## Introduction

Hip and groin pain provides a massive challenge for all those involved in the physical preparation and rehabilitation of athletes at all levels. Diagnostically, the region is puzzling due to the complex and overlapping nature of the anatomy, which is further compounded by the fact that there is a poor understanding of the adverse mechanics that predispose the athlete to injury in the first place. On top of this, the nature and significance of what may appear to be 'pathology' when assessed radiologically is still unclear. The end result is that the athlete often suffers from inappropriate diagnosis and poor management. Moreover, there is a lack of definitive rehabilitation guidelines and return to play criteria to guide efficient and successful injury management. This in turn leads to prolonged absence from participation and injury recurrence.

The aim of this chapter is to provide structure and guidelines in a number of areas:

i) The differential diagnosis of athletic hip and groin pain;

ii) The pathomechanics that predispose and drive pathology;

iii) The development of robust and comprehensive physical assessments to identify factors driving pain and pathology in the region;

iv) The development of an athlete back to optimal performance after hip and groin issues.

## The presenting problem

Both the incidence and prevalence of groin and hip injuries in sport have increased over the last decade, with the highest-risk sports being multidirectional field sports such as the various football codes, as well as ice hockey and tennis.[1,2] All these sports share common multidirectional movement demands and have seen large increases in the physical burdens of the game, as well as required training loads.[2,3]

Although acute injury to the hip and/or groin may occur, as a result of slipping or through direct contact, it is much more common for pathology in this region to have an insidious onset associated with a more chronic accumulation of load over time. The most commonly aggravating activities are high load movements, such as acceleration, deceleration, cutting and kicking, that are frequently involved in these sports. Pain may be located in one and often a combination of the following locations

- Low abdomen
- Inner groin
- Pubic region
- Lateral hip.

Typically, symptoms commence gradually and often ease during warm-up, only to become more severe following rest, especially upon rising from bed the following morning. The gradual onset means that athletes often continue to compete even though they are experiencing symptoms, and therefore the true prevalence of the problem may be underreported.

## Differential diagnosis

Making a definitive diagnosis in the hip and groin is complicated for a number of reasons:

i) The complex and overlapping anatomy with a number of structures that can produce symptoms in the same region, sometimes concurrently;

ii) The vast array of terms that are used to describe pain to the same structures;

iii) The level of 'pathology' in the region reported on MRI in asymptomatic athletes.

The key to navigating around all these obstacles, therefore, is to differentiate between the anatomical diagnosis and the biomechanical diagnosis. The anatomical diagnosis allows accurate identification of the symptomatic structure(s), and ensures the presentation is suitable for rehabilitation. The biomechanical diagnosis identifies movement and control deficits that are driving the athlete's symptoms. It is the biomechanical diagnosis that explains how there can be multiple painful structures in the one area concurrently.

It is important to realize that, for any one anatomical diagnosis, there can be many different biomechanical presentations. For example two athletes may have the same diagnosis (e.g. pubic bone oedema) but present very differently biomechanically. The question is therefore: 'Is the most efficient recovery achieved by prescribing a program for pubic bone oedema, or one that resolves the biomechanical deficits which are causing the pubic overload?'

### Anatomical diagnosis – identifying the victim

It is beyond the scope of this chapter to go into this area in detail, but the anatomy and diagnostic tests are covered in detail in many sports medicine textbooks. Care should be taken when interpreting 'diagnostic tests' in the region given the overlapping anatomy. For example the groin squeeze test will load the adductors but will also load iliopsoas, the pubic bone, the symphysis pubis and the rectus abdominus insertion. The three most commonly used positions are 0 o (longest lever), 45o (highest adductor load) and 90o (abdominal stability component as feet off the ground).[4] Similarly, pain presenting during flexion, adduction and internal rotation (FADIR) of the hip has been shown to be diagnostic of labral tear and hip impingement but is also painful with an irritable iliopsoas.[5] In fact, the absence rather than the presence of symptoms during these tests may be of greater relevance, as it clears the presence of any hip pathology.[5]

### Differential and synonymous diagnoses in the hip and groin

| Hip | Pubic | Adductor | Abdominal |
| --- | --- | --- | --- |
| Femoracetabular | | | |

impingement
Osteitis pubis Adductor tendinopathy Gilmore's groin
Labral tear Pubic bone stress Adductor cleft pain Sportsman's hernia
CAM lesion Pubic symphysis
instability
Anterior plate pain Posterior inguinal wall
insufficiency
Chondral lesion Athletic pubalgia Adductor enthesopathy Rectus abdominus
tendinopathy

Equally challenging is navigating through the vast array of labels that have been given to various pathologies and dysfunctions in the hip and groin region, much of which are synonymous and therefore tautological ( Table 23.1 ).

