Resistance Training for elite level Track Cyclists

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The sprint in Track Cycling is a very explosive event in a strength/power dominant sport. It is one of the few sports that elite practitioners and coaches regard the gym based training as important, if not more important as specific track based training. The sprint demands (like many professionals in athletic preparation would agree) the obvious physical factors of strength, speed, speed strength and explosive power.

These requirements make up Track Cycling’s core of exercises in the resistance based conditioning program. Track Cycling’s energy system demands and the body generated forces require the above qualities to be well trained for an athlete to be world class and in this paper we will discuss these requirements.

Firstly let’s understand the sport of sprint track cycling. For this paper we are looking at the events of the flying 200m Sprint, the Keiren and the Olympic sprint or teams sprint. All three are Olympic events and are characterised by their high intensity maximal strength/power efforts. The flying 200m sprint is a 1000m event whereby the first two laps are warm up for the flying 200m sprint. The athlete aims to be travelling at maximal velocity at the 200m start mark and tries to hold this pace til the finish line. The time is recorded for the flying 200m and is used to rank competitors. This “qualification round” which is done individually is repeated so the athlete is seeded for the races from two trials. The all out maximal effort usually last between 12 secs and low 10 second mark for female cyclists and between high ten second through the high nine second mark for elite male athletes (very simular energy systems to 100m track and field sprint). Once the athlete is seeded he/she races over the same distance against an inversely seeded racer over 3 races (if needed). Depending on the field and
classification, the athlete may have to repeat the racing numerous times during the day or over a few days, thus high intensity repeatability is essential to the track cyclist, especially one with a full program.

The Keiren is a little different, riders (approx 6-8) are paced behind a motorcycle for a few laps until the speed has risen from 20km-50km, this usually occurs around 600-700m from the finish. As soon as the motorcycle leaves the track it is a sprint until the finish. This popular Japanese form of track cycling is characterised by daring racing and numerous crashes. The sprint last a little longer than the flying 200m and dictated a little more by tactics rather than an all out sprint, however sprints can last up to around 40 seconds.

The Olympic sprint or teams sprint is a three lap all out sprint raced between two teams of three riders. After each lap the leading rider from each team leaves the race by going up the embankment til the last remaining rider is left to cross the finish line.

The physical requirements for the race differ between the three individual athletes and this can affect the type of track and resistance training undertaken. The starter needs to have good raw explosive strength and speed strength to push a large gear from a stationary start, the second and third riders need more speed strength and to a lesser extent speed endurance to main the high output over and extended period of time around the 30 second mark.

**Physiological Requirements of Track Cycling**
The Physiological demands of track cycling are important considerations when planning resistance training programs. The Strength and Conditioning coach needs to understand the specific physiological requirements of all track events even at the developmental stage of programming. Without this understanding the athlete may miss out on some important sequential adaptations necessary for high intensity Rate
of force development (RFD) and enhancement of the Stretch Shortening Cycle (SSC). As track cycling is a sprint based sport and most high intensity efforts last between 10 and 40 seconds the two major energy systems used are PCr (Phosphocreatine) and the Glycolytic lactic. The PCr system is characterised by high output lasting from 0 – around 10 seconds and can be resynthesised in around 2 minutes, with full resynthesis in approximately 7 minutes. The Glycolytic lactic energy system on the other hand kicks in where the PCr system leaves off. It lasts from approximately 10 seconds through to 40/45 seconds depending on athlete trainability and variation (6). The energy provided is no where near as high as the PCr system, but is significantly higher than the aerobic system. The aerobic system needs to be trained to allow for good recovery from single bouts/efforts, numerous training bouts and competition, but is generally left to the coach to develop (8). All three systems will be trained on the track, but Strength and Conditioning coach needs to understand these specific requirements and train these parameters in an organised order in the gym. (11)

