A CLINICAL PERSPECTIVE OF POSITIONING FOR THE ENDURANCE BICYCLIST

Duane A. Williams, Erik Moen, Thomas F. Wilkinson

East Tennessee State University, Johnson City, TN, USA
Corpore Sano Physical Therapy/Bike PT, Kenmore, WA, USA
Peak Performance Physical Therapy, Redmond, OR USA

Optimal fitting of the endurance bicyclist to the bicycle is vital for improving performance, increasing control, avoiding overuse injuries, and promoting comfort. Neutral position of the bicyclist as well as static and dynamic fitting for the road and off-road bicyclist is important. Musculoskeletal screening procedures of the bicyclist are also important and emphasis will be placed on prevention and intervention of two common overuse injuries: anterior knee pain and lower back pain. Comparisons of bicycle fit and overuse injuries for the off-road bicyclist and racer will also be introduced.

KEY WORDS: bicycle fit, endurance bicyclist, overuse injuries

INTRODUCTION: Knee and low back pain are the two most common non-traumatic overuse injuries/pain syndromes related to endurance bicycling. Pre-screening to prevent these common problems or clinical evaluation of the painful bicyclist should include a biomechanical assessment of the bicyclist and their bicycle. These two injuries have common and simple pathomechanics. Early evaluation and intervention of common pathomechanic issues will often quickly resolve pain syndromes and be a good start for preventing or managing chronic injuries. Strategies for effective evaluation and intervention will be described.

Bicycle Injuries and Pain Syndromes

Endurance bicycling is highly repetitive and has varied torque requirements. An appropriately sized bicycle and well-positioned components are critical for the endurance bicyclist. A properly fit bicycle position will minimize risk of overuse injury, improve mechanical efficiencies, improve aerodynamics, and improve the safe operation of the bicycle.

Injuries and inefficiencies will ultimately limit a bicyclist’s ability to participate in appropriate levels of training. The vast majority of endurance road bicycle related injuries are overuse injuries and pain syndromes involving structures of the back and of the knee (Clarsen, Krosshaug, & Bahr, 2010; Dettori and Norvell, 2006; Holmes, Pruitt, & Whalen, 1994; Thompson & Rivara, 2001).

The causes of bicycle overuse injuries are multifactorial such as musculoskeletal dysfunction, bike equipment problems, poor technique, and training variables. Clinical screening of the injured bicyclist includes a review of medical and training history, musculoskeletal evaluation, evaluation of bicyclist (static and dynamic), retrofit of their equipment as needed, medical care when indicated, and instruction with adaptive exercises when necessary (Dettori et al., 2006; Micheli, 1986; Thompson et al., 2001).

Neutral Endurance Bicycling Position/Posture

All endurance bicyclists have the commonality of prolonged bicycle posturing, varied power generation, safe control of the bike, and avoidance of unnecessary pain and injury.

The term “bike-fit” has classically referred to a how an athlete fits on a bicycle. It is acknowledged that the body is adaptable and the bicycle is adjustable in this process. Attention to appropriate sized equipment and a well-positioned body have been described (Burke, 1994; Silberman, 2005). However, a review of the literature demonstrates there are no absolute best guidelines for fit of the bicycle to the bicyclist. Position or posture on a bicycle is defined by the body's connection to the bicycle through three interfaces; foot to pedal, pelvis to saddle, and hands to handlebars. Most methods of bike-fit focus on saddle position as a function of creating a safe knee angle. Very little is said regarding the trunk and upper extremity positions. There are varied methods to determine the saddle position (Bini, Hume, & Croft, 2011). Although there are suggested safe knee position ranges, there are not consistent or reliable methods of assessing this position.

"Neutral bike fit" is a good place to start when fitting an endurance bicyclist. This position should optimize equipment positions to meet the needs of the musculoskeletal system. Neutral bike fit allows the bicyclist to maintain bicycling postures for prolonged periods of time, optimize aerodynamics, and improve mechanical efficiencies. Neutral fit of the bicycle should allow ease of access to braking/shifting, ability to ride without hands, the ability to corner at speed, descend safely, hop the bike and generally avoid hazards. This process has also been referred to as "bicycle retrofit". Neutral bike fit will be further discussed within the lecture.

Musculoskeletal Screening for Adaptation to Bicycling

Bicycling requires specific flexibility, stability, mobility, and strength. Optimization of these elements will allow a person to maintain bicycling positions for prolonged periods and produce power consistent with their goals. A musculoskeletal evaluation should be performed by a qualified healthcare provider. The musculoskeletal evaluation of a bicyclist should include consideration of the bicyclist's anthropometrics, postural assessment including alignment measures such as bony symmetry/assymetry, soft-tissue flexibility, muscle strength, and joint mobility measures that affect the adaptation to the endurance road bicycling position/posture.

Strategies for Clinical Bike-Fit Evaluation

The bike-fit process should include elements of client history, musculoskeletal evaluation, a brief warm up performed on their leveled bicycle attached to a stationary resistance trainer, static measures of bicyclist on bicycle, dynamic measures of bicyclist on bicycle, and then instruction with exercises or training.

Static assessment of the bicyclist can be made with simple goniometer and gravity dependent tools (e.g. plum bob). Goniometry is an accepted, reliable measuring tool assuming keen attention to bony landmarks. These guideline measures include; ankle angle, knee angle, knee over pedal, trunk angle, and shoulder (Table 1).

