Bike Fit Unplugged

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This Bike Fit specialist explains his process for fitting the cyclist, not the bike, to address the individual needs of the rider. He provided commentary to LER Editor Janice T. Radak for the photographs taken at a recent bike fitting clinic and displayed in this story.

By Happy Freedman

Bike Fitter Happy Freedman (in blue and white stripes) is checking for the center of balance for female cyclist Diane Goodwin. “It’s important that she’s stable, not unbalanced or bent in any way, because that bend can affect the airways,” he says.

Bike Fit Unplugged is the technique I developed, based on 40 years of conducting Bike Fits. My priority is to preserve airway diameter and function through the Fit process. The process begins with a phone interview. This is to determine if there are injuries that are not appropriate to be treated with a Bike Fit. This is followed by emailing the client/patient a detailed questionnaire to get a history which includes cycling skills, injuries, and other medical conditions and considerations.

We start the fitting process with a musculoskeletal examination conducted by a physical therapist, or trainer with a masters in exercise physiology or comparable degree. This exam is followed by the actual Bike Fit. I do all the fitting at Hospital for Special Surgery (HSS) in the Leon Root, MD Motion Analysis Laboratory (LRMALab). The lab is equipped with a 14-camera motion capture system, high-speed video, electromyography equipment (EMGs), and force plates. I also have a pulse oximeter, an assortment of lasers, a spirometer, and a metronome in my toolbox. Specific to cycling, we have an Apex sizing bike from the UK, a Rock‘n’Roll trainer, 2 feedback sports trainers for small-wheeled bikes, and a custom Moulton

bicycle from the UK that's equipped to use as a rolling fit bike and for patients with limited mobility in the hips and knees. It has a low stand-over height that is easy to step through for patients with limited mobility and is equipped with short cranks (145 cm length), an adjustable stem, adjustable seat post, and saddle with very long rails. I also have an assortment of handlebars, stems, and saddles in conjunction with a collection of wrenches, Allen keys, and assorted shop tools required to properly fit myriad brands of bikes.

After the musculoskeletal exam, which includes strength, flexibility, and neurological function assessments, we perform the bike measurements required to capture all fit contact points, saddles, pedals, and handlebars, along with all pertinent frame dimensions. The bike is in place on a trainer when the examination is conducted. Cleats are checked for wear and adjustments, while shoes are checked for proper fit. If foot orthoses or insoles are present, they are also inspected.

The on-bike examination is conducted next. Generally, we start with a warm-up. During the warm-up, I use a pair of lasers lined up off the 2nd metatarsal and patella to give me a centerline and the ability to image lateral motion during the pedal stroke. Among the observations I have made over the years, quadriceps make inadequate stabilizers. Poor posture usually affects your ability to breathe well, yet most cyclists are set up in a quad dominant position.

Figure 1. The green laser is tracking how cyclist Diane Goodwin's knee is bending when she pedals. It is aligned with the second metatarsal and the patella when the pedal stroke is between 6 o'clock and 9 o'clock. Bike Fitter Happy Freedman is looking for lateral excursion as she pedals. The greater the travel, the more likely someone will exhibit knee pain over time. If the knee moves medially, toward the bike, it will create medial knee pain, says Freedman; if it moves laterally, there are increased odds of lateral knee pain.

He can't eliminate the pain, he says, but he can reduce it using shims, orthoses, and revamped cleat settings. "I try to retrain the cyclist to use antagonist muscles. I like to focus on the glutes, which are key knee stabilizers." He notes that the laser usually tracks errors that come from above. "If the core is unstable, or the hips are unstable, the knees will follow their lead and be unstable," he says. "If you strengthen the core, the knees will fall into place. If you can figure out which muscle groups to use—which muscles need to be activating when, you can achieve corrections that will avoid subsequent injuries…and that makes everybody happy."

Start With the Breathing

When fitting, I start at the top, looking at airway function and posture, trying to find positions where the core is stabilized but breathing capacity is not impaired. When tracking errors of the knees are observed, I look at upper extremity mechanics as well as the hips (see Figure 1). I have often found the cyclist to be quad dominant with their gluteus minimus and medius on vacation. I also work on opening up the chest to improve tidal flow and volume. And I look for temporal mandibular joint syndrome (TMJ), which can affect your airway function and therefore can affect your performance. Rhomboids usually need to be strengthened in the cyclist to help open up the torso and intercostals.

At this point in the fit I look at use of the diaphragm, breathing, and intercostal expansion. I also look at the elasticity of the intercostals when the cyclist is breathing on both the hoods and the drops using different handlebars. I'm looking for the loss of elasticity within the intercostals—which can occur if the bars are too wide or too narrow—so I'm searching for the sweet spot in the middle (see Figure 2).

Next, I start to move the cyclist forward and back. The cyclist is assessed both on and off the saddle, looking at which muscle groups are activated as well as the position of the center of mass. In particular, I'm looking for how far back the cyclist needs to go to get the gluteus maximus and medius to fire.

The goal is to teach mobility—when you are riding a bike on the road, you need to be able to transfer weight back and forth between the wheels. If the bike setup locks you into one position, it affects the handling. You need to be able to move forward and back as a rider for climbing and descending, sprinting, and to improve cornering, by maintaining traction when exiting a corner.

The cyclist must be nimble on the saddle to maximize the handling characteristics of a bicycle. Being seated in one position eliminates stability. Observation has taught me that your gluteals are stronger than the quadriceps, and, over time, will produce a more efficient pedal stroke.

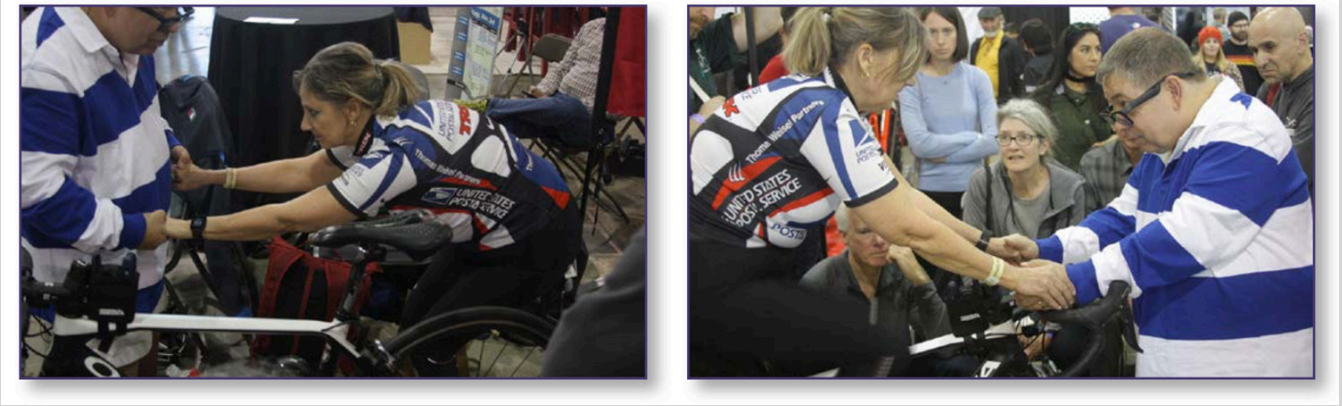

Figure 2. Bike Fitter Happy Freedman is checking cyclist Diane Goodwin's center of mass, first with the rider in a squat with her arms extended, then on the saddle. He's trying to determine if her core is active or if she is collapsing on the handlebars. While you can measure with a strain gauge on the handlebars, he says, it takes more time; this hands-on method allows for real-time correction and the ability to work with the cyclists and teach them to distinguish the correct posture from one that might feel comfortable, but not be helpful.

He's also looking at the elasticity of her intercostals to determine appropriate width for the handlebars. Handlebars that are too narrow can restrict breathing as can those that are too wide. "Because the vertebrae compress and we're not as tall later in the day, that can affect the measures on the bike, so you have to make assumptions about how much more or less stable the cyclist will be…and then make adjustments accordingly." This, as he sees it, is the problem with computerized bike fitting —such measurements don't take into account the physiological changes that occur over the course of the day. "This drives some competitive cyclists to think the numbers are chiseled in stone and they panic when things are off a millimeter, yet the variability of the human body is in centimeters," Freedman says. "Look at a pro-bike race when team racers give the leader their bike after a crash with no adjustment… the leader is able to keep going because the ankle, knee, shoulder, and wrist are all mobile-adapters. Any joint that travels through multiple planes can work as a mobile adapter, so if you know where you need your torso to be, you can compensate…most people don't realize that. So, it's training the body as much as fitting the bike."

