Anterior Anguish

So many people with knee problems are told to ride a bike as both a rehabilitation tool and a form of exercise, yet we see professionals such as Jan Ullrich crippled by knee pain. How can cycling be so good and yet so bad? **Emma Colson** explains.

The problems that cyclists encounter from riding are usually very different to the problems suffered by people who take up cycling to 'help' their knees. You hear many old runners/footballers starting cycling because they can no longer run—"The knees gave up," they say. Most of these knee injuries are tibiofemoral and intra-articular—in layman's terms, problems within the actual knee joint proper (as opposed to the patellofemoral joint, tibial tendon, iliotibial band insertion).

Most knee pain in cycling is broadly called 'anterior knee pain' and may be caused either from the patello-femoral joint (PFJ), the patella tendon, or the insertion of the patella tendon. This term is occasionally incorrectly interchanged with the term Chondromalacia patella. Chondromalacia patella specifically refers to actual changes on the chondral cartilage of the joint surface. In reality most people with pain do not have the changes and so just fall into a less specific all encompassing diagnosis of 'anterior knee pain'.

Anterior Knee Anatomy

The patella sits within a groove in the lower part of the thigh bone (femur) (figure 1). It is a small disc like structure; the design is to provide a fulcrum mechanism for the quadriceps muscle to increase its leverage and hence power/efficiency. The joint is synovial, and so has a shiny smooth cartilage on each joint surface and is enclosed in a capsule containing lubricating fluid. This fluid is continuous with the fluid in the knee joint, hence swelling in this compartment may be visible at the back of the knee. The patella tendon runs from the lower end of the quadriceps muscle; it contains the patella within it and inserts into the tibial tuberosity (the bump below the patella).

Causes of Strain/Pain

Alignment issues and tracking

In some people this joint is aligned at a mechanical disadvantage. Rotory malalignment can be due to femoral internal rotation and relative tibial external rotation (figure 2). The addition of repetitious load of the pedalling motion may then cause the patella to track out of the groove and irritate it. Pronated feet (flat feet) can have a similar effect. A patella that is very small in relation to the bulk of the quadriceps may also struggle to sit in the groove—this is especially so if the groove is shallow and the patella is flat on the undersurface. Some small female elite cyclists who develop enormous quadriceps bulk have this problem.

Margins of the patella sitting in the groove of the femur.

Internally rotated femur, externally rotated tibia and pronated foot on the right side put the patella at a mechanical disadvantage during pedalling motion.

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Dynamic Alignment Issues

Even in cyclists who have 'good' biomechanics, once they start pedalling the motion of the leg might create lateral forces on the patella that cause it to mal-track. For example, if the hip joint is stiff or the gluteals particularly tight, the rider might find that as the leg goes near topstroke, the knee drifts to the side pulled by a tight hip, and once out of the top-stroke position the leg will re-align (figure 3). This motion looks like elliptical tracking of the knee with pedal stroke and creates a lateral force on the patella. If the cyclist is not still in their core while riding, the knees may sway to the side to pull them back to the centre with every pedal stroke.

The Iliotibial band at the side of the thigh inserts partly into the lateral part of the patella. Tightness in this will also create a pull to the side with pedal strokes. This situation is made worse if the cyclist is relatively underdeveloped in the V.M.O (Vastus Medialis Oblique Muscle) which counterbalances the pull of the larger V.L (vastus lateralis) muscle. Often as cyclists develop bulk they do so more in their VL at the expense of the smaller V.M.O. (figure 4)

The knee drifts off to the side at top-stroke.

The V.M.O is the smallest quadriceps muscle.

Bike Issues—Q-Factor

The Q factor is the distance between the midline of each foot as the foot sits on the pedal. It is surprisingly variable depending on the choice of the following equipment:

- Shoes (some are wide, some narrow),
- Pedals (some high end pedals have a Q-factor adjustment)
- Cleats, most of which have the option of running them towards the inside of the shoe hence increasing Q factor or the outside – reducing Q factor. Some cleats are sloppy (not to be confused with float). This slop creates extraneous motion whilst pedalling, allowing the leg to track all over the place. Float should allow motion when required, but hold still when not required. A high stack height (distance of the foot to the pedal) will also allow for the introduction of unwanted motion.
- Bottom bracket. Be aware here that mountain bikes are around 20mm wider than a road bike. A mountain biker with narrow hips may get knee problems if they attempt to do their base kilometres on the MTB.

Excessive Loading and Compressive Forces

This can be caused by particular training or technique methods—Jan Ullrich used to climb using a very big gear, resulting in excessive loading. It's good to see the revolution in pedal revolutions! The days of Pantani and others saying things like 'if you are riding a 25 (tooth sprocket) you are not a hill climber' have changed with the success of Lance 'cadence' Armstrong. We even have grown men looking at things like triples and compact crank sets now. The more rate the less the load. The lower the load the less the compressive force on the PFJ.

Excessive load can also happen to a spinner; it may be that the spinner is just doing too much strength work in the hills or loading the knees in the gym. A well thought out program can sort a lot of overuse issues.

Pedal Technique

A cyclist who is excessively 'toey' – effectively places the knee into more flexion throughout the pedal cycle with each stroke resulting in increased load (Figure 5)

Toey pedal action places the knee in more relative flexion throughout pedal stroke.

Underutilisation of the Gluteal Muscles

The power phase of the pedal stroke consists of the quadriceps working on the knee and also the gluteals working on the hip joint. Up to 30% of power of the pedal stroke can be derived from the gluteal muscles. Hence a cyclist who has poor gluteal use will overcompensate with their quadriceps muscle hence increasing load on the patello-femoral complex.

Other Joints

The ankle and the hip motion will both affect the knee. If the ankle is stiff into dorsiflexion (backward motion) which may be the case following an old ligament sprain, the knee will be relatively more flexed throughout the pedal cycle and hence increase compressive forces.

Bike Set-Up

The patello-femoral joint will suffer from increased compressive forces in two situations:

If the seat is too low or, if the seat is too far forward (Figure 6)

Both situations will result in increase of relative flexion of the knee throughout the pedal cycle

The saddle here is either too low or too far forward, placing the knee in front of the pedal spindle, hence increasing flexion and loading the PFJ.

What to Do

- Treat any active inflammation—ice for 20 minutes following each ride and relative rest (this may mean less hills, less time in the gym or more recovery rides etc).
- Address any bike issues discussed above such as equipment choice and set-up.
- Devise training modifications to accommodate the injury. If possible, it is best to keep the legs ticking over. The cyclist and coach must carefully address training aims and objectives and alter load/intensity depending on the condition. Jan Ulrich had to learn to pedal again and change his technique from grinding to spinning.
- Rehabilitate the body where deficiencies exist. Some cyclists with anterior knee pain have nothing wrong with their body and then I see them doing all these non-specific exercises to get better. The key here is diagnosis. Once made, then rehabilitation can be best directed towards the most likely causative factor.

→ page 68

← page 66

Recommended Exercises

The following photos demonstrate effective exercises for anterior knee pain.

V.M.O in sitting. The cyclist is instructed to stick the foot on the ground and imagine there is chewing gum holding it there. They must then try to slide the foot forward, using the V.M.O muscle to do so and using very little of any other muscle.

The iliotibial band is a band—hence it doesn't stretch like a muscle but is best made supple by the use of a foam roller to self massage.