Athletic low back pain: practical strategies to enhance movement quality and control

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Pain-free sporting function depends upon the effective integration and co-ordination of spinal movements within the kinetic chain. Efficient movements not only minimise the metabolic cost of a given activity but also provide stress shielding of spinal structures. Assessment and management of athletic low back pain (LBP) requires a clear understanding of the role spinal mechanics play in effective sporting performance and how key dysfunctions in movement, coupled with sport-specific stresses, contribute to the development of pain and perpetuation of symptoms. This article outlines the role of the spine in effective sporting function and highlights common dysfunctions associated with low back pain presentations. Key considerations to inform assessment are outlined and a management approach to restore movement quality and control in a sporting context is proposed.

LEARNING OUTCOMES
TO SUPPORT PHYSIO FIRST QAP

1. Understand the theoretical framework for the role of the spine in sports performance.
2. Appreciate the contributing factors and the relationship of sport to low back pain and dysfunction.
3. Understand assessment of movement quality and control.
4. Gain practical techniques to improve movement quality and control.

Introduction

Assessment and management of athletic low back pain (LBP) requires a clear understanding of the role spinal mechanics play in effective sporting performance and how key dysfunctions in movement coupled with sport-specific stresses contribute to the development of pain and perpetuation of symptoms. Pain-free sporting function relies upon the integration of a number of physical subcomponents including range of motion, strength and endurance, as well as the ability to adopt, maintain and control a wide variety of sport-specific movement patterns in an often challenging and highly variable environment.

There is evidence that sports involving movements at the extremes of flexion or extension may be associated with a higher incidence of LBP (Bahr *et al* 2004). Similarly, a higher incidence of LBP has been reported in sports such as gymnastics, wrestling, skiing and rowing (Foss *et al* 2012). The habitual and automatic nature of many sporting movements through large ranges of motion has the potential to significantly influence the presence of pain. A dysfunctional movement pattern that is performed repeatedly, over a long period of time, may result in repetitive stress on injured tissues and the reinforcement of aberrant patterns of recruitment.

Importantly, LBP may result in persistent performance decrements in athletic populations. In a study investigating 210 collegiate athletes, Nadler *et al* (2002) observed that those with LBP or a history of LBP performed significantly worse on a 20m shuttle run test than those without any history of LBP. It is therefore reasonable to suggest that low back pain may be a significant cause of underperformance and morbidity in sport.

Key spinal movements and their relationship to sporting performance

In addition to local and general tissue capacity, pain-free function also depends upon factors such as strength, range of motion, endurance and movement control. Disruption of any one or more of these subcomponents may contribute to the development of LBP in athlete populations. To assess movement control in athletic LBP effectively, it is important to understand how these factors contribute to the optimal function and stress-shielding of spinal structures and how they are altered in the presence of LBP. Key sporting actions such as running, high-speed rotational and unpredictable multidirectional movements are particularly important to consider.

THE SPINAL ENGINE

Efficient sporting movement requires effective storage and release of energy through the elastic recoil of myotendious and fascial tissues. In 1985, Serge Gracovetsky described “The Spinal Engine” where he proposed that the spine is primarily responsible for pelvic movement and that the lower limbs serve to amplify the movements

"OVER ACTIVITY OF LUMBAR ERECTOR SPINAE MUSCLES HAS BEEN IDENTIFIED AS A COMMON PRESENTATION IN LBP PATIENTS"

of the pelvis. He illustrated this theory through the example of the ability of amputees to walk without legs. Efficient movement is made possible by the temporary storage, and subsequent release, of energy achieved through axial rotation of the spinal column. Failure to utilise this highly efficient system during repetitive high and low load movements can result in reduced performance as well as increased mechanical loading of the spine.

The link between the torso and the pelvis is even more important during high-speed movements such as running. Rather than operating in a primarily in-phase manner, the torso-pelvic relationship changes to become more anti-phase as the velocity of walking or running increases (Lamoth *et al* 2002a & 2002b). This anti-phase movement facilitates the tensioning of tissues and the release of kinetic energy. Importantly, Lamoth *et al* (2006) have reported that this de-coupling of torso-pelvic rotation around the vertical axis is reduced in patients with low back pain and that they continue to display torso-pelvic movements that are more in phase. Further, the authors observed that these patients tended to adopt greater degrees of movement in the frontal plane (side-flexion) to compensate for the reduction in de-coupling. This is a significant point as the loss of effective de-coupling or "dissociation" of trunk and pelvis rotation will result in reduced efficiency during higher speed activity and increased loading though the lumbar spine.