The musculo-skeletal requirements centre on the powerhouse of the human body - the Glutes. Without strong and well developed gluteus muscles the athlete cannot generate the forces necessary for world class performance. A strong back kinetic chain (Calves, hamstrings, glutes) is paramount to transfer the cumulative forces from this “chain” of muscles through the pedals down the cranks to power the bike. A strong front chain (Hip flexors, Quadriceps and Tibialis anterior) is also import to assist and balance the forces generated from the hips to make sure the force is transferred with correct technique. The mid-section or “core” of the body needs to remain rigid during the race as excessive movement through hips, mid-section or upper body results in form loss, power loss, lack of aero dynamic qualities and in turn loss in time. The upper body needs to be strong also to deal with the forces generated
from the hips and the rotational forces generated from the upper body in starting. Without a strong and compliant upper body (and lower body) the cyclist may need to reduce his chain ring to a lower size to allow the forces necessary to propel him/her from the starting position and into race speed (Starter in Olympic Sprint) with minimum stress. (5, 9)

Track cycling athletes need a full range of resistance training protocols to achieve their training goals. The program at times concentrates on basic muscle, tendon, ligament, skeletal and joint adaptations such as Hypertrophy. This increases the muscle cross sectional area and can also increase the fibre density, which is of importance to generating strength. Strength or the total amount of force lifted is also an essential part of Track Cycling resistance training. This training develops not only the musculo-tendinous structures but develops the nervous system which is a driver of high intensity performance. As strength has been closely correlated to improve power, this component of the resistance training program is well utilised (12). Power training is the third major training component and is defined as the force being exerted divided by the time taken to generate the force. Therefore it would make sense that as power is a significant component of Track cycling, the development of power would be the driving force behind the resistance based training... Some of the techniques used to develop power are as follows (2, 10).

- Maximal strength
- High load power
- Low Load Power
- Complex Training
- CCS (plyometrics) and Jumps
- Weightlifting/Olympics Lifts
- Combinations of Weightlifting/Olympics lifts

Core stability, as listed earlier is a notion that pops up regularly in Strength and Conditioning circles and journals. Although limited data exists on its efficacy (13), It
is widely acknowledged amongst professionals that a strong and functional mid-section will provide a compliant link between upper and lower extremities and vice-versa. The VIS cycling working definition of Core Stability is a reflection of the mid-section and pelvis and the working relationship of these areas with the muscular and neural systems that support it. Thus Inner Core (deep abdominal musculature), Outer Core (more superficial, gross movement musculature) and pelvic lateral stability work together as a mid-sectional troika. Thus exercises other than prescriptive one to alleviate issues are not the focus of the program, but exercises to assist the overall function of being an elite track cyclist. The most important musculature of the core group is the glutes. These factors contribute to the overall efficient and strong functioning of the centre of the body (3).

Balance and spatial awareness are important trainable qualities of the track cycling conditioning process. Although limited research data exists on specific benefits of non specific gym based balance and body awareness training, we have and more specifically the athletes have noticed benefits from these forms of training. Kahle et al found that balance and core stability exercises do have a function in dynamic postural movement and thus could be extrapolated out to sport performance. Further research is needed to quantify the perceived benefits of this component of track cycling resistance training (3).

Flexibility and range of motion through joints, be it dynamic in the physical preparation warm-up or static and yoga based make up a significant element of the development of elite level track athletes. It is through a process of musculo-skeletal screen which determines certain muscle and ligamentous limitations or over usage. A close coordination between Physical Preparation and medical professionals ensures
verification and quantification of screen values. The screening and re-screening of athletes can serve as a valuable quantification tool to measure the effectiveness of the physical preparation program (7, 9).

**Explosive starts**

Explosive starts demand maximal strength contractions to reduce the time to top speed. Athletes at the elite level gain an advantage by being able to ride a bigger gear and not lose out on acceleration and time to top speed. This allows the team as a whole to gain an advantage over a less physically gifted rider/team. Overall body strength, speed strength and rate of force development are essential here and generally the strongest team member will lead out the team sprint event. Resistance training exercises used to gain general lower body strength in this area are Squats, Deadlifts, Single Legged Squats, Single Legged 45° Leg Press amongst numerous other exercises. These exercises are primarily used to build mass and strength to the glutes and front and back kinetic chains. The power component with explosive starts needs to have a greater emphasis on speed strength of SSC, so a greater weight is used to the detriment of speed, however this is necessary for the starting. Commonly used exercises to develop the power of this component is Single Leg 45° Leg Press Throws, Clean Pulls, High Pulls and Power Cleans to name but a few. These exercises would commonly be done at 60-70% of 1 RM to develop the strength qualities of the power movement (4). These exercises have been shown over many years to increase power in strength/power athletes and track cycling is no different in its requirements of these necessary trainable qualities (1).