Previous literature has grouped anatomical diagnosis into hip joint, abdominal, adductor, pubic and iliopsoas groups to reduce some of the nomenclature uncertainty,6 and yet, despite this attempt, there is still confusion. How, for example, do you explain to an athlete that multiple different surgical procedures exist to treat a sportsman's hernia when there is actually no hernia present at all?

Appropriate anatomical diagnosis will identify the painful anatomical structure, the presence of pathology referring symptoms to the anterior pelvis and hip (for example lumbar spine), and indicate whether rehabilitation is appropriate for the presenting problem. For example symptoms emanating from the muscultendionus and osseous structures of the anterior pelvis and groin whose symptoms are modulated by load will be very responsive to rehabilitation.

The use of MRI in finding the victim

Whilst MRI can be of great use when targeting the 'victim', it does present us with the challenge of determining what are relevant and what are incidental findings in both symptomatic and asymptomatic athletes. Pubic bone stress has been shown to be highly prevalent in asymptomatic multidirectional field athletes;7 therefore, there is a high chance that should we go looking

for a problem we are likely to find one, even if it does not relate to the athlete's symptoms.
It is essential that MRI is used to confirm the anatomical diagnosis following a thorough clinical examination, as opposed to simply using the scan as the main diagnostic tool.

Table 23.1

Differential and synonymous diagnoses in the hip and groin

Hip Pubic Adductor Abdominal

Femoracetabular

impingement

Osteitis pubis Adductor tendinopathy Gilmore's groin

Labral tear Pubic bone stress Adductor cleft pain Sportsman's hernia

CAM lesion Pubic symphysis

instability

Anterior plate pain Posterior inguinal wall

insuffi ciency

Chondral lesion Athletic pubalgia Adductor enthesopathy Rectus abdominus

tendinopathy

## Using MRI to diagnose impingement

The greatest diagnostic challenge surrounding the relevance of 'pathology' on MRI is at the hip joint, especially in relation to femoroacetabular impingement (FAI). FAI refers to a dynamic abutment of the femoral head in the acetabulum and often involves a subset of



morphological changes in hip known as CAM and pincer lesions. 8 CAM lesions refer to changes in the amount of clearance between the femoral head and neck due to an osseous bump on the femoral neck (Ganz lesion). Pincer lesions, on the other hand, refer to an over-coverage of the acetabulum-restricting free passage of the femoral head in the acetabulum. These morphological variants can commence development through adolescence, and their presence means that the athlete has little margin for error in their hip control and high-speed mechanics before impingement occurs.

Care must be taken prior to rushing in to intervene on the basis of these anatomical variants, however, as they have a high prevalence in asymptomatic athletic populations.9 Indeed, neither CAM nor pincer lesions are diagnoses per se, rather descriptions of hip morphology. Whether or not these lesions lead to impingement cannot be diagnosed by a static image, since impingement is dynamic in nature. Bone oedema on the femoral neck, acetabular rim and labral tears are suggestive of the consequences of dynamic impingement, but these are not always present.

Structural and dynamic impingement

What we should move to, therefore, is an appreciation that there are effectively two forms of impingement: structural and dynamic. Structural impingement occurs as a result of the altered hip morphology, especially CAM or pincer lesions. Dynamic impingement occurs when there is a failure to maintain control of head of the femur in the acetabulum or avoid end-range articulation during movement. Think of it this way: structural impingement is the truck being too high to pass under the bridge (or the bridge being too low for the truck), whereas dynamic impingement occurs when there is faulty driving leading to the truck clipping the walls of the bridge.

It is important to note that one can lead to the other. Take, for example, the hip joint of an athlete who, through heavy resistance training and poor single-leg control during cutting, running and landing, drives his hip into end-range flexion, adduction and internal rotation repeatedly (dynamic impingement). The body lays down extra bone in response to this load (osteophytes/ CAM lesion), which reduces the clearance of the femoral head, leading to further abutment (structural impingement). Rehabilitation and restoration of dynamic hip control is key to resolving hip symptoms while minimizing the further development of structural impingement.

