Journal of Pelvic, Obstetric and Gynaecological Physiotherapy, Autumn 2020, **127,** 5–11

OPINION

Is the saddle always to blame? A discussion of potential causative factors of saddle discomfort

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Abstract

Cycling is a unique sport that requires fixed points of contact. Because riders need to distribute the load involved through their anatomical structures, they are vulnerable to the pressures and shear forces that occur as a consequence. Although it has been reported that the vast majority of cyclists experience genital numbness and other forms of discomfort when riding, the actual incidence rate is unknown. This is because there is a tendency for individuals to under-report their symptoms, which many regard as normal side effects of using a bicycle. The aim of this paper is to explain which parts of the bicycle may be involved in the discomfort experienced by riders, and how these can be adjusted to improve the experience of cycling.

Keywords: bike fitting, causative factors, cycling, pelvic pain, saddle.

Introduction

Although it has been reported that up to 91% of cyclists experience genital numbness and other forms of discomfort when riding (Leibovitch & Mor 2005), the actual incidence rate is unknown. This is because there is a tendency for individuals to under-report their symptoms, which many regard as normal side effects of using a bicycle.

Cycling is a unique sport that requires fixed points of contact. Because riders need to distribute the load involved through their anatomical structures, they are vulnerable to the pressures and shear forces that occur as a consequence. Bike fitting is a method of ensuring that individuals are correctly positioned on their bicycles. It is intended to enhance not only performance, but also comfort, since the latter is crucial to engagement in the sport.

The saddle receives a disproportionate amount of blame for cycling-related discomfort. Although saddle-related symptoms have been well documented (Mellion 1991; Leibovitch & Mor 2005; Trofaier *et al.* 2016; Balasubramanian *et al.* 2020), a rider's contact with a bicycle at the pelvis may be dictated by many factors. Numerous articles about saddle choice have been published, and the white paper by Russ *et al.* (2013) is an excellent introduction.

The aim of the present paper is to explain which parts of the bicycle may be involved in the discomfort experienced by riders, and how these can be adjusted to improve the experience of cycling.

Bicycle anatomy

In order to understand the aspects of the riding position that can be manipulated, it is helpful to have a basic understanding of bicycle anatomy (Fig. 1).

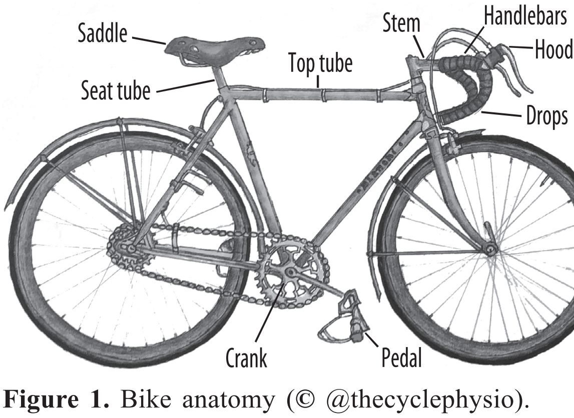

Figure 1. Bike anatomy (© @thecyclephysio).

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Saddle angle

Until relatively recently, the Union Cycliste Internationale (UCI), the international governing body for the sport of cycling, did not permit the angle of a saddle to exceed ±2.5° of tilt above or below the horizontal (Sani 2015; Caddy *et al.* 2016). This limited the ability of professional cyclists to adjust the position of the saddle for comfort. However, it is important to note that recreational athletes were not subject to the same regulations.

The restriction enforced by the UCI caused great discomfort among riders, particularly female athletes, who were required to spend many hours training in a given position. Therefore, British Cycling (www.britishcycling.org.uk) worked in conjunction with various professionals in order to produce evidence to support a change in the rules. Thankfully, this initiative was successful, and the UCI regulations now allow up to 9° of deviation from the horizontal (UCI 2020). However, this much saddle tilt is excessive in many cases, and will result in an unstable saddle position, i.e. the rider will slide forwards or increase the distribution of weight through his or her upper body (Box 1).

Rider weight and power output

Cyclists will often advise new riders that they need to allow time for their “break-in”. While this guidance is partially based on old conventions (e.g. old leather saddles taking over 100 h to mould to the shape of the rider), it still holds some truth. Some of the simple mechanisms that can be involved are described in this section.

