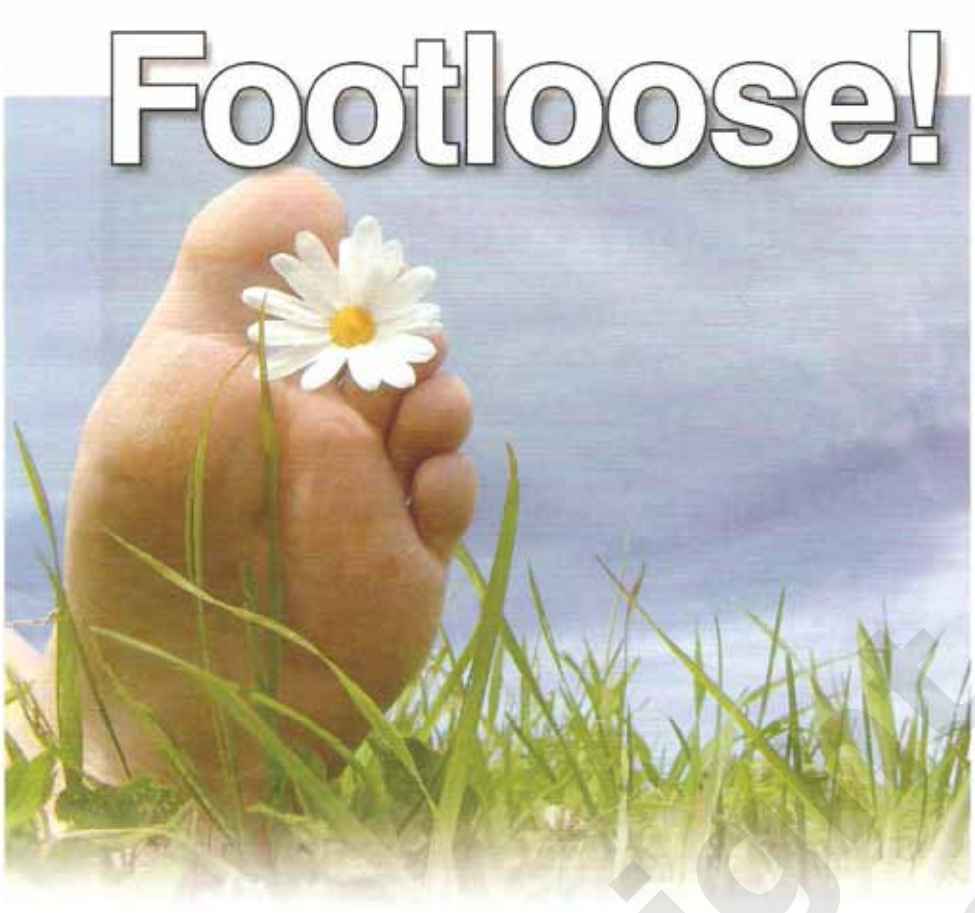
Footloose!



Steve Hogg drives a wedge into cleat positioning and reveals how a simple adjustment can dramatically improve your pedalling efficiency.

It often surprises me that riders who are otherwise serious about their sport don't know what their cleat position is. They may train to a periodised program and use training aids like heart rate monitors and power measuring devices but not fully appreciate the implications of their cleat position. In answer to my query I often hear "I just put them on without thinking", or "My shop / friend / coach put them on for me. I'm not sure what position they are in".

Every watt a rider produces is transferred to bike via feet on pedals and cleat position has an affect on the pattern of muscular enlistment of the legs and the quality of proprioceptive feedback to the cerebellum from all the links in the kinetic chain involved in applying force to the pedals. In turn this can affect performance, propensity to injury and recovery time. This article will attempt to explain the in and outs of cleat position. There are five basic variables to consider:

1. Position fore and aft.
2. Cant
3. Rotational angle
4. Lateral placement
5. Whether to shim or not.

Position Fore & Aft

A foot in a rigid soled cycling shoe functions as a lever. The efficiency of that lever depends on its length and the placement of the fulcrum. The fulcrum of the foot is at the ankle, near the rear of the foot. This is not the ideal fulcrum placement for maximising lever efficiency by maximising lever length. So where to place the cleat?