Failure to correct dynamic impingement results in increasing hip morphological changes, and as a result, earlier and worsening impingement over time, thus reducing the athlete's 'room for error'. Moreover, surgical intervention to 'correct' this CAM lesion by removing it is unlikely to be successful if the dynamic impingement is not corrected, as the bony stress will reoccur and the CAM lesion will reform.

## Biomechanical assessment of hip and groin – identifying the culprit

Athletic groin pain and hip injury are driven by insufficient control of multi-joint, multiplanar athletic movement. Indeed, for every anatomical diagnosis there can be multiple different biomechanical diagnoses. It is essential to identify all the factors contributing to the athlete's overload and to individualise our management plans based on these specific issues for the most



successful and efficient rehabilitation. Optimal performance in the region requires appropriate function of the supporting hip and pelvic musculature to balance load transfer around the hip and pelvis while optimizing multiplanar control throughout the kinetic chain during high-speed multidirectional movement. This keeps the hip and pelvis in relatively neutral positions, especially in the frontal and transverse planes, for optimal loading of the articular and musculoskeletal structures (i.e. avoid excessive pelvic drop, hip abduction/trunk sway).

3D motion capture is the gold standard when analysing high-speed sporting movements.

The testing protocol should provide a progressive neuromuscular challenge looking at all aggravating activities, including, jumping, landing, changes of direction (planned and reactive) and kicking. Assessing these sports-specific movements and understanding their link to injury and performance is key to successful outcome. Furthermore, analysing the entire kinetic chain during these tasks will help shed light on the forces, moments and torques placed on the muscultendinous structures and joints around the hip and pelvis.

Take cutting, for example, where athletes often display aberrant movement patterns that increase shearing forces within the hip joint and overload of the musculotendious structures.

An increase in trunk sway and rotation away from the direction of intended travel during stance phase has loading implications for the lateral ankle, knee, hip and spine. In particular, it can lead to increased loading toward end-range hip abduction, altered positioning of the resultant hip vector through the acetabulum and a high eccentric load through the adductors and abdominals. These patterns of kinetic linkage when cutting, jumping and landing are outlined in Table 23.2, along with the influence they have on the hip and supporting muscles.

Table 23.2 Kinetic linkage deficits during jumping, cutting and landing

Hip Musculotendinous

Trunk-on-pelvis Increased hip and trunk

flexion

Anterior impingement &

pubic bone overload

–

Increased trunk sway Lateral impingement Adductor longus overload

Increased trunk rotation – Rectus abominus and hip

fl exor overload

Pelvis-on-hip Excess pelvic tilt Anterior impingement &

pubic bone overload

Rectus abdominus &

adductor longus overload

Hip internal rotation/

pelvic rotation

Antero-superior

impingement & pubic

bone overload

Adductor longus overload

Pelvic drop/hip

adduction

Anterio-superior

impingement & pubic

bone overload

Adductor longus overload

Knee Valgus/abduction Anterio-superior

impingement & pubic

bone overload

Adductor longus overload

Flexion Increased hip & pubic

loading

–

Ankle Excessive DF Increased hip & pubic

loading

–

Foot External rotation

relative to pelvis

Lateral impingement Increased adductor loading



Of course, not everyone will have access to a 3D biomechanics laboratory, but that does not mean that these movements should not be assessed with high-definition cameras, which are more readily available. Although accurate measurement, individual joint loads and multiplanar observation will not be possible, moderate to gross deficiencies should be detectable.

Components of rehabilitation

Once a comprehensive assessment has been carried out, an individualized program can be devised to guide an athlete back to optimal performance. Each program is specific to the athlete's biomechanical deficits, not their anatomical diagnosis and should be phase-based and progressive in design ( Figure 23.1 ).

Whilst it is not imperative that each level of the programme is completed in its entirety before progressing to the next phase, it is important to realize that optimal performance at one level is not possible without competence at a previous level (for example modifying the deleterious influence of poor/uncontrolled lordotic/kyphotic posture on running biomechanics).