SAGITTAL PLANE CO-ORDINATION

Bosch (2005) highlighted the importance of anterior-posterior pelvic rotation (tilt) for the elastic storage of energy and efficient functioning of the hamstrings during high-speed running. He postulates that control of anterior pelvic tilt at foot-strike (facilitated by iliopsoas activity) facilitates hip extension and improved efficiency of force transfer through the hamstrings. This position may also facilitate a better position of the foot at foot-strike, thereby reducing potentially higher impact forces. If the point of contact is in front of the body, it tends to act as a braking force, further accentuating impact forces and lumbar spine loading on what may be an already "stiffened" system.

Over-activity of lumbar erector spinae muscles has been identified by a number of authors as a common presentation in LBP patients; it has also been observed that these lumbar extensor fail to relax during flexion movements (Ahern *et al* 1988; Paquet *et al* 1994; Watson *et al* 1997). Increased activation and inability to relax lumbar extensors may reduce the overall endurance of these muscles during sporting movements, resulting in an increased anterior pelvic tilt, reduced performance and concurrent increased spinal loading.

TORS-PELVIC DE-COUPLING

The ability to effectively de-couple trunk and pelvic position becomes even more important during high-speed rotational sporting movements such as throwing, kicking, golf swing and racquet sports. The term "X-factor" in golf was first described by Jim Mclean in 1992 and refers to the relative torso-pelvic separation at the start of the downswing. Many studies have highlighted the relationship of the X-factor to club head speed with evidence suggesting that it is the degree of X-factor stretch at the start of the downswing that is the key performance determinant (Myers *et al* 2008). X-factor stretch relates to the ability to actively initiate rapid pelvic rotation without associated torso rotation (dissociation) which permits the rapid release of elastic energy and consequent rapid trunk and limb movement (figure 1). Similar ability to dissociate the trunk and pelvis is also critical in rotational sports such as throwing, boxing, kicking and racquet sports. During these movements, the anterior myofascial slings are loaded through a diagonal spiral that follows a relatively straight line of force.

FIGURE 1: Golf swing x-factor

In athletes with LBP it is common to observe reduced rotational dissociation that is often accompanied by an attempt to increase range by extending and / or side flexing through the lumbar spine, resulting in a disruption in the line of force and increased focal loading of these tissues.

"HIP ROTATION, ACCOMPANIED BY EARLY PELVIC MOVEMENT HAS BEEN IDENTIFIED IN PATIENTS WITH LBP"

> "PATIENTS WITH LBP ARE LESS RESPONSIVE TO CHANGING TASK CONSTRAINTS, TENDING TO ADHERE TO PREFERRED MOTOR STRATEGIES"

THE ROLE OF THE HIP

In addition to torso-pelvic dissociation, effective lumbopelvic-hip dissociation during sporting activities is also necessary for efficient force transfer; this can be seen in movements such as kicking (figure 2). A number of studies have reported that patients with LBP display early lumbopelvic movement during limb movements when compared to people without LBP (Esola *et al* 1996; Li *et al* 1996; Luomajoki *et al* 2008). Notably, Roussel and colleagues (2009) reported that decreased control of lumbopelvic motion with limb movement is predictive of development of LBP (Roussel *et al* 2009).

The ability to dissociate hip movements appears to be particularly important. A number of studies have identified that hip rotation is accompanied by early lumbopelvic movement in patients with LBP (Gombatto *et al* 2006; Scholtes *et al* 2009). In a series of studies, van Dillen *et al* (2001, 2008) demonstrated that when lumbopelvic movements are manually restricted in LBP patients who have reduced dissociation of hip medial or lateral rotation, symptoms improve. A recent study by Hoffman *et al* (2011) noted that it is the ability to dissociate and control hip and lumbopelvic movement that appears to be the important factor in the development of LBP rather than the available hip rotation ROM. Therefore, reduced ability to effectively dissociate limb and lumbopelvic movements may predispose athletes to LBP through increased spinal loading and reduced efficiency of force transfer.