The time honoured advice is to place the cleat so that the centre of the ball of the foot is over the centre of the pedal axle as measured with the shoe level and the crank arm at the 3 o'clock position. Is this valid advice?

Maybe, maybe not; there are other factors to consider. The muscles of the lower limb stabilise the foot on pedal. The further forward the cleat is relative to foot in shoe, the harder the calves have to work to control that lever length. The further back the cleat is relative to foot in shoe, the less hard the calves have to work to control the foot. Bear in mind that the work the calves are doing with regard to control of foot and ankle doesn't, in most cases, directly contribute to propulsion of the bike, just to controlling the foot and ankle. Lower leg amputees demonstrate clearly that moving the cleat back directly under what would be the ankle of an able bodied cyclist is valid in the sense that it can be made to work effectively. Conversely many track sprinters also demonstrate readily that a far forward cleat position can be made to work just as effectively for them. Published studies of cleat position generally conclude that cleat position doesn't have a lot to do with the ability to generate power. However cleat position has a profound effect on the relative pattern of muscle enlistment.

Most road riders need a cleat placement far enough back to relieve the calves, Achilles tendon and plantar fascia of unnecessary load and one that gives them a solid feel under foot, while not being so far back that it limits their ability to sprint or to climb while off the seat. My experience is this – generally speaking (and I include that caveat because there will always be exceptions), the shorter and more extreme the effort, the further forward the ideal cleat placement. The longer the effort required, whether of high or low intensity, the further back the cleats should be. The gluteals, hamstrings, quadriceps and calves are all heavily involved in pedaling. Of these muscle groups, the calves are the smallest and often the first to fatigue.

Here are some general recommendations for cleat positioning. Properly applied, they are unlikely to cause harm and will make a positive difference for the great majority of riders –

Shoe size 36 - 38: centre of ball of foot 7 – 9 mm in front of the centre of the pedal axle
Shoe sizes 39 - 41: 8 – 10 mm in front
Shoe sizes 42 - 43: 9 – 11 mm in front
Shoe sizes 44 - 45: 10 – 12 mm in front
Shoe sizes 46 - 47: 11 – 14 mm front
Shoe sizes 48 - 50: 12 – 16 mm in front

There are a number of qualifiers that I will attach to those recommendations. This info is for road, triathlon & mtb riders.

- For general track riding, I would reduce the amount of foot over the pedal by a mm or 2 depending on shoe size and event.
- For sprinters and kilo riders, I would at least halve the recommended amount of foot over the pedal
- For riders with an exceptional heel dropping pedalling style, I would increase the amount of foot over the pedal slightly; i.e move the cleat further rearward. The converse is true for the exceptional toe down style pedalers. For both groups I'm talking about technique under moderately severe load, not cruising in a small gear pedalling fast.
- For riders with a lot of heel lift in their shoe last, I would increase the amount of foot over the pedal slightly.
- For riders with flexible soled shoes; sneaker or sandal type mtb shoes for instance, I would increase the recommendation slightly

as with this type of more flexible soled shoe, the heel deflects downwards more under load.

There is also another approach worthy of mention. A small minority of riders including some Euro pros and elite triathletes are using a midfoot cleat position popularised by Germany's Gotz Heine. This involves placing the cleat so that the pedal axle is under the highest point of the arch of the foot. There are both advantages and disadvantages to this. Many riders perform better and recover more quickly with cleats positioned like this, some astonishingly so, particularly ultra endurance and TT riders.

Space doesn't allow me to go into the detail that cleat fore and aft position deserves, but ultimately the message I am trying to get across is this – Don't be afraid to experiment with cleat position. Individuals vary in both the type of riding they do and what works best for them. Have a play & make a personal decision.

