<u>Bike set up</u>: optimise performance and minimise injury.

Trish Wisbey-Roth

B.Sc.,Physio, MAPA
Masters of Sports Physio (AIS/UC)
Team Physiotherapist
Aust Cycling 1993-99,
Olympic Physiotherapist.

1

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.

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.

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.

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 appox. 1cm) as lighter and stiffer.

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)

TROCHANTERIC HEIGHT (CM)	(inch)	SEAT TUBE LENGTH (CM)	(inch)
84.0	33	51.0	20.08
86.0	33.85	52.0	20.47
87.0	34.25	52.5	20.67
88.0	34.64	53.0	20.87
89.0	35	53.5 / 54.0	21.06 / 21.26
90.0	35.43	54.0 / 54.5	21.26 / 21.45
91.0	35.83	55.0	21.65
92.0	36.22	55.5	21.85
93.0	36.61	56.0	22.0
94.0	37	56.5	22.25
95.0	37.4	57.0	22.44

TROCHANTERIC HEIGHT (CM)	(inch)	SEAT TUBE LENGTH (CM)	(inch)
96.0	37.8	57.5 / 58.0	22.64 / 22.83
97.0	38.20	58.0 / 58.5	22.83 / 23.0
98.0	38.6	59.0	23.22
99.0	38.98	59.5	23.43
100.0	39.37	60.0	23.62
101.0	39.76	60.5	23.81
102.0	40.15	61.0	24.0
103.0	40.55	61.5 / 62.0	24.21 / 24.4
104.0	40.94	62.0 / 62.5	24.4 / 24.6
105.0	41.34	63.0	24.8

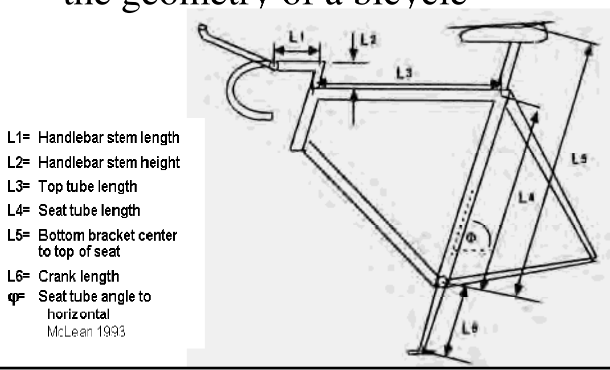
Bicycle seat tube height vs. lower limb length

(McLean 1990)

TROCHANTERIC HEIGHT (CM)	(inch)	CRANK LENGTH USED (MM)
Less than 87.7	33	170
87.7 – 90.7	34.5 – 34.75	170 or 172.5
90.7 – 95.5	35.5 – 37.5	170 or 172.5 or 175
95.0 – 99.7	37.5 – 39.25	172.5 or 175
Longer than 99.7	35	175

Crank length 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.

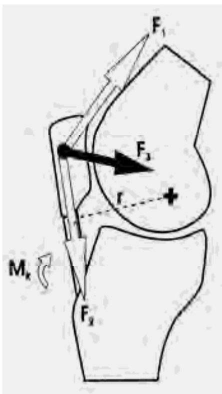
- Forward seat position will shorten gluteals and increase quads contribution in the earlier part of the downstroke to produce the same power (affects particularly climbing).
- Gastrocs length also decreases thus decreased ability to produce knee flexor torque.

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).
F1 = Quadriceps Tendon Force
F2 = Patellar Tendon Force
F3 = Patellofemoral Compression Force
+ = Rotation Axis
r = Patella Tendon Moment Arm
Mk = Knee Extensor Moment
Mk = r x F2



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.

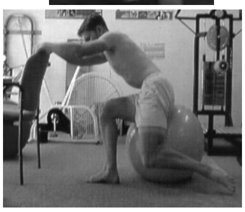
Relevant History

- 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)

Case Study – Cyclist with left lumbo pelvic pain & left knee pain.

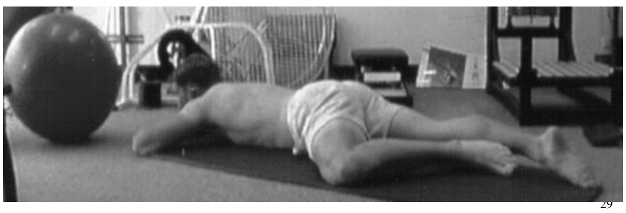


Grade 0

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

28

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.

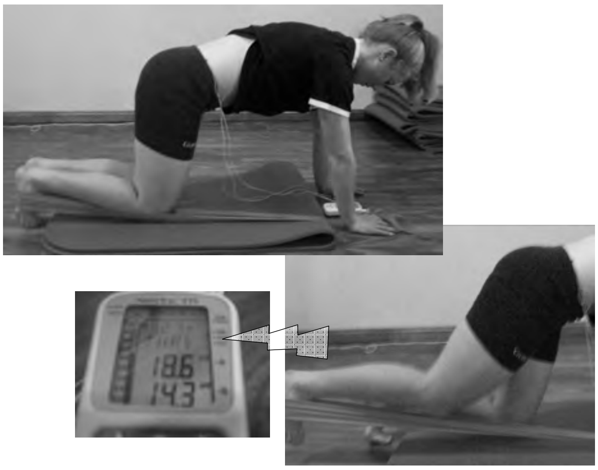


29

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.

30

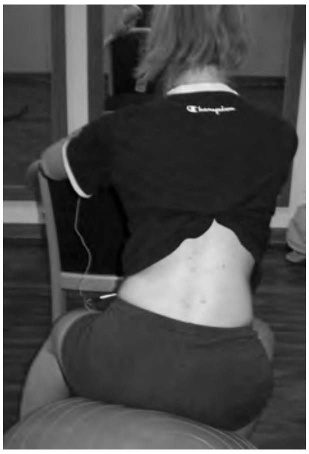


31

Grade 3

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

32



Grade 4

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

35

36

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.

37

38

Aim: Optimal dynamic function