FIGURE 2: Diagonal spiral during kicking. Note the straight line of force that spirals around the trunk

Movement control, athletic performance and low back pain

The ability to dynamically control movement during athletic activities is central to effective and safe sporting function, and requires the selection of the most appropriate motor strategy. The strategy adopted by an individual depends upon a range of factors, including presence of pain, the complexity of the task, environment, i.e. major sporting event vs. training, accurate feed-forward input, afferent feedback (joint receptors), previous experience, i.e. novel vs. familiar skill, as well as individual motor capabilities, e.g. range of motion, strength, endurance. Through continuous sampling of all of these factors the individual selects and modulates or "tunes" the motor strategy to ensure effective completion of the task. Motor learning through subsequent success or failure of the response informs future attempts to respond to similar situations leading to a more adaptable and robust system (Hamstra-Wright *et al* 2006; Milton *et al* 2007).

It has been demonstrated that patients with LBP are less responsive to changing task constraints and tend to adhere to preferred motor strategies, resulting in a reduction in the motor strategies available (van Dieen 2007). LBP has been linked to a range of underlying motor control deficits such as altered recruitment patterns of muscles (Cholewicki *et al* 2005), reduced proprioception (O'Sullivan *et al* 2003), increased postural sway (Hamaoui *et al* 2007), reduced responsiveness to environmental perturbations (Radebold *et al* 2001) and impaired activation of deep stabilising muscles, e.g. transversus abdominis (Hodges *et al* 1996). All these factors may contribute to the altered integration of lumbar spine movements within the kinetic chain as outlined above. While it is well accepted that such impairments exist in patients with LBP, there is growing evidence that alterations in motor control may contribute to the development of pain and dysfunction (Key 2010).

In a sporting environment that is frequently unpredictable and highly challenging in terms of skill task, strength or endurance requirements, such maladaptive movement patterns can contribute to the development and perpetuation of pain. This may ultimately result in a loss of the optimal state of movement variability, causing the motor system to become more predictable and rigid. A reduction in movement variability may have long-term implications for joint and tissue health. An interesting postulation is that increases in movement or behavioural rigidity cause systematic loading of the same tissues and, subsequently, increase the risk of damage and pain.

It is important to recognise that, secondary to pain or other habitual movements, maladaptive responses are part of a wider picture related to reduced motor control and, as such, a management approach that simply attempts to change the maladaptive responses without increasing the ability of the motor system to respond appropriately to variable environmental stimuli may not affect the underlying problems. Consequently, it is essential that any intervention for athletic LBP must also seek to enhance motor