Cant

The knee is a more or less single plane joint positioned between two multi plane joints, the hip and the ankle. Very few people have a perfect foot plant angle on a pedal. My research suggests less than 1% only. The great majority of cyclists have common malformations of the foot and other misalignments within the kinetic chain involved in cycling. In theory, most should experience knee pain as the price they pay for exerting force with less than wonderful feet and / or other elements within the kinetic chain. Most don't experience pain unless riding with unaccustomed intensity or for uncommon (for them) duration. They don't experience pain because they compensate and there are 3 main ways to do this on a bike. Everyone uses at least two of these methods of compensation to individually varying degrees.

The first is to load up the outside edge of the foot (or far less commonly, the inside edge of the foot) in an autonomic effort to keep the knee tracking straight. The tell tale is a callous under one or both 5th MTP joints; the base knuckles of the small toes.

The second is to internally rotate one or both hips (point the knees inwards) or to externally rotate one or both hips (point the knees outwards), both of which will cause issues with the hips, lower back and general posture over time.

The last is that neurologically speaking, we all favour one side. My experience is that on a bike, 90 - 95% of riders, whether right or left handed, favour and protect their right leg on a bike at some level great or small and sacrifice their left leg at some level great or small. This 'favouritism' takes the form of a perceptible hip drop or pelvic twist. If the rider is functionally superior, then this may be almost imperceptible. If they are functionally poor, then it is very obvious.

There are other potential causes for

Installation of wedges takes a lot of time. Both the inside and outside foot have to be measured and the correct angle decided upon.

these issues but many, many times they can be positively influenced by altering the cant of the foot on the pedal. Something over 98% of riders will perform better and / or lessen their chance of incurring overuse injuries with some degree of cant under one or both feet. The majority of those need the foot to be inverted, i.e. the inner edge of the foot lifted. The rest will need the outer edge of the foot raised. There are currently 2 ways to do this.

The first is to use BFS Cleat wedges which are shaped plastic wedges that fit under the cleat. There are versions that will work with all major pedal systems. There is also a type that will fit inside a shoe underneath the insole. Specialized also make in shoe wedges. Of the two the BFS wedges are superior for the following reasons.

