**Bike Setup: optimise performance and minimise injury.**

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**Cycling Biomechanics**

- The interaction between body and machine is a complex one and influenced by many variables.
- Riding position directly influences the power that can be produced by the athlete, physiological efficiency and resistance caused by wind drag.

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**Pedaling technique**

- Also an important contributing factor to cycling performance.
- Power is produced by applying force to the pedals and in many cases the pedaling technique by which this force is applied can be improved.
- Choice of equipment will also affect overall performance.

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**Choosing the right bike size.**

- Seat tube length is the most important measurement.
- Top tube length is usually within 2cm of the scat tube length. Adjusted via handlebar stem length and height.
- Balance between optimal aerodynamics and biomechanically possible.

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**Optimal Riding Position**

- Determined from anthropometric measurements.
- Lower limb = height of the greater trochanter from the floor. Measure with feet slightly apart.
- Many road cyclists choose a bike slightly smaller (seat) tube approx. 1cm) as lighter and stiffer.

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**Optimal Seat Height**

- Minimises oxygen cost and maximises short term power output.
- Shoe cleat thickness effectively lengthens the lower limb between 13mm to 40 mm.
- Orthotic devices must also be incorporated if they extend to under the forefoot.
- Saddle height = 0.98 (LL. length +sole/cleat height)
- Look cleats much thicker than Time cleats.
Trochanteric Height
(McLean 1990)

<table>
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<th>Trochanteric Height (CM)</th>
<th>Trochanteric Height (inch)</th>
<th>Seat Tube Length (CM)</th>
<th>Seat Tube Length (inch)</th>
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Bicycle seat tube height vs. lower limb length

Dimensions describing the geometry of a bicycle

Setting Handlebar Time Trial Position.
- Aim- reduce aerodynamic drag and promote comfort and stability while riding.
- The trunk, should be low with upper lumbar/thoracic spine flat. Optimal angle of the upper body to the horizontal is 20 degrees.
- Upper arms slightly forward (9-18 degrees).
- Forearms slightly tilted up (8-17 degrees).

The Role of Pelvic Position.
- The greater the degree of anterior rotation of the pelvis the less spinal flexion required.
- As the pelvis anteriorly rotates, hamstring and gluteal muscles are lengthened.
- Lower limb muscles in cycling operate optimally over small range of their total available length, which is close to their maximal length.

Minimising injury by optimising bike position.
- Excessive anterior pelvic rotation (over lengthening of the LL. Muscles) can strain muscles and structures of the lumbar spine.
- The seat can be moved forward, placing the hip in greater extension.
- Moving the seat forward (hips forward over the crank axle) will decrease limiting factors of hip flexion range.
Cycling - What Effects the Hip Effects the Knee.

- Forward seat position will shorten gluteals and increase quads contribution in the earlier part of the downstroke to produce the same power (affects particularly climbing).
- Gastrocs length also decreases thus decreased ability to produce knee flexor torque.

Optimising Quads Extensor torque's.

- Significantly influenced by seat height.
- Axis of knee rotation (AOKR) for flex/ext lies in the lateral femoral condyle.
- Femoral condyles are not spherical, thus centre of rotation changes as knee extends.
- Perpendicular distance from AOKR to the line of the patellar tendon force is known as the patellar tendon moment arm (PTMA).

Knee joint load during extension

(McLean and Blanche, 1994).

\[ F_1 = \text{Quadriceps Tendon Force} \]
\[ F_2 = \text{Patellar Tendon Force} \]
\[ F_3 = \text{Patellofemoral Compression Force} \]
\[ + = \text{Rotation Axis} \]
\[ r = \text{Patella Tendon Moment Arm} \]
\[ M_k = \text{Knee Extensor Moment} \]
\[ M_k = r \times F_2 \]

Knee joint forces with changes in knee flexion during cycling

(McLean 1990)

- Moving the seat from 95-100% Trochanteric height (approx. 4.5cm with LL. = 93cm) produced a 3% decrease in knee flexion and a 5% increase in PTMA at 70 degrees past TDC (Smidt 1973).
- This resulted in a decrease in knee joint force if torque remains constant.
- Such changes decreases patellar ligament force by 5%, decreases quads tendon and patellofemoral forces by 10% (Nisell & Ekholm 1985).

Seat too high

- If seat height is too high the ankle is forced into plantar flexion at BDC, compromising hamstring effectiveness and increasing lateral pelvic tilt.
- Many different factors are involved in optimising the biomechanics of cycling.
- Physiological, and individual structural/strength attributes must also be considered.

Cycling Style - Things to look for!

- Thoracic and lumbar spine flexion/scoliosis - one shoulder sitting higher than the other.
- Excessive trunk & pelvis side to side movement or rotation.
- Excessive use of the upper body to stabilise.
- Excessive abduction or adduction of the knee at TDC or adduction at BDC.
- Toeing on pedal or pigeon toe position. Sitting twisted on the seat.
**Relevant History**

- Pilates exercises aggravated pain.
- Now mild awareness of right leg and feels low back pain when cycling. However feels tenderness/stiffness in upper lumbar spine.
- Swimming regularly and has recently gradually improved.
- Most gym exercises do not help.

Core stability and bike fit work together to optimise cycling performance.

A Practical Core Stability Grading System. (Wisbey-Roth, 1996)

**Grade 0**

*Unable* to maintain a isometric contraction without compensatory movement of the core, in a position aimed to facilitate the stabilising role of key muscles.

**Grade 1**

*Able* to maintain an isometric contraction (min 10 sec) without compensatory movement of the core, in a position aimed to facilitate the stabilising role of key muscles.

**Grade 2**

Able to maintain an isometric contraction (for min 10-20 seconds) without compensatory movement of the core, with superimposed slow movement of the limbs.
Grade 3

Able to maintain control of the core without compensatory or inappropriate movement, while performing slow movements of the trunk itself.

Grade 4

Able to maintain control of the core, while performing joint angle and contraction specific movements of the limbs.
Grade 5

Able to maintain contraction of core stabilisers while performing sport specific:-
  a) fast movements of the trunk.
  b) fast movements of the limbs.
  c) against increased resistance reproducing concentric/eccentric roles of key muscles.

Aim: Optimal dynamic function