Box 1. Saddle angle

> A saddle angle between 0° and 3° is a good starting point. However, it is important to take the manufacturer’s recommendations into account when installing a saddle. Ensure that an excessive saddle angle is not required because of suboptimal saddle height or crank length. A greater saddle angle may be required when riding in an aerodynamic position (e.g. during triathlons, track cycling and time trialling) (Fig. 2). If you are not sure why this is, sit on a chair, place your hands under your ischial tuberosities and lean forwards. Note how the weight on your hands reduces and translates forwards towards the pubic rami. You will now understand why a saddle tilted upwards at the nose might not be so comfortable!

Figure 2. An example of a cyclist riding in an aerodynamic position. Note the use of handlebars that facilitate a lower torso position. This will usually change the loading pattern through the pelvis, and require a different saddle choice or more negatively tilted saddle.

First, pressure is force divided by area. It is possible that new riders may lose weight when they start cycling, thereby decreasing the force applied to the saddle.

Secondly, cycling increases the strength of the leg muscles. As riders push down harder on the pedal, more pedal reaction force pushes back up, reducing the load on the saddle. If you take your feet off the pedals and put all your weight through the saddle, it is much less comfortable than if you share some of the load through your feet.

Thirdly, in instances where riders sit with a slight anterior pelvic tilt, the pressure that they experience may be on the pubic rami, which generally do not bear load in daily life. After a few shorter rides, the body quickly adapts, and that feeling of excessive pressure goes away (Box 2).

Pelvic tilt

There does not appear to be an optimal pelvic position when riding; this will very much be down to the individual in question. However, identification of a cyclists’ preferred loading posture can assist with saddle selection.

Box 2. Rider weight and power output

> Be patient: in some cases, the discomfort takes care of itself. If the discomfort is leading to regular shuffling in the saddle or additional pelvic symptoms, then a review is required. If a cyclist has recently lost a significant amount of weight, then he or she may now be loading alternative areas on the saddle, which may necessitate a positional or saddle review.

(a) (b) (c & d)

Figure 3. Saddle pressure mapping: (a) anterior tilt, i.e. loading through the pubic rami; (b) posterior tilt, i.e. loading through the ischial tuberosities; and (c) before and (d) after adding orthotic support, a reduction in peak pressure of >700 mbar. (To view these full-colour images, scan the Quick Response codes.)

Some practitioners will use a simple forward bend to identify where the bowing occurs: is it a hinge through the hips with a neutral spine, or does the pelvis remain more upright while the lower back takes on a significant curve? The general rule of thumb is: if it is the former, the rider is likely to sit with an anterior tilt (and may well load the pubic rami) (Fig. 3a), while the latter may result in a posterior tilt (and therefore, load through the ischial tuberosities) (Fig. 3b). However, there is no substitute for viewing how cyclists interact with their own bikes, or for example, changes of saddle. Accordingly, different saddles will accommodate different loading patterns (Russ *et al.* 2013).

Manufacturers have recently adopted tests like the one described above as a simple method of identifying the correct saddle for a rider. Unfortunately, this is an oversimplification of the variables that is intended to allow shop-floor sales staff to sell a product with some degree of personalization. Physiotherapists may be able to further explore these movement patterns, and assess whether they are intrinsic or related to range-of-movement restrictions (e.g. posterior tilt caused by "shortening" of the posterior sling).

Unfortunately, several other variables may result in riders tilting their pelvis in a different way to how this test would suggest. For example, individuals who have their bars too far forward with respect to the saddle, or too low, may have no choice but to anteriorly tilt the pelvis. If they are riding on a saddle designed for a posteriorly tilted pelvis, this can result in central pressure on soft tissue. In such instances, riders may want to sit with a more neutral or even posteriorly tilted pelvis, but their bicycle set-up will compromise their interaction with the saddle.

Equally, you may see the opposite. Cyclists who are very sensitive to soft-tissue pressure may posteriorly tilt their pelvis to avoid contact with the saddle. This does not mean that they need a saddle that has been designed to load the ischial tuberosities, but rather, that it is necessary to observe how they react to a saddle that is designed to remove that pressure. A different saddle may allow them to adopt a more anterior pelvic tilt (Box 3).

Box 3. Pelvic tilt

Assess the degree of pelvic tilt when the individual is mounted on the bicycle, but beware of red herrings. Encourage riders who posteriorly tilt on a saddle to try one with a large relief channel in order to see if the angle of pelvic tilt alters. If it does not change, then this might not be a saddle pressure issue. Try raising the handlebars or shortening the stems of riders who anteriorly tilt. If you only see small changes in the tilt, then the handlebar position was either not the issue or these were not adjusted enough (Fig. 4).