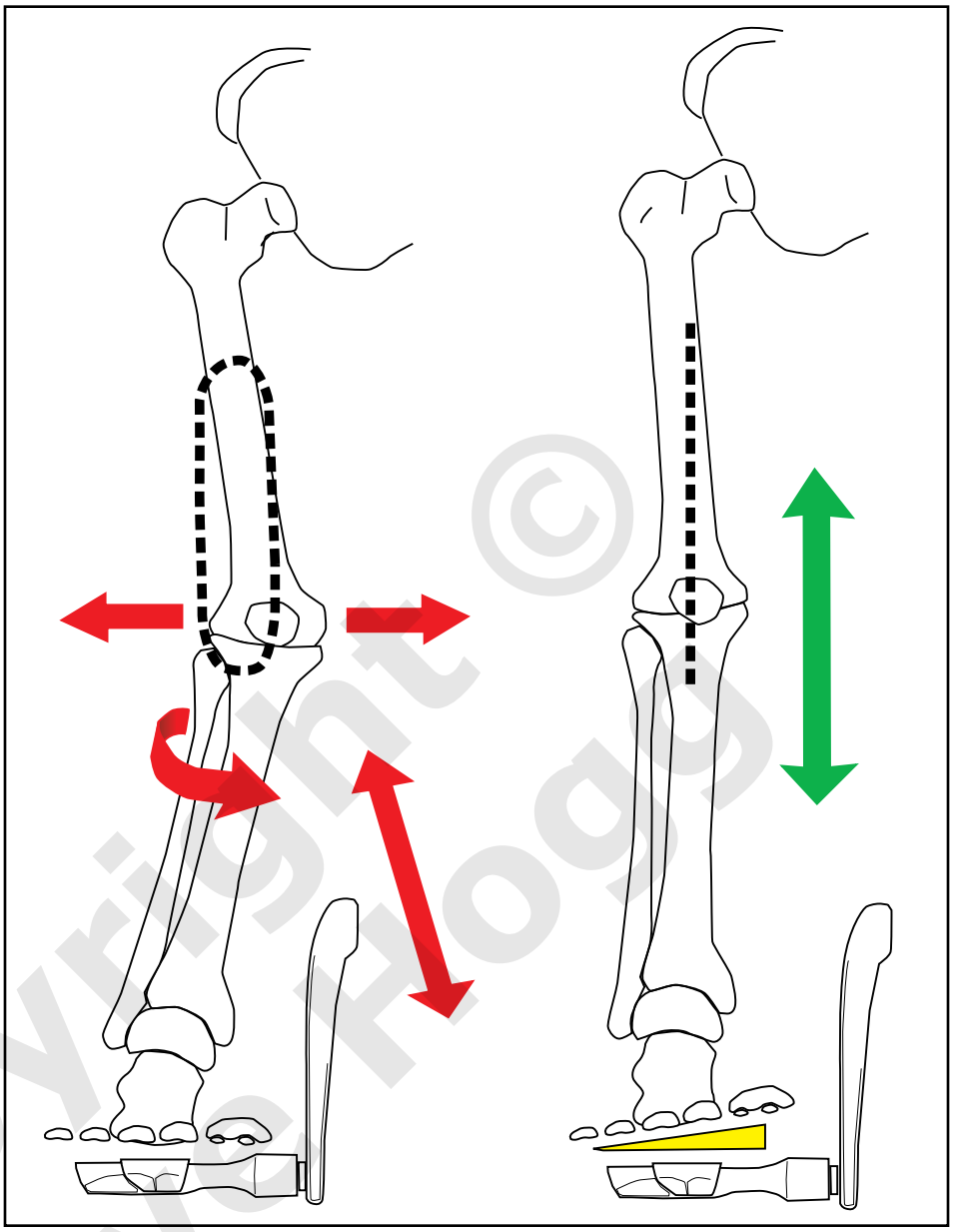
In my view, the only way to definitively determine the ideal amount of foot cant is by measuring the quality of the proprioceptive feedback from the kinetic chain involved in pedaling to the central nervous system. I am in the process of patenting a method of determining this. What the research involved in the patent has shown me is the BFS wedges do effect a change in the quality of proprioceptive feedback when the correct quantity is used. This same research also indicates that the Specialized in shoe wedges have zero effect on proprioceptive feedback no matter how many or how few are used. (There are reasons for this but I don't want to divulge them at this time.)

This is extremely important in my view, as the greater the brains' awareness of what is going on in the kinetic chain, the greater the ability to coordinate the action and the lower the chance of overuse injuries.

Rotational Angle

Most current pedal and cleat systems have an amount of 'freeplay' built into the cleat or, as in the case of Keywin, the pedal body. The purpose of this freeplay is to allow the foot to move to some degree while remaining securely locked into the pedal. Some pedal and cleat systems have a fixed amount of freeplay, some have adjustable freeplay and others offer a variety of cleats with differing amounts of freeplay. For instance, Look offer a black cleat with zero freeplay, a grey cleat with 4.5 degrees of play and a red cleat with 9 degrees of play. The ideal rotational angle of the cleat on the sole of the shoe is the one where while pedaling under load; the rider has a more or less even degree of free movement either side of where their foot naturally sits on the pedal. If the foot is locked in place at a less than ideal rotational angle, stresses on the knee result; or, autonomic self protection of the knee from stress shifts the load to other elements in the kinetic chain involved in pedaling or structures involved in stabilising those elements.

The simplest method to gain the correct



The knee without and with canting of the foot

rotational angle is as follows. While riding at a solid pace, stop pedaling and coast with the right foot forward. Attempt to move your heel inwards. Is there available movement?