The cyclist needs to be comfortable on the bike. "If you're not comfortable, you won't be efficient for long." He notes that posture can also affect cardiovascular efficiency, so by manipulating the cyclist's position on the bike, you can improve endurance and recovery. "If your posture is poor, you have dysdiaphragmatic breathing…with proper diaphragmatic breathing, you can draw more air into the lungs. The diaphragm needs to be free to expand to draw larger volumes of air; bad posture can cause obstruction. The more bends you have in the line, the greater amount of friction you have when breathing. Everybody talks about aerodynamics as outside the body, but you can also look at it inside the body, from the lungs all the way down. If you round off 30% of the throat by pushing the chin forward, you get much greater throughput. It's all about how riders position themselves on their bikes."

Size Changes

One of the pearls of a dynamic bike fit is that all cyclists will change their height over the course of the day—we're tallest in the morning and shortest in the evening. One may change between 1.5 and 4.5 cm during the course of a day. Therefore, a precise measurement in the morning is less likely to be correct in the evening. This biological drift due to the viscoelastic nature of spinal soft tissue is better served with a 'target range' when bike fitting that accounts for these inherent variabilities.

This fluidity in size calls into question how accurate our measuring systems need to be for determining frame size and component positions/alignments. A millimeter of error may not be relevant in the context of the biological variability throughout a bike ride. When fitting, I look at the body as a series of interconnected mobile adapters. These articulations are the ankles, knees, hips, shoulders, elbows, and wrists. The spine may function as one large mobile adapter. No joints are looked at in isolation. As professional bike fitters, we take this larger, biomechanical view of joint function when evaluating the cyclist on a bike.

Cyclists need to be mobile when on their bike, to improve ride quality as well as to optimize their own body mechanics through the ability to self-adjust. This is part of the process that I try to teach the cyclist. Furthermore, in my fittings, I encourage gastrocnemius and soleus complex activation. This is done to help improve venous return to the heart. As described by Starling's law, stroke volume of the heart increases in response to an increase in the volume of blood in the ventricles, before contraction (the end diastolic volume), when all other factors remain constant. A mobile position can potentially lower the cyclist's heart rate. Cycling is an endurance activity, so my goal is to make the rider as comfortable as possible while improving efficiency.

A good rock guitar solo is a wonderful treat to the ears, but the true master musician will exceed that experience when unplugged. Given that the big picture—breathing, comfort, agility, and efficiency are what's really important in the bike fit—unplugged may be the way to achieve that goal, especially in the hands of a true master bike fitter.

Happy Freedman serves as a Master Bike Fitting Specialist in the Leon Root, MD, Motion Analysis Lab at the New York Hospital for Special Surgery (HSS). A cycling coach, innovator, and internationally recognized expert in the field of bike fit, Freedman helped develop the first multi-disciplinary hospital-based state-of-the-art Bike Fit Lab, to be used for performance, clinical bike fit evaluations, and research at HSS in New York City. His professional experience covers a range of related areas and his current position in Prosthetics and Orthotics in the HSS Rehabilitation Department allows him to work in close cooperation with physical therapists and investigators in the motion lab.

FINAL THOUGHTS

If you use foot orthoses for correction, you can manipulate the tracking of the knee, Freedman explains. But, he notes, this doesn't necessarily correct issues further up the line, such as the hip or weak glutes, and may mask them. "Some people may need only the orthoses," he says, "but you need to look at the whole line." He notes that classic bike fitting starts at the foot and makes corrections with shims and wedges. "You can change the cleat angle with a wedge or a stack of wedges which will change the angle of the foot to the pedal, but," he asks, "what if in reality the problem is an instability in the pelvis?" If you start wedging before you examine the whole body on the bike, you're not necessarily fixing problems, but could be masking problems. Each tool serves a different purpose, he says; the secret is to know which one to use.

"The body is not parts all stacked up, it's a complex organism. Bicycles are complex too," he says. "The goal is to make them–body and bike–work together efficiently as a unit."