**Getting a Jump**
Jumping or getting a jump on an opponent is a rapid acceleration at an opportune time or a predesignated position in a race. This rapid acceleration is once again a combination of strength and power of the lower limbs, derived primarily from the Glutes and assisted by the hamstrings and quadriceps. Strength training exercises used for this component are typical with that of the explosive start. The power component of getting a jump is generally made at speed, so great forces or initial strength aren’t necessarily important. What is important is speed and contractile qualities of the athlete’s Stretch Shortening Cycle (SSC) to rapidly increase the force and rate of force over a short period to gain the advantage necessary to pull the attack. Thus with this component of track Cycling the power element of the SSC needs to be developed. For these power movements the athlete’s requirements are speed and strength with a focus on speed (4). Resistance training exercises to train these movements would include High Box Jumps, Hops for Distance, Double and Single Legged Jumps for Height/Distance as well as various Olympic Lifts with the emphasis on lighter weights and greater speed. A general guideline on this would be 30% of 1 RM of weightlifting exercises (Clean Pull, High Pull etc) (1).

**Holding form/position:**
The holding position relates to all three disciplines and is the aerodynamic position that the athletes assumes when he/she is going at or near top pace. This position requires good overall body functional flexibility whilst maintaining a very strong streamlined fixed position. If there is excessive movement through either the arms, mid-section, hips or feet power and in turn time/races is/are lost. For the athlete to be in a aerodynamically position the thoracic spine needs to be flexible, but strong enough to hold position. The musculature of the upper body, i.e. major pushing and pulling muscles needs to be strong and balanced with also strong grip strength to deal
with the excessive body torsion forces that are applies from the hips and upper body to the handle bar. The gluteals need to be flexible as well as strong to deal with anterior/posterior as well as lateral forces demanded from track cycling and in particular this position. Resistance exercises to help keep the holding position are developed by working on specific areas of the whole body and have been highlighted in full in the rationale section of this paper (5, 9);

Program development

The process of elite track cycling resistance training planning starts with the initial phase of collating information.

(i) Talking to the coach about the athlete’s history, stage of development and specific short and long term goals.
(ii) Talking to the athlete and asking about perceived strengths, weaknesses, goals and training history.
(iii) Liaising with medical staff about athlete’s medical history, injuries, and limitations.
(iv) Organising a musculo-skeletal screen of the athlete to gauge a starting point with which to progress athlete.

Let’s assume we’re working with a 17 year old male targeted elite sprint track athlete. Having worked with this population over many years I will go through a sample of the restrictions and limitations that are typical of this athlete with reference to the above.

Coach History:
Has had limited high intensity training, be it on the track or in the gym. The coach suggests the athlete is 3 – 5 years away from elite level international competition (World Cups and Olympics). Short term goals are introduce more intensity into training and start a resistance training program that addresses the screen and moves the athlete strength and power development.

Athlete History:
Athlete has limited strength training and generally goes from season to season racing various types of cycling from track endurance to some criterion racing to even endurance type road racing.

Medical Staff:
No real injuries other than tight mid and lower back issues that require physiotherapy from time to time.

Musculo-Skeletal Screen:
Has tight/overdeveloped quadriceps, ITB/TFL, hamstrings
Tight: Hip flexors, Glutes including Med and piriformis, Quadratus Lumborum, Thoracic spine.
Weak: Calves, Tibialis Anterior, Glut Max, Glut Medius, Deep Transversus Abdominus, Multifidus, Scapular Control including Rhomboids, External Rotators , Serratus Anterior

Rationale:
The rationale for the program is an important part of being an elite Strength and Conditioning coach. If the professional cannot provide well thought through answers and direction for the program than how is he/she going to explain to the athlete or coach. The following exercises address the screen and lay the foundation for increased improvements in strength, power, flexibility and staying injury free across the initial 2 program stage. The direction taken after these programs is driven by the adaptations in the athlete.