If the answer is no, stop and adjust the cleat to allow the front of the cleat to face further towards the inner edge of the shoe, and then retest until there is available movement. Once you have available heel in movement from your natural placement under load, repeat the pedal and coast test but this time attempt to move the heel outward. Is there available movement?

If the answer is no, stop and adjust the angle of the cleat so that the nose of the cleat faces further to the outside of the shoe. Retest until the amount of heel movement in and out of your natural rotational angle is fairly even.

Then repeat on the other foot.

For the great majority of riders, freeplay in pedal / cleat systems is desirable. If you are not using the available free movement, then it isn't there. If you are using it, you need it.

There are many factors that will influence what the ideal cleat rotational angle is for you. Hip width, Q factor of cleat and crank combination, flexibility in hips and lower back etc. It is an individual thing and the ideal rotational angle may vary between left and right sides because of functional asymmetries.

Lateral Placement

Ideally our knee joint should track straight up and down during pedaling. Generally speaking, the centre of the knee should descend over the second toe. Wider hipped riders should have their feet further apart than narrow hipped riders but hip and lower back function plays at least as great apart in what the ideal lateral cleat placement should be. We all have seen riders whose knees stick out while pedaling because they are tight in their hips and lower backs. They will need their cleats further in on the shoe (that's right, moving the cleats further inboard, moves the feet further apart) than similarly built riders who are more functional. In extreme cases fittings called Knee Savers need to be fitted to space the pedals 20, 25 or 30 mm further out than can be achieved by altering cleat lateral placement alone. For less extreme cases, both Keywin and Speedplay make a variety of axle lengths for their pedals.

One of the problems with achieving ideal lateral placement for cleats is that most pedal manufacturers combine the rotational angle adjustment and lateral placement adjustment functions. Usually this is effected by having a washer for each cleat mounting screw sitting in a slot that is wider than the washer. The problem being that the more the cleat rotational angle varies from straight ahead, the less lateral adjustment this combined adjustment approach allows.

Speedplay deserve special mention for being the only pedal system that separates rotational angle adjustment and lateral adjustment functions

Whether to Shim or Not

The last factor to consider with regard to cleat position is cleat shimming. A shim is a build up placed under one cleat to compensate for a measurable or functional leg length difference.

A measurable leg length difference is one where there is a known bone length difference between sides. The only definitive way to determine this is with an X ray, MRI or similar. Competently taken measurements of leg length using external bony landmarks have a typical plus / minus error factor of 5 mm which means that they are not accurate. A functional leg length discrepancy is one where for instance, one hip, or the hamstrings on one leg are noticeably tighter than on the other side which may limit the ability of that leg to extend even though there is no measurable difference in length.

One of the aims that we are all trying to achieve on a bike is to sit as squarely as possible on the seat and have both legs reaching the bottom of the pedal stroke with similar power and control. Any measure that moves the rider closer to that goal is a positive, at least in the short term. Adding a shim under one cleat can make a positive difference for something over 70% of riders.

There are various 'rules of thumb' for what height of shim stack to use to compensate for a measurable leg length difference depending on whether the difference is in the upper leg, lower leg or a combination of both. Like all 'rules of thumb', they are as likely to be wrong as right so I don't place any weight on them. The correct height of shim stack is the one that allows the measurably or functionally shorter leg to reach the bottom of the pedal stroke with the same or as similar as possible degree of fluency and control as on the other side, while concurrently, not causing the rider problems at the top of the pedal stroke.

As a guide, if the majority of measurable difference is in the femur, then that discrepancy doesn't need to be fully compensated for because the femur doesn't point vertically during seated pedaling. In contrast, the lower limb stays closer to vertical for most of the pedal stroke and so any discrepancy needs to be more fully compensated for.

Conclusion

Twenty eight hundred words aren't enough to get into the really fine detail of cleat position but I hope there is enough here to make people who are fitting new cleats stop and think a bit about the implications of what they are doing.

- Steve Hogg

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