A key point during retraining is to ensure all exercises are carried out in the absence of pain. It makes little sense to further stress a joint or musculotendinous structure that is already being overloaded. This does not mean, however, that we should simply provide the athlete with analgesic medications prior to rehabilitation, since pain is often the best guide to the quality of the exercises being carried out. For this reason steroid injection in the region may hinder the process as much as help it, as time is often lost due to post-injection soreness that is better used with rehabilitation and symptom reduction may falsely reflect athlete progress.

Hip Range

of Motion

Level 1

Posture/

Lumbopelvic

Control

Hip Stability

Strategies

Kinetic Chain

Strength

Level 2

Hip and Groin Biomechanical Performance

Rate of Moment

Production

and Absorption

Sports Specific

Conditioning

Linear

Performance

Level 3

Upper Limb

Propulsion

Level 4

Sports

Specific Skill

Application

Multidirectional

Performance

Figure 23.1 Hip and Groin Biomechanical Performance components



It is also essential to review the key outcome measures (hip range, pain provocation, posture, neuromuscular control) at the end of every session. Appropriate exercise selection and execution will ensure that they have been progressed during every session.

Pain provocation tests provide information regarding the irritability of the athlete’s symptoms, efficacy of rehabilitation and readiness to progress to higher load training. The cross-over test is carried out in the Thomas test position. If resisted hip flexion on the lower leg reproduces symptoms on the opposite side, it reflects a high level of irritability. The squeeze test is also useful at assessing load tolerance across the anterior pelvic ring. It can be carried out at 0°, 45° and 90°. Using a pressure cuff can identify the load at the onset of symptoms and the maximum pressure that can be exerted. Effective exercise prescription should see improvements in squeeze test at the end of every rehabilitation session.

Level 1

Posture/lumbo-pelvic control

Postural control is a key foundation area that is often overlooked during rehabilitation. Restoration of neutral posture is achieved through exercise selection and postural advice. Increased anterior tilt dramatically reduces hip flexion/adduction/internal rotation range of movement, resulting in hip impingement earlier in range.10

Compound movements that challenge the athlete's ability to maintain lumbo-pelvic neu-tral while avoiding aberrant bracing are extremely effective with improving postural control. Deadlifts are useful in this regard, as are 'goblet' squats and split lunges. These are low-load patterning exercises and should be carried out daily, if possible. It is important to improve thoracic extension concurrently and be wary of driving into anterior pelvic tilt during upper body strength training.

Hip range of motion

Loss of hip range of motion, especially internal hip rotation, is a well-established risk factor for athletic groin pain. Reduction in hip range has also been strongly associated with both athletic groin pain and hip changes.11 , 12 This loss of range can be due to:

i) Hip morphological changes (un-modifiable)

ii) Hip capsular restriction (modifiable)

iii) Muscular restriction (modifiable).

When assessing hip range it is important to differentiate between the various drivers of loss of range:

i) Thomas test – hip extension – primarily restricted by iliopsoas

ii) Internal rotation at 90o flexion in supine – primarily restricted by gluteus maximus

iii) External Rotation at 90 o flexion in supine – primarily restricted by joint capsule

iv) Internal rotation at 0 o in prone – primarily restricted by joint capsule and the small external rotators

v) External Rotation at 0 o in prone – primarily restricted by TFL/gluteus minimus.



Capsular restrictions can be improved with mobilisations with band assistance to improve hip glide. Generally speaking, hip flexion and medial rotation restrictions are improved with a posterior glide, and extension and lateral rotation are improved with an anterior glide. Mobilisations should be fluid movements (i.e. without pause) and carried out with high rep ranges (>20) every day. Those athletes who have undergone surgery or have marked hip joint changes should carry out these mobilisations before every session, since the persistent low-grade synovial reaction in the joint, as well as the associated capsular changes, mean they will always have to work to maintain range.

A loss of hip range of motion, especially hip rotation at 90o flexion, is commonly a result of muscle imbalance around the hip joint. Restoration of optimal hip range is an essential component to restoring normal biomechanical loading to the region. While soft tissue massage, foam rolling and dry needling may all temporarily increase range around the joint that has been lost due to muscular tone, this range will not be retained unless the control deficits highlighted above are identified and rectified concurrently.

Identifying drivers of hip range-of-motion loss and efficient restoration is key to successful rehabilitation of hip and groin pain.