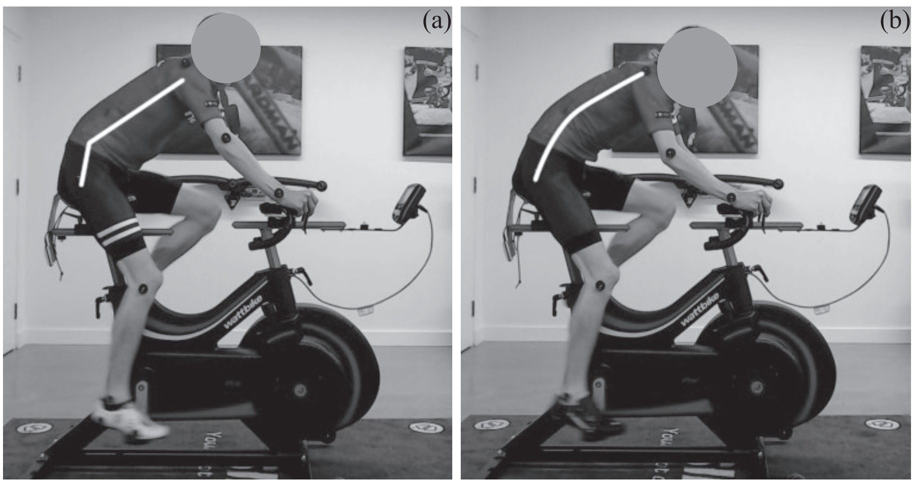

Figure 4. Pelvic tilt: (a) note the hinge at the thoracolumbar junction; and (b) note the improvement in the spinal position, the shape is much more uniform.

Pelvic stability

When a muscle contracts, it pulls the two segments that it is connected to closer together. This is not quite the same as saying that a muscle acts as a flexor or extensor, but it is an important distinction to make when discussing closed-chain activities such as cycling.

The gluteal muscles act to extend the hip, but it is the stabilizer muscles working in conjunction with the former that move the femur while the pelvis remains stable. If a rider is applying large amounts of force to the pedals, then there is greater resistance to the femur moving. If the pelvis is less stable than the femur, this means that it will move posteriorly. Likewise, the hip flexors may cause an anterior pelvic tilt if the force that these apply to the pelvis is not resisted or balanced by other muscles.

The main take-home point is that you should trust your experience. Some symptoms cannot be resolved by adjusting a bicycle, and these will require commitment to a period of rehabilitation. As a physiotherapist, it is well worth exploring control issues, and encouraging cyclists to improve these, even if they may ultimately require some assistance with bicycle position.

Around 80% of total force applied to the pedal will be from quadriceps and gluteal work (Mornieux *et al.* 2007; Aasvold *et al.* 2019). The ratio of which muscle is more dominant varies between individuals. Research has suggested that it may be as much as a 2:1 ratio, i.e. 66% from the gluteal muscles and 33% from the quadriceps, or *vice versa* (Jorge *et al.* 1986; Mornieux *et al.* 2007; Aasvold *et al.* 2019). Therefore, athletes who use their gluteal muscles more heavily than their quadriceps are more likely to have a posteriorly tilted pelvis.

Since cycling is a phased and asymmetrical exercise (i.e. one leg is active while the other is passive), the tilting force will only be applied to one side of the pelvis at a time. If riders pull up on the pedals during the recovery phase (which is no longer advised), the hip flexors may apply an anterior tilting force to one side of the pelvis while the gluteal muscles apply a posterior tilting force to the other.

The various combinations and levels of force that can be applied to the pelvis may result in poor control in the lumbopelvic area. If the pelvis is moving around a lot on the saddle, friction can result in discomfort, as can soft-tissue pressure spikes if the pelvis is being forced into an anterior tilt. It is important to be aware of the forces at play, and the muscles that stabilize the pelvis should be worked on to reduce unwanted movement in the saddle, which can help to relieve discomfort (Boxes 4 & 5).

Box 4. Pedalling technique

> Train your riders to avoid pulling up on the pedals and squashing soft tissue. This has been shown to be an inefficient pedalling technique by Korff *et al.* (2007). However, it can also often occur in conjunction with excessive saddle height or crank length.

Box 5. Pedalling power

> Encourage riders to shift towards a higher cadence (i.e. the number of revolutions per minute that they can pedal in any given gear). This will decrease the required muscle power, and therefore, reduce the forces acting on the pelvis, making it easier to counter these with stabilizing muscles.

Proprioceptive feedback from the feet

Many people are taught to squat by loading through their heels, while others naturally stand with most of their weight on the hind foot. This can quickly develop into a feedback loop that results in individuals feeling for stability through the heel. On a bike, they will lose this proprioceptive control because the pedal is under the forefoot alone.

The answer is not to advise people to put their heels on the pedal! It is important to remember that the ankle modulates the direction of the force and improves pedalling fluidity, and therefore, it is undesirable to reduce its role.

Common visual cues that imply that this might be an issue include riders dropping their heel a lot at the bottom of the pedal stroke, or their pelvis shifting laterally and dropping to one side. This can be an indicator that cyclists are moving over to that side of the bike, and dropping down as they continue to search for something solid to push their heel against.

This is more commonly seen as a single-sided issue, where riders only drop their pelvis on either their left or their right. In addition, a leg-length discrepancy may also need to be accommodated (Box 6).

Range-of-motion restrictions

When cycling, particularly when riding in "closed hip" positions, hip flexion restrictions

Box 6. Proprioceptive feedback

Start by proposing some appropriate arch support to provide more contact between the foot and the surface below it. Pressure on the plantar fascia plays a key role in proprioception, but the tension applied through the windlass mechanism is not achieved when cycling in a stiff-soled cycling shoe. An unsupported foot may collapse under load-bearing, and while the pressure spikes during cycling are not as high or as rapid as those seen during gait, the loading can still be enough to cause "instability" in the foot (Fig. 5). In extreme cases, this can even affect saddle height. If the foot collapses a long way, this could alter the effective functional length of the leg, causing a deviation in knee tracking in the frontal plane or a host of other issues. Installing insoles is a relatively safe remedy that can rule out a few common complaints (Fig. 3c & d). However, the choice of the insole should always be determined by arch length and not shoe size: it is very important that the full length of the arch is supported. Unlike running, where heel striking commonly seen, cycling is a forefoot activity that requires support right up to the back of the first metatarsal head.

Figure 5. "Toe scrub" can occur when a foot is poorly optimized; gripping with the long flexors ensues.

can contribute to many pelvic issues. Obviously, the saddle remains in the same place, but the distance to the pedal changes constantly. This change must be absorbed at the ankle, knee, hip and pelvis/spine to allow the pedal to return up and over the top of each stroke. If hip flexion is restricted, then it becomes difficult for the pedal to smoothly flow over the top of the stroke, where peak hip flexion occurs.

Riders often accommodate this in one of two ways: either the knee moves out laterally, or the pelvis may hitch up on the saddle on that side to temporarily increase the distance to the pedal.

Although low saddles increase hip flexion, it is important to note that excessive height also promotes rocking, and an increase in shearing at the saddle–pelvis interface. Ensuring that saddle height is set correctly is an important first step in reducing lateral pelvic rocking and discomfort.

Another important variable is handlebar position and pelvic tilt, or trunk orientation. Poor hip flexion affects femur position and alters pelvic tilt. Therefore, another way of decreasing hip flexion is to encourage riders to adopt a more upright position by either decreasing stem length or raising the handlebars. This is not always a popular suggestion if a client has racing goals, and wants to adopt a lower position in order to be more aerodynamic.

It is also possible to reduce hip flexion by bringing the saddle forwards, but this may have a negative impact on riders' weight distribution on their bicycle. For example, it can decrease how easily individuals can sustain their upper body position without fatigue as a result of a forward shift in their centre of gravity. If the saddle remains further back, then the direction of force application to the pedal is slightly forwards. This means that the reaction force from the pedal is to the rear, which helps to keep riders back in the saddle, and stops their upper body from toppling forwards.

In many cases, cyclists may not even present with a hip flexion restriction, but the anatomy of the bicycle is such that it places riders outside of their normally permitted range of motion (e.g. in the case of smaller individuals). In these circumstances, it is usually essential that riders shorten their crank length in order to reduce the angle of peak hip flexion. This may also be a beneficial change for those who present with arthrogenic restrictions within the hip, knees or even ankles. It is feasible that, if one hip is restricted, then cyclists may adopt a twisted position because of accommodation, and this can result in single-sided saddle sores or chafing on one thigh (Box 7).

Box 7. Range-of-motion restriction

An off-the-bike assessment is key to determining whether there are any morphological restrictions. If this is the case, then it is necessary to identify whether these are transient or fixed. This will dictate how a rider's overall position on a bicycle is managed. If you are analysing an individual's interaction with a bicycle, please ensure that this is done in both the sagittal and frontal planes.

Cockpit too long and low

As alluded to above, bicycle positioning needs to be treated in a holistic manner. Regardless of whether there is any restriction of range of motion or not, a cockpit (i.e. the handlebars and shifters) that is too long and/or low will also place undue pressure on the soft tissues of the pelvis, and increase friction (Fig. 6).

Raising the cockpit and shortening the stem are two of the available options. However, in some cases, the limitation may be a result of the geometry of the bicycle. For example, it may have a more aggressive configuration that does not permit the adjustments required for the individual. On the other hand, the bicycle could simply be the wrong size. In most cases, it is prudent to assess cyclists on a jig that has relatively infinite adjustment. This can facilitate the ideal position for riders, and it also allows quick adjustments to be made.

Is it that simple?

No! There are other variables and potential factors that have not been discussed in the present paper, and some complicated cases can involve a combination of the variables discussed above. Resolving saddle discomfort can be far more complicated than simply changing the saddle itself. Nevertheless, the process can be simplified by ensuring that any simple modifications are implemented first.

Not all professionals are confident enough to troubleshoot all of these potential issues with a client, particularly if they have had no prior experience with bicycles. In this instance, or indeed, if a plateau has been reached, it is worth making a referral to a certified bike fitter. While bike fitters are not as well-regulated as medical professionals, organizations such as the International Bike Fitting Institute (IBFI) are working hard to raise standards and identify the best-trained professionals. Suitable individuals can be identified via the IBFI website (www.ibfi-certification.com).

If you are in doubt, then you should refer clients to a qualified professional. Competent bike fitters also find themselves in situations in which they refer individuals to specialist physiotherapists (e.g. cases involving tissue trauma and sexual dysfunction). It is likely that your patients will appreciate that you have done what you can for them: they will always remember you as the professional who helped to solve their problem, even if all you did was refer them to someone else who ultimately resolved the issue.

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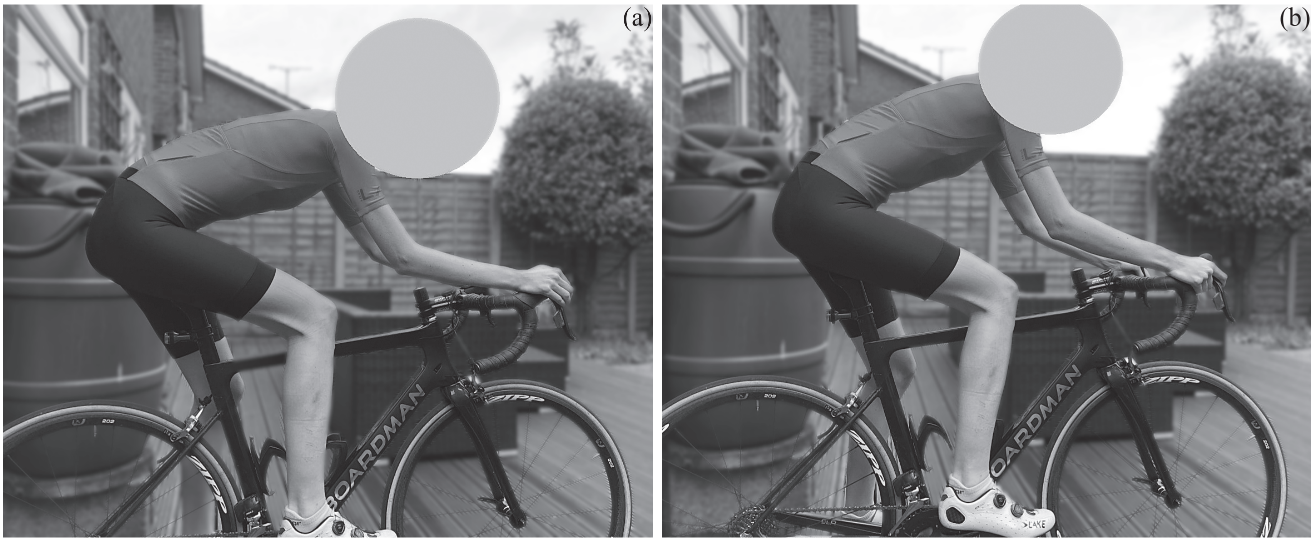

Figure 6. Examples of a cyclist in: (a) a long and low position; and (b) one that is still relatively aggressive, but not as extreme.

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