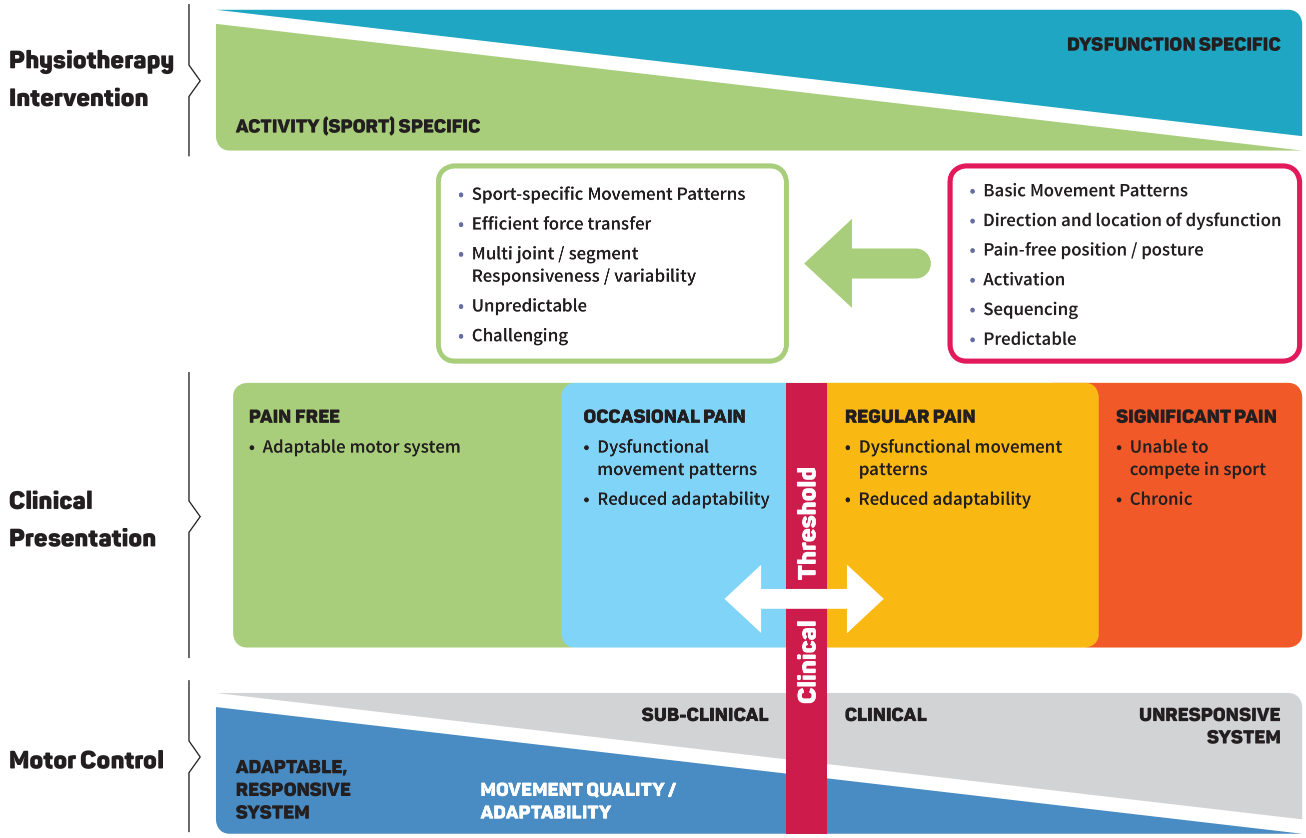

FIGURE 3: Movement control and physiotherapy management. The red line corresponds to the clinical threshold

control by improving the ability of the motor system to effectively respond to variable challenges.

As outlined above, common clinical patterns that emerge in the athletic population during dynamic movement include:

- reduced torso-pelvic dissociation
- reduced lumbopelvic-hip dissociation
- reduced active hip extension accompanied by increased lumbar extension loading
- reduced spinal axial rotation
- reduced upper and lower quadrant integration
- reduced endurance
- reduced strength
- focal areas of increased / reduced mobility
- altered patterns of recruitment.

Strategies to enhance movement quality and control

Specific strategies to address each of these dysfunctions are outside the scope of this article. However, there are a number of key principles that may be applied to facilitate effective management. Figure 3 summarises the approach to managing athletic LBP and its relationship to motor control. Where an athlete has significant pain, or reduced control, initial treatment should focus on relatively simple motor skills that stimulate peripheral afferents and encourage re-education of normal movement. The initial aims are to address specific limitations of function while protecting painful structures. It is usually necessary to adopt a more supportive position that allows pain-free movement and correct patterning of simple single-segment, uni-planar movements. It is also important when attempting to re-educate muscle patterning to break any association between specific movement patterns and pain. Functional movements during this phase should be familiar, predictable and smooth; manual assistance or facilitation may be particularly useful in this respect. For example, actively assisting pelvic movement during rolling may quickly improve function and reduce any muscle guarding.

Once basic functional positions and activation patterns can be achieved, neuromuscular control through multiple planes may be introduced. Simple goal-oriented exercises that have an external focus will facilitate automation of known movement patterns and can be effective in improving control. There is evidence that attention directed towards movement outcomes, rather than the movement itself, may aid learners in discovering individual optimal solutions to a particular movement problem (Davids *et al* 2008). Practical examples include basic skills such as reaching and bending from different starting postures.

The difficulty of motor skills should be progressed into more challenging functional positions that require

> *"THE INABILITY OF THE MOTOR SYSTEM TO RESPOND TO A DYNAMIC AND VARIABLE ENVIRONMENT IS OFTEN KEY TO THE PERPETUATION OF SYMPTOMS"*

increased dynamic control. During this stage it is often necessary to continue some level of isolated segment work, but this may be reduced as movement patterns improve. Similarly, once specific muscle weakness has been addressed, strengthening should become more multi-segmental.

As rehabilitation progresses the complexity of the task should be increased to involve multiple segments through multiple planes of movement. Early examples of this include some of the movement tests carried out during the assessment such as combined trunk and upper limb PNF patterns and standing spirals (figure 4). Particular attention should be given to facilitating effective loading of tissues through functional diagonal patterns and to the release and attenuation of force. Examples include upper and lower limb combined diagonal patterns, resisted "Crazy Ivans" (figures 5a & b.) or decelerating the trunk and upper limb after throwing a medicine ball. The addition of external load or increased complexity of task should only be considered when movement quality allows. Key progressions that may be used include time or space constraints as well as the use of sporting equipment.