## Hip stability strategies

Dynamic control around the hip and pelvis is a balancing act between torque-producing muscles and stabilizing muscles, as well as between agonists and antagonist muscle groups. This balance is lost when athletes develop patterns of movement that preferentially recruit torque-producing muscles to stabilize, or when previous injury or posture leads to reduced function in stabilizing muscles, with the torque-producing muscles taking up the slack. This leads to two eventual consequences – loss of dynamic stability around the hip and resultant joint impingement OR excessive load through the torque-producing muscles resulting in overload, usually at the musculotendinous junction, tendon or, most commonly, at the attachment site on the pelvis. The high prevalence of concurrent hip and musculotendionous pathology suggests both actions happen simultaneously.13 There are a number of key muscles around the hip whose function is essential for optimal hip control.

## Iliopsoas

Iliopsoas is a vital stabilizer of the anterior hip joint, as well as a flexor of the hip due to its capsular attachment and anatomy.14 Dysfunction of iliopsoas can lead to hip impingement if it is unable to stabilize the anterior hip against a tight posterior capsule or the pull of tensor fascia lata (TFL) or rectus femoris, as well as the drive of the posterior hip muscles. It also leads to excessive load through the anterior joint towards end-range extension.14 Concurrently, it may result in rectus femoris, as well as TFL overload, as they try to accommodate a poorly functioning agonist.

Iliopsoas is best isolated in inner-range hip flexion to avoid over-activity of TFL and rectus femoris and is best assessed in supine with the hip in inner range flexion. Isometric holds can be started in supine but quickly progressed to standing with the addition of resistance as



tolerated. If carried out appropriately, it is key to feel the hip flexor working through the inguinal crease, as opposed to over-activity in TFL laterally or rectus femoris in the upper thigh.

## Gluteus medius/minimus

Gluteus minimus and gluteus medius are important stabilisers of the lateral hip through their deep and capsular attachments.15 Poor function leads to an inability to stabilize the hip to counter the superior pull of upper gluteus maximus and TFL driving lateral hip impingement (similar to the deltoid and the rotator cuff in the shoulder). They also provide antagonistic stability in single-leg stance to hip adduction and internal rotation which, if absent, leads to overactivity and bias towards the adductors.

Gluteus medius and minimus work optimally in closed chain positions during inner range abduction, where they have a mechanical advantage over TFL and upper gluteus maximus.16 Hip hitching is a highly effective exercise at achieving this. Gluteus medius (posterior) also works as an external rotator and this can be combined with abduction in lateral band marching drills.

Obliques

External and internal oblique have both anti-tilt and anti-rotation functions, and therefore optimal performance is carried out isometrically. They are often overpowered by rectus abdominus, which is primarily a flexor of the thorax, as it tries to provide stability against pelvic tilt and trunk rotation, which it does not have the mechanical advantage to do. The result is excessive tone and traction at its insertion to pubic symphysis. Exercise strategies should challenge neutral lumbopelvic position while avoiding bracing strategies. Pallof presses, chops and lifts are very useful in this regard.

Groin pain during 'core' exercises is commonly reported and is a reflection of inappropriate exercise selection and execution. Planks are regularly prescribed in supine and side-lying with the athlete collapsing into anterior pelvic tilt, thoracic kyphosis and bracing rectus abdominus, driving ongoing irritation of symptoms and providing no improvement in abdominal control.

Adductors

The adductors are important stabilisers of the pelvis on the hip joint, especially during single leg stance activities. Adductor strengthening is often prescribed and infrequently required in athletic groin pain athletes. In general, the adductors tend towards hypertonicity, and additional strengthening of overactive/painful muscles is counterproductive. Overload is often driven by poor trunk-on-pelvis and pelvis-on-hip linkage, most commonly during cutting, when there is a high eccentric load through the adductors when swaying into hip abduction. Apparent strength deficits are often the result of pain inhibition, rather than actual weakness with adductor strengthening only further aggravating symptoms. However, if there is residual weakness on strength testing once symptoms have been resolved, this should be addressed through closed-chain exercises that replicate their stabilizing role.



Normalising control and tone in the muscles around the hip and pelvis is key for optimizing hip stability and available hip range. There is a high emphasis on the quality of these accessory exercises over quantity but they can be carried out in higher rep ranges (>12 reps; 2–4 sets) 4–5 days per week.