Upper Body:

- Dumbbell and Bench Press – General Upper Body strength with a focus on Pectorals and anterior shoulder and Elbow extensors.
- Supine Pull Ups and Bench Pulls – General Upper body strength with a focus on Latissimus Dorsi, rhomboids, middle trapezius, Elbow flexors and forearm flexors/extensors.
- Thoracic Spine Mobility – Yoga Block Tx,
- Spatial Awareness and whole body Flexibility - Down Face Dog Pose
- Shoulder Compliance – DB Serratus Press (Serratus Anterior and scapula stability), Handstands (shoulder compliance), Cable External Rotations (Shoulder External Rotators and shoulder stability)

Mid-Section:

- Swiss Ball Side and Twists (outer core – Obliques and Rectus Abdominus)
- Transversus Activations (inner Core Transversus abdominus and Multifidus)
- Arabesque Pose, Glute Hamstring sequence and Ankle/Knee Clams (Hip Stability – Glute Max and Medius, postural and body awareness, Balance and the relationship between ankle, knee and hip)

Lower Body:

- Similar strength/power exercises to starting position and Jump position. The rationale has been discussed earlier
See Appendices I and II for actual Programs

**Progressions:**
The first progression of the resistance program starts with addressing the screen and teasing out the deficiencies. This may be overlooked by many practitioners, but simply it deals with current issues and avoids overloading a vulnerable body. As you wouldn’t overload and particular joint/area too soon post injury (i.e. sprints, hops or heavy squats 1 week post hamstring strain) the same theory applies if an athlete has clearly identified musculoskeletal issues (5). From there depending on the specific athlete’s needs the loading can take place. The type of strategy used depends on the phase of the season/year the athlete is currently in and the hierarchy of needs, which is generally coach driven. I tend to use a concurrent system where most if not all the physical requirements are trained within each strength session and each program or phase emphasises a specific parameter. This allows for progressive development and complements the strength/power high intensity training focus on the track.

**Frequency**
How often the athlete should undertake resistance training is always a contentious issue. For the initial program where the changes are working on flexibility, balance and hip/core stability I would recommend the program be done 3-5 times per week. Once the athlete reaches the second program and the coach assessment of the athlete deems he/she has successfully addressed some of the highlighted deficiencies, then the program should be done 3 times per week, generally with a day away from the gym in between. All the above recommendations are on the proviso of the workload fitting in with the Cycling coach’s periodised schedule and the athlete’s requirements. The athlete should be monitored on a regular basis to monitor workload and more specifically resistance training technique.
Evaluation

The program is evaluated every session when the athlete is monitored by the practitioner; however the following is a guide of useful evaluation techniques. A re-screen is invaluable and is necessary depending on the rate of change/adaptation seen by the practitioner. Everyone develops at their own rate, but a general rule a re-screen is necessary between 3 and 6 months to fully allow for the changes to take place. If possible use the same medical practitioner/physiotherapist to ensure validity.

When the athlete has progressed to more “typical” strength training exercises (around 6 months) the following tests are beneficial to ensure athlete progression.

- Squat 3RM and 1RM
- Bench Press and Bench Pull 3RM and 1RM
- Single Leg 45° Leg Press 3RM and 1 RM
- Single Leg 45° Leg Press Throws – Power recorded
- Power Clean 3RM,
- Using a Force Platform – Rate of Force Development, Ground Contact time and power output from Jump Squat at 30% 3RM and 60% 3RM (Dependent on access to Force Platform)

Conclusion

Undertaking any form of resistance training for sport is about developing athletically and most importantly enhancing performance. It should become very clear that staying injury free, increasing strength/power and developing flexibility are essential requirements of an elite track cyclist. There is limited research into specific resistance programming for track cycling, but utilising the basic tenets of strength/power development and understanding the requirements of the sport and individual are fundamental for track cycling resistance training programming. The specifics of resistance program periodisation are dependent of the individual, the current track workload, competition and training age thus wasn’t a consideration with this article.
References:


