Developing the soccer player as an athlete

By Andy Jackson & Matt Wallden
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In January 2001 the Football Association produced an audit of injuries in professional football (1). The relevant details of injuries sustained are as follows:

- 87% of injuries were to the lower limb. Of these, 23% were thigh injuries, 17% were knee injuries, 10% were groin injuries and 30% were ankle, calf and foot injuries.
- 69% of all injuries were strains or sprains
- 19% of all injuries were during running
- 15% were during tackling
- 9% were during twisting and turning
- 6% were during stretching.

The relevance of this to the corrective exercise specialist is the fact that so many of these injuries are non-impact, or injuries caused by "intrinsic" forces. If the all soccer players' biomechanics were improved through corrective exercise, the incidence of injuries in football and sports as a whole, would significantly decrease.

It is apparent when reviewing the research that, as C.H.E.K. Practitioners, we can do a lot to prevent injury, improve function and raise performance in the soccer player. Typically lower limb issues such as hamstring strain, ankle sprain, medial meniscal tear, and anterior cruciate ligament injury, are a result of musculoskeletal imbalance and faulty movement patterns.

We believe the following issues to be responsible for the cause of many injuries and decrease in performance, and aim to discuss these issues in this paper so to progress the soccer player to optimum function:

- Assessment and evaluation
- Posture and function – laterality, pronation patterns, and abdominal inhibition
- Over training
- Tissue recovery
- Program design

Assessment and Evaluation

While it is out of the scope of this article to fully discuss assessment and evaluation it is suffice to say that the C.H.E.K. system enables a comprehensive and practical method of analysing musculoskeletal function. For example, if your musculoskeletal findings show tight hip flexors and tight hamstrings (which is very common in soccer players) then you know that this can overwork the thoraco-lumbar junction and it causes the player to have to over rotate at the pelvis and spine to allow effective gait stride due to the limitations of hip flexion and extension. This could cause considerable musculoskeletal pain and dysfunction.

If you are a level III or IV then higher-level systems are taken into consideration. For example, one must consider the atlas-axis complex in a player who has constant groin pain. Functional hip compensation to correct for a subluxed atlas is common. If the player constantly rotates into the rotation of an atlas subluxation then the hip on that side will give to allow the body to move into place more easily and consequently these players will have a hard time stabilising their sacroiliac joints and may suffer with groin pain as a direct or indirect result.

As an NLC the visceral and glandular systems can be screened, as well as nutritional and lifestyle habits. For example, a soccer player with exhausted adrenals and a poor diet will have compromised stability at the T12 area. He is constantly rotating his trunk (when shooting, turning, cutting, faking) during a game, and a combination of an exhausted adrenal gland and inhibited stabilisers, due to poor nutrition or adrenal stress will compromise stability in this area and will cause the player back pain due to abdominal inhibition.

One must remember to assess the biomotor abilities that are predominant in the game of football. This will be discussed in the following section.

Posture and Function

Prior to any conditioning phase, posture must be evaluated and corrective measures taken as needed

'Ideal posture encourages maintenance of concentric joint motion and an optimal instantaneous axis of rotation. Poor posture represents faulty alignment of joints. Loading joints which are moving eccentrically from the optimal instantaneous axis of rotation, will certainly lead to destruction of the joint.' (2, prog design).

A soccer player will be predisposed to muscle imbalance as is the case with all athletes in all sports. The C.H.E.K. Practitioner is the ideal therapist to address these issues through corrective stretching and exercise. This would normally be done in the off-season phase so that the likelihood of muscle and joint injury is decreased at the beginning of the season where the volume and workload of the sport increases. This will be discussed further in the program design section

Typical muscle imbalance in soccer:

- **Pronation pattern**

Forward head
Rounded shoulders
Increased thoracic kyphosis
Anterior pelvic tilt*
Medial instability of the knee
Foot pronation
These postural discrepancies would couple biomechanically with lower limb lateral collateral ankle sprains, medial collateral ligament (of the knee) strains. ACL tears, medial meniscal tears and hamstring strain.

- **Laterality**

In the clinic we typically see this pattern in right-footed soccer players (and the reverse in left footed players):
Right leg – medial rotational instability
Left leg – good stability
Right ilium – anteriorly rotated
Left shoulder to right hip anterior sling weakness/inhibition
Left sacroliliac joint restriction

***Please note:** Often the presence of a hypolordosis (flat back, with anterior sway) is noted in the standing examination, but under conditions of load, such as sprinting, the player falls into a hyperlordosis and anterior pelvic tilt – ie a pronation pattern *under load*.

Typical exercises we would give to correct right-footed laterality would be:

1. Left single arm cable push
2. Right, right, left upper Russian twist
3. Right, right, left lower Russian twist
4. Right, right, left Lower Abdominal 2A/B

All of these exercises work the weakened sling e-concentrically, thereby providing a significant carry-over to the sporting environment. Correction of a laterality pattern can occur very quickly (6-8 weeks), so reassessment is critical to ensure you are not unbalancing the athlete in the opposite direction!

Lower abdominal inhibition
This is also a common finding and can cause functional instability affecting static and dynamic posture. One must therefore assess TVA function in relevant primal patterns (such as the lunge and twist) as well as in isolation. One must also then consider visceral referral and digestive function as issues that can inhibit the abdominal wall. The reader is referred to Matthew Wallden's article in volume 1 of the C.H.E.K. report for further reading on this important issue. (3)

Function - Planes of movement and biomotor abilities

The soccer player needs to be efficient in the sagittal, frontal, and transverse plane. Biomotor abilities will depend on the individual and the position they are playing in. For example,

During a match a player performs around 1100 changes in activities, e.g. switching from standing to moderate running to walking. The table below shows the number of activities performed (A) and the average duration of each activity (B) during a match for the players of the Danish league. The distance covered with the ball was between 0.5% and 3% of the total distance. At every level of play, attackers sprint more than defenders and midfielders. This distance is attributable to the number of short forwards sprints attackers carry out, due to the fact that they are normally tightly marked. Midfielders have to make more long sprints as a consequence of their linking role between defence and attack. (4)

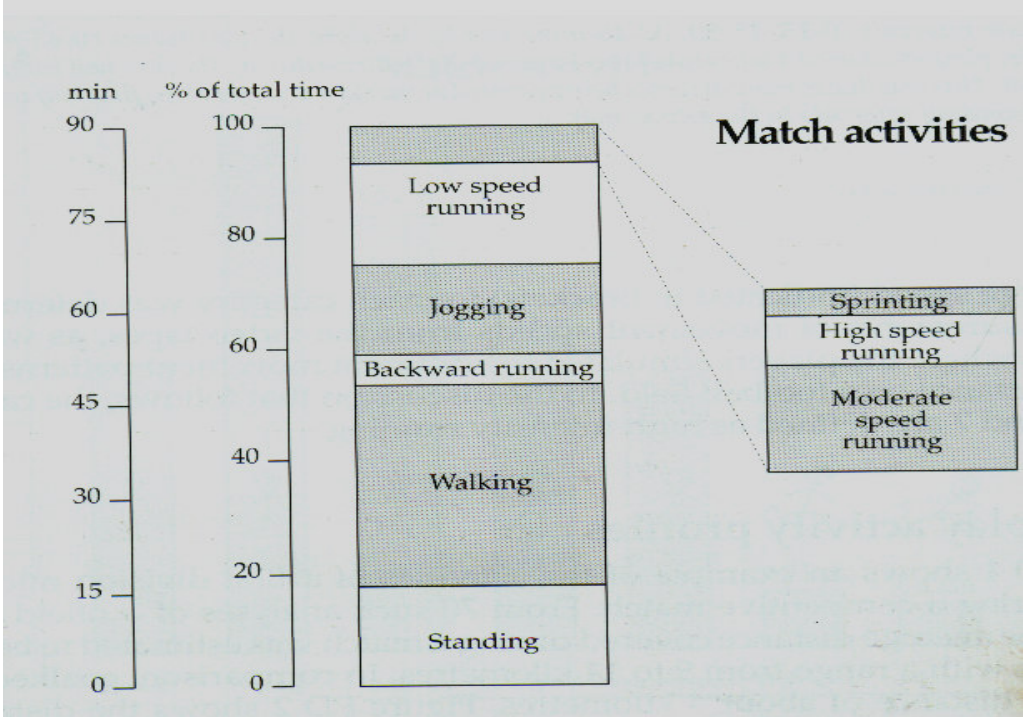

Figure 1: Basic analysis of player movement patterns during a match

Many activities in soccer are forceful and explosive e.g. jumping, tackling, kicking, turning, and changing pace. The power output during such activities is related to the functional strength of the muscles involved in the movements. The muscular strength of the players appears to be related to the position in the team. Studies show muscular strength to be the lowest for the midfield players and the fullbacks compared to the goalkeepers, forwards and central defenders. Soccer players make 100 to 200 sprints form 5-30 metres. The sprints last 1 to 2 seconds on average. (5)

- Forwards, central defenders and goalkeepers generally need to be strong so they can jump higher and further. Also so that they can shield the ball.
- Anaerobic power tends towards the profile of sprinters, goalkeepers, and central defenders.
- Midfielders have the most shots at goal
- Defenders make the most sliding tackles
- Defenders and attackers jump to head the ball most often.
- Some players do not fully utilise their physical capacity during a match due to supreme technique and skill. (6).

In general biomotor abilities in soccer can be summarised as follows:

Biomotor Ability	Rating out of ten
Strength	7
Power	9
Endurance	7
Speed	8
Coordination	8+
Flexibility	6+
Agility	8
Balance	8

As you can see, a soccer player requires a high level of most biomotor abilities and that many biomotor abilities are co-dependant upon each other (7) and as a conditioning specialist, you can clearly see that there are many additional factors involved in successfully designing a conditioning program for a soccer player. Because of the nature of soccer, it would be necessary to test:

Leg strength	Leg power
Speed endurance	Start speed
Coordination	Agility
Flexibility	Balance

Exercise selection

Correction of posture must take precedence initially during the off-season. When the season is approaching fast then corrective exercises can be phased into the phases of the season. Muscle imbalance findings must also influence exercise selection.

Primal Patterns
The ***main*** primal patterns used in the game of soccer are:
The lunge - cutting, changing direction, turning, tackling
The twist - turning, twisting, kicking/shooting
The squat - jumping
Gait - running, sprinting and jogging

Outer Unit Slings
The outer unit slings are all functional in the game of soccer within the primal patterns above and must therefore be considered when programming the player:

Outer unit sling	Soccer specific action	Appropriate exercise
Posterior Oblique Sling	Holding a player off/shielding the ball from a player	Wall standing or original Supine Lateral Ball Roll (see fig.s 2 & 3)
Anterior Oblique Sling	Change of direction and change of speed. Power for kicking ball.	Prone Ball Roll Single arm/Single leg Cable Push
Deep Longitudinal Sling	Jumping	Power Cleans Deadlifts
Lateral Sling	Balance on a single leg when kicking – e.g. taking a free kick	Single Leg Swiss Ball Lean – 'The Free Kick' (see fig.s 4-6)

One must remember that the intensity and volume of training will depend on the training age and experience of the player and also the total current physiological load.

Figure 2: A typical shielding play in soccer.

Figure 3: A standing lateral ball roll (Swiss ball against wall).

Complex training

Complex training is characterised by the use of both heavy and light loadings on biomechanically similar exercises to enhance power performance. It combines traditional strength exercises with power (plyometric exercises). For example; heavy squats followed by a 3 minute rest and then 3 – 6 drop jumps.
The benefits from the strength exercise are increased neural activity and increased muscle mass. However, to develop the rate of force the type 2 b fibres need to be targeted as these are the ones that produce force most explosively allowing for maximal power. The logic behind these matched pairs of exercises is that the resistance work gets the nervous system in to full action so that more type 2b fibres are available for the explosive exercise, hence a better training benefit. This is rather like picking up a

bucket of water that you think is full but it is actually half empty; you recruit more fibres than you actually need to.

There is now a great deal of both anecdotal and scientific study to highlight the effectiveness of this type of training. It is also very useful when time is an issue and many biomotor abilities, skills, and techniques need to be trained.

Developing aerobic fitness and its relationship to tissue recovery and repair

Soccer requires a high level of cardiovascular fitness to enable physical performance for 90 minutes and to enable fast recovery from high intensity bursts. For this reason the aerobic system must be trained effectively. It is important to consider the issues that affect the development of aerobic capacity:
Soccer, being partly an aerobic sport will work the adrenal gland considerably. The adrenal gland responds to aerobic exercise by releasing epinephrine and norepinepherine (catecholamines) from the adrenal medulla as a response to what it considers to be stress (fight/flight). This increases metabolism and causes breakdown of glucose from the liver and muscles for energy. Insulin is released and energy is delivered to the tissues that need them (8). The stressful demands of physical activity may also stimulate the release of cortisol from the adrenal cortex which mobilises protein and fatty acids from tissues for synthesis via gluconeogenesis. During this time energy is shunted from other non-critical physiologic functions such as:

1. Digestion
2. Detoxification
3. Cellular repair
4. Sexual function

Now this is fine if the body is generally in an anabolic state where it has a strong hormonal and immune system meaning physiological and mental stress levels are within their homeostatic boundaries. This enables regeneration, repair, and reconstruction after exercise. However, if the body is stressed through over training, lack of sleep, non-steroidal anti-inflammatories, poor posture and alignment, poor nutrition etc, then the adrenal gland will become overworked and over time, if stress levels remain high, the ability of the adrenal glands to produce cortisol and DHEA will diminish. This will cause the body to be in a constant catabolic state where physiological and mental stress levels are excessive or prolonged and repair and regeneration is affected. This state is known as *allostasis*.

Remember – the body is a system of systems. You cannot affect one system without affecting the others

One can see that if cortisol rhythm is out of balance then recovery from an injury will be compromised. Cortisol's other main functions are to act as an anti-inflammatory and to direct immune function. When these levels are out of the physiological ranges then there is an effect of dysfunction and a reduction in tissue repair and recovery.

The Adrenal response

Eating too many simple and refined carbohydrates, over training, poor posture, NSAID's, and faulty circadian rhythms will cause:

- Increased blood sugar levels
- Increased adrenal function
- Increased insulin and cortisol levels

= Overworked pituitary and adrenals

= Decreased cortisol release and compromised tissue recovery and repair

One can therefore see that circadian cortisol rhythm is crucially important. Too many simple and refined carbohydrates can also reduce the effectiveness of the immune system. The theory of carbohydrate loading must surely be challenged further as our grains become more processed and biochemical individuality comes to the forefront of nutritional support One must consider parasympathetic exercises or stimuli to support the adrenal gland and allow it to function optimally allowing effective release of cortisol as an anti-inflammatory. Examples of sympathetic stimuli include massage, sauna, Tai Chi, Qi Gong, Breathing, and meditation. See figure 4 below.

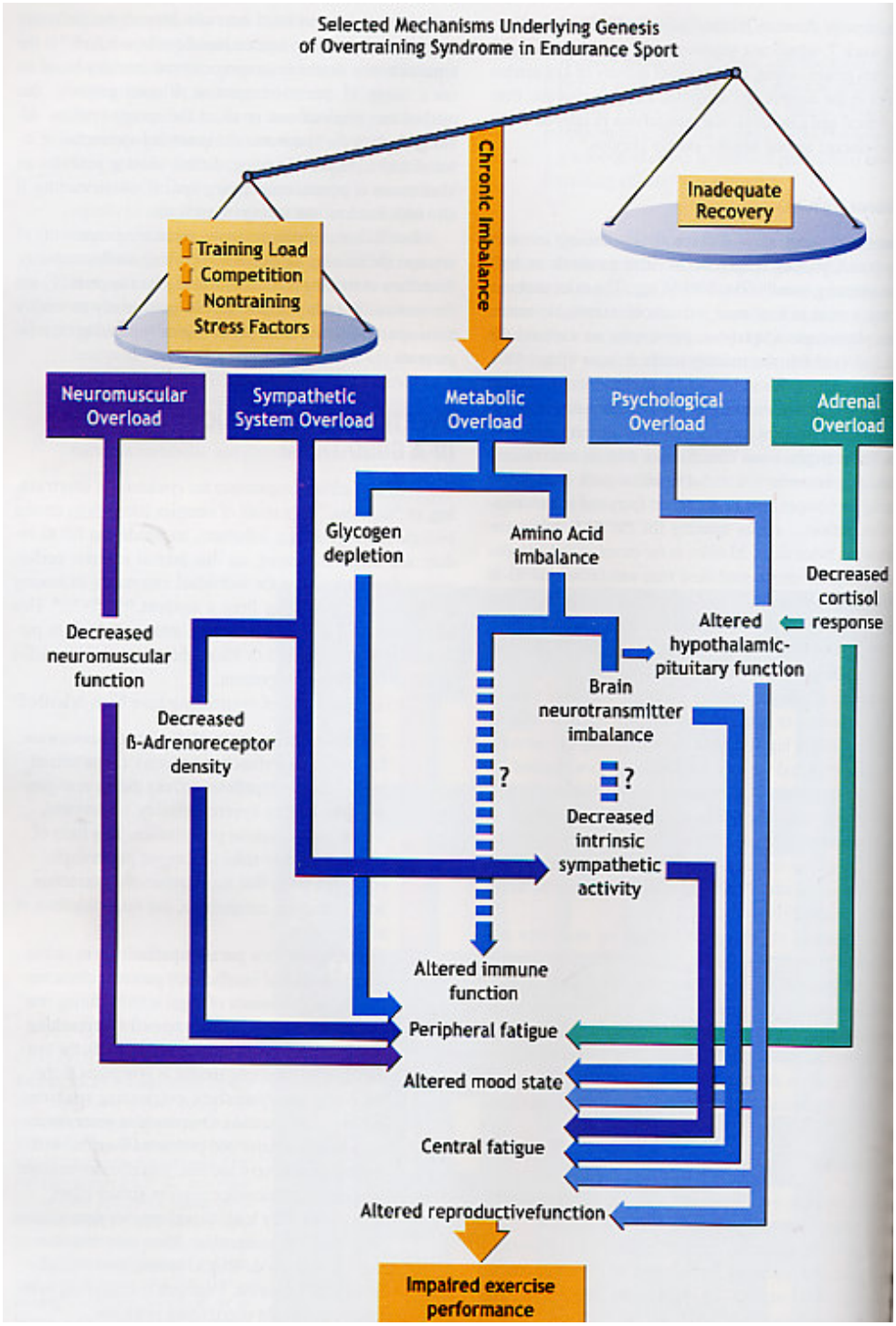

Figure 4: Schematic overview of the over training syndrome - taken from McArdle et al (2000) pp490

One must also consider the following factors when designing aerobic training:

Work tolerance – Is the player eating right for their metabolic type to allow optimum energy production?

Heart health – Sense man / rhythm man – What is happening above and below the heart

Alignment and stability – dysfunction in either of these areas will affect the efficiency respiration and movement.

Program design for the soccer player

Periodisation

After a summer break of one or two months, players have a relatively short period of time to regain match fitness, i.e., to get back to the level of technical, tactical, and physical fitness that is necessary to compete effectively.
Football differs from standard athletic conditioning in that peak performance must be maintained from August until mid-May rather than peak for a limited number of events. It is therefore important to periodise players' training programmes. This means dividing the whole year into manageable portions that are quite specific to the players' training needs at that time. The maintenance of strength and endurance during the off-season allows the quality work (speed and speed endurance exercise and development of skill) to begin earlier in the pre-season or pre-competitive phase of the season.

Here is an example of a general periodisation table for the soccer player. Obviously individual positions and differences will have an effect on the format, but we hope this will help guide you.

Conditioning type	**Conditioning priorities**			
	Off season	**Pre season**	**In season (first half)**	**In season (second half)**
Aerobic conditioning Low Intensity High Intensity	 Moderate Moderate / High	 Moderate/High Moderate/High	 Moderate Maintenance/High priority	 Moderate Maintenance/Low priority
Anaerobic conditioning (Speed endurance)	Low	High	Maintenance	High quality
Speed conditioning Starting speed Acceleration Agility Quickness	 Low Low Low Low	 High High High High	 Maintenance Maintenance Maintenance Maintenance	 High quality High quality High quality High quality
Power conditioning Plyometrics / Weights	Low	Moderate/High	Maintenance	Maintenance
Strength conditioning General Sports specific	 Moderate/High Low/Moderate	 Low/Moderate High	 Low Low/Moderate	 Low Low/Moderate
Stability conditioning Corrective exercise prog	High	Low/Moderate	Moderate	Moderate/High
Stretches / **Mobilisations**	High	High	Maintenance to high	Maintenance to high

Integrated conditioning

At the start of pre-season, complete training sessions or parts of them can be devoted to improving a single soccer-fit component. The further the preparation period progresses, the more the sessions include specific elements of real games of soccer. During a season, High intensity Stamina-fit training should be given a high priority. Sprint-fit training and speed-fit training (more for higher level players) should be performed regularly. The extent of strength training during the season should be determined by the total amount of time available.

The programme provided below would be divided into weekly session as well. It is possible that separate cycles/programmes must be developed for positional roles, although the degree of change need not necessarily be too major. Any periodisation must be flexible due to unforeseen breaks, injuries etc.

A Typical Off-Season Corrective Exercise Program

Muscles that we see in the clinic typically tightening due to soccer are:

Muscle	**Reason for tightness**
Gluteals	Lunging, jumping, powerful movements, hip/leg stability
Rectus Femoris (dominant side)	Dominant leg: Kicking action / non-dominant leg:

	single leg support in kicking
Psoas	Running, change of speed, kicking
Hamstrings	Poor abdominal function/inhibition, microtrauma from kicking / sprinting / change of direction work
Triceps surae	Excessive plantar flexion, unstable surfaces – therefore ankle & knee stability
Sternocleidomastiod	Heading the ball
Quadratus Lumorum (on dominant side)	Over use

For this reason we must consider the effect that these tight muscles can have on the body, the corresponding muscles that are going to become weaker or inhibited, and then design the appropriate corrective exercise program. Below is an example of a program that a player could do during the second half of the season. The objective is to maintain power, maintain stability in all planes and prevent muscle imbalance.

Late in-season training

Exercise	Rest	Intensity	Reps	Tempo	Sets	Reason for exercise
1. Single arm D/B Snatch to lunge	+3:00	-1 rep	4 - 6	X	2 – 4	Maintains power output, lunge pattern and functional stability
2. Supine Lateral Ball Roll	1:00	Bodyweight	6 each side	Hold for 3 secs	2 - 4	Maintains stability in all 3 planes
3. Single leg supine hip extension	1:00	Bodyweight	8 - 12	202	2 – 4	Maintains hip stability Integrates hip stabilisers with core stabilisers
4. Horse Stance Horizontal	1:00	Bodyweight	6 each side	Hold for 10 secs	2 - 4	Strengthens spinal stabilisers
5. Lower Abdominals	<1:00	40mmhg +30mmhg	12 - 20	202	2 – 4	Maintains core strength
6. Standing Deep Cervical Flexors	<1:00	30mmhg +10mmhg	10	Hold for 10 secs	2 - 4	Maintain deep flexors strength

Below is an example of a pre-season program for a soccer player where optimum sports specific performance is the main goal. It is accepted for this example that all corrective exercises have been successfully completed prior to this stage:

Program A

Exercise	Rest	Intensity	Reps	Tempo	Sets	Reason for exercise
1. Power Cleans		-1 rep	4 - 6	X	2 – 4	Good all round power developer and coordinator,
2. MultiDirectional Lunge		-1 rep	3 circuits	Fast	2 – 4	Trains one of the main primal patterns
3. Single Leg Woodchop		-2 reps	8 - 12	Fast	2 – 4	Trains the other main primal pattern in a sport specific manner
4. Swiss Ball Cross Crunch	1:00	-2 reps	8 – 12 each side	202	2 – 4	Trains the AOS
5. Standing Lower Abdominals	<1:00	40mmhg +30mmhg	12 - 20	202	2 – 4	Strong abdominals in standing. Helps prevent tight upper thigh muscles
6. Proprioception		Body W	5 mins		1	Injury prevention and

Training						balance

Figure 5: The free kick / dead-ball strike in soccer.

Figure 6: The single leg Swiss ball lean (posterior view)

Figure 7: The single leg Swiss ball lean (anterior view)

Program B

Exercise	Rest	Intensity	Reps	Tempo	Sets	Reason for exercise
1. Back Squats	3 min		2-3	303	2	Complex training. Do this complex twice - Rest 8 mins between each complex
Depth Jumps	3 min		10	X	2	
2. Prone Roll	3 min	Body W	Upto 15secs	X	3	Works the AOS powerfully
3. Single Leg Squat Joubert's manoeuvre	1:30	-2 reps	3 circles	slow	2 – 4	Helps correct / prevent lateralisation
4. Supine Lateral Ball Roll – against wall	1:00	-1 rep	6 – 10 each side	Hold for 2 secs	2 – 4	Stability in all planes in a sports specific position
5. Ladder Drills	1:00	Body W	6 - 10	Fast	2 - 4	Works fast feet / change of direction
6. Deep Cervical Flexors	<1:00	30mmhg +10mmhg	10	Hold for 10 secs	2 - 4	Strengthens deep neck muscles in preparation for heading the ball

Conclusion

As you can see from the information above, the field of conditioning in soccer is a vast area; due to the complexity of the game and its interactions. This is a topic that is not well addressed in the literature, and all too often research that *is* available is limited in its use due to the unrealistic constraints of research methodologies. In response to this situation, the global growth of soccer, as well as the level of injuries it creates (over half of all sports injuries in Finland are due to soccer [9]), we are writing a book for publication in 2004 on the biomechanics of soccer performance. In it we hope to share with you a lot more of our experience, ideas and research.

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Andrew and Matthew have both played soccer at a semi-professional level and have worked with various professional soccer teams, players, as well as having close links with the English Football Association Medical Centre.

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