### Level 2

#### Kinetic-chain strength

Given the often long-standing nature of symptoms in the region, strength deficits may not be the initial driver of pain in the region but may develop subsequently as a result of pain inhibition and altered movement patterns. Given that the majority of groin presentations are unilateral, this should be reflected in assessment using unilateral leg press or single-leg squat to assess limb strength.

Figure 23.2 Lateral sled pulls

Whilst there is often a reluctance to prescribe unilateral exercises for athletes with hip, pelvic or groin symptoms, they are, in fact, good to employ from day one. Contrary to popular thought, there is no pubic shear, only excessive musculotendinous traction, when exercises are poorly executed (except in the rarest of post-partum cases).

It is vital to strengthen the entire chain in multiple planes of movement. Despite the fact that these athletes perform in predominantly multidirectional environments, strength training is often limited to the sagittal plane (squats, deadlifts, land lunges).

Lateral sled pulls provide an excellent stimulus in the frontal plane and incorporate all components of the upper limb, trunk and lower limb ( Figure 23.2 ). The dosage prescribed



will depend on the athlete's training history, degree of atrophy and where they are in the season. However most unilateral exercises would fall under accessory exercises, and rep ranges of 6–12 or so three times a week will achieve appropriate stimulus.

## Rate of moment production and absorption

The key characteristic in most field sports is the rate at which muscular force is developed. It is critical to be able to identify any side-to-side differences in this quality, as well as deficits compared to baselines. Bilateral assessments are useful, but given the mostly unilateral nature of hip and groin issues, it is also important to examine single-leg force generation qualities. Total force production can be assessed by employing a countermovement jump, while assessing individual joint moments is also useful. Wherever possible, this should be combined with motion analysis to examine for any side-to-side kinematic differences in either force generation or absorption.

Power development should focus on unilateral deficits and begin to resemble the motor patterns they are going to be used for on the field of play. Explosive lunge step-ups re-enforce triple extension patterns utilized in acceleration mechanics, while medball lateral bounds reproduce the explosive frontal plane moments required for multidirectional mechanics. As with all power exercises, they should be carried out with lower rep ranges (< 5), higher recovery times with an emphasis on maximum effort and excellent technique 2–3 times per week.

## The importance of load transfer

Whilst important, a reduction in force production is not the most fundamental factor predisposing an individual to hip and groin problems. We must also examine the athlete's ability to transfer this force efficiently. Rate of moment absorption refers to the body's ability to absorb and transfer load as efficiently as possible, improving athletic performance but also minimizing excessive loading of musculotendinous structures. This is often referred to as limb stiffness or reactive strength, and utilises the stretch-shortening cycle (SSC). It can be measured using single-leg drop jumps and calculating the reactive strength index, and is also readily visible qualitatively when looking at running mechanics in the frontal plane. This key attribute is often neglected in rehabilitation and performance programmes in preference for strength and concentric power development.

Low-load SSC exercises can be commenced very early on in rehabilitation and are vital for efficient energy transfer. Many athletes will not have the training history or competency to commence drop jumps during rehabilitation. Single-leg cone hopping can be used in multiple planes to improve 'stiffness' across the lower limb, and introducing overhead arm position can also influence trunk stiffness very effectively. These can be progressed to lateral bounding drills and drop jumps as competency and symptoms allow. The key with these exercises is to minimize the ground contact time by emphasizing good tempo and minimal light ground contact time. Higher repetitions are recommended for the low load plyometric drills, again with an emphasis on excellent technique, 2–3 times per week.

Sports-specific conditioning

Fatigue has a negative influence on athletic performance and neuromuscular control and also increases injury risk. 17 , 18 Many athletes with hip and groin issues may have had modified



training loads in order to keep going during the season or may have had a long period off trying to resolve the problem and have become deconditioned during this process. Off-feet conditioning can reduce this deconditioning without aggravating symptoms until running is tolerated. Symptom irritability may compromise cross-training choice in the early phases of rehabilitation, but bike work, ropes and swimming are usually well tolerated. Once high-speed running is tolerated, on-feet conditioning can be re-introduced.

Level 3

Bridging the gap from the gym to the field is often poorly addressed or completely neglected during rehabilitation. Improving on-field mechanics is hugely beneficial for both performance and injury prevention.