Table 1: Goniometric Ranges for Neutral Endurance Bicycle Positioning

Anatomical Reference	Angle in Degrees
Ankle angle at most extended knee position	15-20˚ plantar flexion
Knee angle at most extended position	32-40˚ from full extension
Trunk	35-45˚ from horizontal
Shoulder (glenohumeral)	90˚
Elbow	20-40˚ from full extension

Dynamic assessment of the bicyclist may be performed in many ways. The most popular forms of readily available dynamic systems include Dartfish and Retül. Each system has benefits and limits. Merits of these systems will be discussed as to understand their appropriate applications to a clinical scenario. Generally, bicycling motion analysis shares common marker sets. Many popular dynamic fit strategies strive for absolute symmetrical position and function on a bike. This may be an unrealistic goal. Asymmetrical pedaling in a 40km time trial in a healthy experienced bicyclist has been demonstrated (Carpes, Rossato, Faria, & Mota, 2007). Furthermore, when considering motion analysis as the gold standard of bike fitting, errors in determining the position of the hip joint center have been demonstrated (Hull, Beard, & Varma, 1990). Errors may arise from the measuring device, movement of the markers due to skin slippage overlying bony landmarks, and by anthropometric uncertainties. Errors were found that ranged from 2.5-30mm. So, a reliable hip marker is crucial for the utilization of motion analysis. This study called into question the reliability of the hip marker.

Clinical Profile of Common Cycling Injuries

The two most common oversuse injuries for the endurance bicyclist are anterior knee pain and low back pain (Clarsen et al., 2010) and this is reflected in our own clinical experiences. Anterior knee pain is most frequently a cartilaginous irritation of the patella-femoral joint that is commonly caused by alignment/tracking issues or training faults. Lower back pain is common in the general population and is commonly exacerbated for endurance cyclists. It commonly becomes a chronic strain of the back musculature due to long duration loading and irregular postures such as exaggerated flexion or hyperextension of the lower back. Most injuries are related to some identifiable mechanical reason(s) and/or dose of exercise. Micheli (1986) stated that the treatment of a bicycle related injury should be done in light of the true origins of the injury. Clinical findings from Moen's unpublished data will demonstrate musculoskeletal and bike equipment trends as they correlate to back and knee injuries.

Off-road Cycling Perspective

Much like road and cross country racing, bicycle fit and body position are imperative to performance in gravity racing (Downhill, Enduro, Dual Slalom, and Four Cross). However, correct bike fit and dynamic positioning on the off-road bike allow the rider to adjust to ever changing terrain and trail conditions. Bike set-up focuses largely on the rider's ability to safely manage obstacles at high speeds. Generally speaking, the only time gravity bicyclists get overuse injuries are when they are using road bikes to train for endurance. Overuse injury related to bike fit is mostly related to bicycle sports where positioning on the saddle for prolonged periods of time is the dependency. Gravity sports are short bouts (~2-3min tops), not dependent on saddle position (mild exception to the enduro rider who will use a dropper seatpost). The "bike set up" is probably more important than "bike fit" in gravity mountain biking. Gravity sports are mostly about getting the saddle out of the way, widen the bars, angle the levers for standing and shorten the stem.

Riders need the ability to dynamically alter their center of gravity as they navigate different obstacles on the course. Riders have to be comfortable without being stretched out too far. Enduro riders have a similar set-up to cross country except those bikes will typically have shorter stems, wider handlebars, and ability to raise and lower seatpost on the fly. This allows them to pedal efficiently to the top, but to have maneuverability on the bike for the downhill race portion. Downhill and dual slalom bikes are extremely sport specific and include low saddle heights that are less efficient when in the seated position. Combine that with a short stem and wide handlebars and riders have the ability to greatly alter their center of gravity. Unfortunately there are not specific bike fit guidelines for gravity mountain biking. Cross country mountain biking set-up can generally begin by using road geometry and tweak for optimal position and control.

Unlike road and cross-country mountain biking, gravity racing requires increased stand-over height and a lower saddle position as compared to a typical cross-country bike setup. Gravity racing events require racers to ride at a high intensity with short intense bouts of pedaling followed and preceded by riding over obstacles (Burr, Drury, Ivey, & Warburton, 2012; Hurst, Swarén, Hébert-Losier, Ericsson, & Holmberg, 2012). Although this may not be optimal for endurance and efficiency, it allows the optimal available power output and control to be achieved in a variety of course conditions (Barratt, Korff, Elmer, & Martin, 2011; Hansen &

Waldeland, 2008; McLester, Green, & Chouinard, 2004). Gravity racing events require racers to ride at a high intensity with short intense bouts of pedaling followed and preceded by riding over obstacles (Burr et al., 2012; Hurst et al., 2012). Unlike traumatic injuries that commonly involve falling forward over the handle bars, overuse injuries for off-road bicycling are not well documented.

Conclusion

Positioning of the bicyclist should be individualized and progressively adapted over time as a function of musculoskeletal tolerances. Variables of strength, coordination, mobility, and chosen technical demands are considered in the progression/assumption of body position on a bicycle. Optimization of bicycle fit and musculoskeletal functioning will allow for improved mechanical efficiencies, bicycle handling and an avoidance of injury.

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