize / diagnose it. Like any profession, this requires specialist knowledge and evaluation tools, usually in the form of differential diagnostic tests.

Screening for the main causes of pronation, namely; forefoot varus and tibial varum should be a priority. These two conditions are somewhat different yet for some reason the majority of established Bikefit organisations address them similarly. In Part 2 of this article, the authors will explore this controversial area, by looking at the choice of different wedge options.

Conventional checks for range of motion on ankles, knees, hips and spine should be routine. Particularly emphasis should be placed on the hip and pelvic regions for restrictions commonly associated with pelvic muscle imbalance. Pelvic muscles, typically the quadratus lumborum, piriformis, tensor lata fascia / ilio-tibial band, psoas and adductors are often hypotonic and sensitive. An immediate restoration programme involving manual therapy and musculo-skeletal rehabilitation should be introduced to normalise affected structures. This action will help to eliminate some of the confusion with respect to leg-length issues – discussed below.

Leg-lengths should be checked for differences (Figure 5), however without the use of radiographs (x-rays), leg-length differences (LLD) are difficult to reliably diagnose. LLD can be classified by two main categories, anatomical and functional. Great care is required when attempting to diagnose LLD and differentiate between the two categories i.e. anatomical and functional. For example, anatomic LLD is often mistaken for functional LLD; inadvertently compensatory packing shims are fitted to the cycling shoe unnecessarily, further exacerbating the problem. This issue alone highlights the importance of a comprehensive assessment.

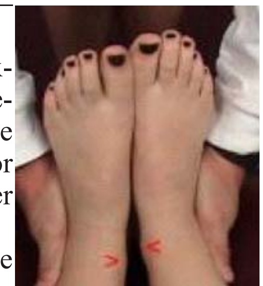

Figure 5

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, it usually occurs as a result of muscular weakness or inflexibility at the pelvis or foot and ankle complex. These include pelvic obliquity, adduction or flexion contractures of the hip, foot disorders including pronation. In the absence of x-rays, and since there is not one reliable test to determine LLD, it is recommended that a battery of tests be used in the clinic to arrive at a reliable hypothesis [15,16,30-34]. The therapist should use a battery of LLD tests taken while the patient is standing, prone and supine – combined with keen palpatory and visual skills.

Conclusion

In order to treat something, we must first be able to recognise and diagnose it. This article clearly highlights the need for appropriate screening prior to Bikefit. As demonstrated, efficient, injury free cycling is highly reliant on pedalling symmetry. Part 2 of this article will look at the different strategies for addressing pedalling asymmetry arising from the foot/pedal interface - thereby provide opportunity for the cyclist to acquire the all too elusive marginal-gains. These strategies will include the emotional topic of Wedges (shims) versus Musculoskeletal Rehabilitation; and the controversial issue of In-Shoe Wedges versus Cleat Wedges. O

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To read the author article: CAN FOREFOOT VARUS WEDGES ENHANCE ANAEROBIC CYCLING PERFORMANCE IN UNTRAINED MALES WITH FOREFOOT VARUS? Clink **HERE**.

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