The introduction of unanticipated movements is essential for effective restoration of function. As discussed earlier, the inability to respond to a dynamic and variable environment is often a key driver in the perpetuation of symptoms. Gradual introduction of physical perturbations facilitates reactive

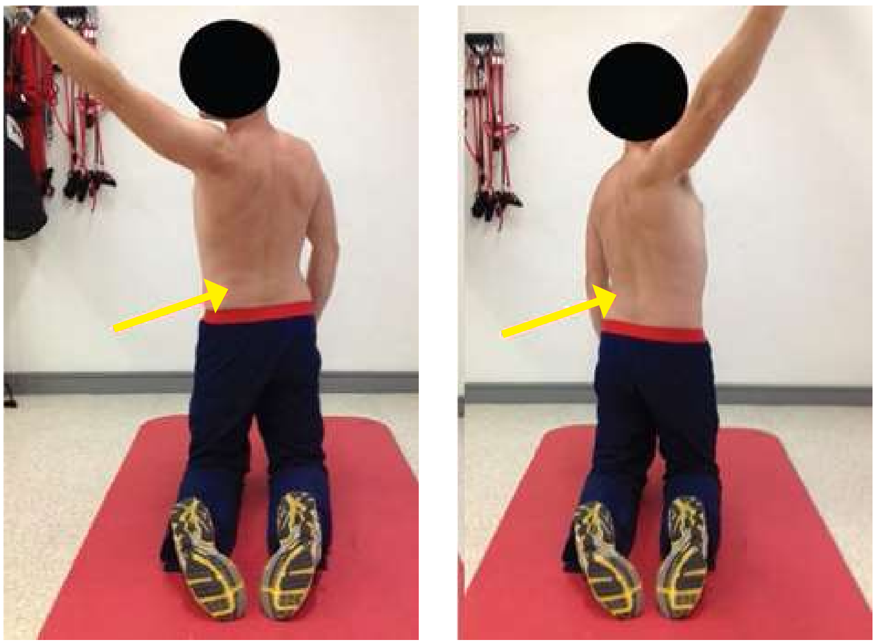

FIGURE 4: Upper / lower quadrant integration tests; figure 4a above illustrates the high kneeling trunk rotation (yellow arrows) and upper limb diagonal test. Figure 4b below shows the standing spiral test

FIGURE 5: Illustrations of multi-planar, multi-segmental exercises; figure 5a, above, the skater lunge, and figure 5b, below, resisted "Crazy Ivans"

neuromuscular adaptations as well as sudden responses to verbal or visual commands. At all times the quality of the movement is monitored and, where maladaptive patterns are adopted, exercises should be regressed to ensure correct form.

Reintroduction of sport-specific skills, competition and other environmental constraints should focus on widening the movement repertoire of the athlete and allow sufficient time for skill acquisition and consolidation through practice.

Conclusion

Pain-free sporting function depends upon the effective integration and co-ordination of spinal movements within the kinetic chain. Efficient movements not only minimise the metabolic cost of a given activity but also provide stress shielding of spinal structures. Assessment of the athlete with LBP should seek to identify focal areas of stress and impaired control through the use of dynamic movements that challenge different aspects of spinal function. The focus of management should be on restoring the ability to perform and control movement in a variable and unpredictable environment. Principles to assist the clinician in developing effective interventions in this regard have been outlined.

About the author

Phil Glasgow has worked with some of the best athletes, coaches, sports and performers in the world. He has extensive experience in high-performance sport both as an expert practitioner and as a mentor to the "team behind the team". He was the Chief Physiotherapy Officer for Team GB at the Rio 2016 Olympic Games where he led the physiotherapy team of the most successful British Olympic Team in history.

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Phil is recognised as a leader in the field of sports medicine and performance and has worked on globally consulting to international sporting bodies, World and Olympic champions, as well as healthcare providers and commercial businesses. He was Head of Sports Medicine at the Sports Institute Northern Ireland for 14 years before becoming a director of performance consultancy company Refine Performance Ltd in early 2017. Phil is particularly interested in understanding the factors that influence the development of mastery and effective performance in sporting and professional environments. Phil is also a visiting professor of the School of Sport at Ulster University and teaches on a number of postgraduate programmes at various UK and European universities.

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