Linear running performance

Linear running is the most common mode of transport on the field of play and therefore plays an essential role in athletic performance and loading of the hip and anterior pelvis. Too often, rehabilitation focuses on static drilling and progressive exposure to running volumes and speed tasks without reviewing and developing linear running performance.

The main deficits that contribute to overload of the hip and groin and reduce performance are:

i) Poor swing-leg recovery – leads to reduced hip fl exor recruitment and over-striding;

ii) Prolonged ground contact time – leads to increased joint load and increased musculotendinous load through reduced stretch-shortening efficiency;

iii) Over-striding – increased anterior hip load in end-range extension and altered loading of the acetabulum through heel striking in front of the centre of mass;

iv) Pelvic drop/trunk sway – increases hip joint load as well as the demands on hip adductors and abdominals;

v) Excessive trunk rotation – unstable base for leg drive leading to excessive abdominal loading.

Developing drills that challenge neutral lumbopelvic control and optimal swing leg recovery are critical features in optimizing linear running mechanics. The best drills allow the optimal patterns to emerge with minimal coaching. Skipping, barbell running and sled running are highly effective drills and encourage the athlete to improve running posture, leg mechanics and ground contact times. These exercises should be carried out on alternate days during early rehabilitation and as part of every field session warm-up.

Multidirectional performance

Critical to improving multidirectional mechanics is addressing the neuromuscular control deficits that optimize biomechanical performance in conjunction with reactive or decision making stimuli to replicate sports-specific demands for optimal efficiency upon returning to the field of play. Step drills with bungees and side-to-side shuffle drills with medicine balls both work on optimizing foot placement, body positioning, explosive push off and trunk



stiffness (Figure 23.3). These drills should be progressed to incorporate a reactive component using external stimulus (shadowing) or sports-specific stimulus (passing).

Upper body propulsion

Upper body throwing or swinging patterns should reflect the dominant patterns displayed in the sport. For example a slap shot in hockey, baseball throw and golf swing can all be replicated explosively with medball drills in various positions while adding in external stimulus and perturbations to challenge the pattern of movement.

Level 4

Sports-specific skill development

Injury risk and performance decrement can be influenced by technical deficiencies in sports-specific tasks (i.e. tennis serve, throwing technique, kicking mechanics). 3D biomechanics can be used to assess and modify these complex movement patterns, but appropriate intervention requires appropriately qualified and experienced coaches, which is often beyond the scope of

Figure 23.3 Bungee lateral step drill



practice of an individual physiotherapist or strength and conditioning coaches, and like all interventions, a multi-disciplinary approach works best.

Return to training/competition

It is important that both the player and the team management understand that a graduated increase in training load from this point is essential to continue the most efficient recovery.

Key outcome measures – hip range and pain provocation tests, especially the morning after a session, will indicate how well an athlete is tolerating the training load.

An appropriate guide to progression is:

i) Commence linear running volume when the athlete demonstrates pain-free crossover test and symmetrical internal hip rotation at 90o of hip flexion;

ii) Commence multidirectional running volume when the athlete has pain-free squeeze at 45 o, symmetrical and appropriate local hip control, pain-free at top sprint speed (low volume);

iii) Commence team training when the athlete demonstrates symmetrical and efficient multidirectional mechanics and pain-free squeeze at 0o, 45o and 90o.

The general rule of thumb is that a player is clear to return to competition once they are able to demonstrate both full confidence and competence with all the demands that the sport places on them. Every movement demand should have been tested during training under fatigued conditions and the athlete should have demonstrated that they have regained full strength, power, speed, stiffness and endurance. Obviously, the longer the athlete has been away from competition the longer they will take to gain full confidence, and so they may require a number of weeks of full training before being considered fully recovered. A more detailed analysis of this decision making process can be found in chapter 18.

## Summary

The pathomechanics, and therefore the rehabilitation, from hip and groin pain in athletes is highly individual. Key to understanding this is differentiating between the anatomical diagnosis and the biomechanical diagnosis, and appreciating that for any one given anatomical diagnosis there are multiple biomechanical presentations. Rehabilitation must therefore address all the factors driving pain and place a high focus on assessing the athlete during high-speed multiplanar movements and optimizing these mechanics. The focus should be on returning the athlete to optimum performance, not only to reduce the risk of re-injury, but also to allow them to hit the ground running on return from injury. Finally, we should be aware of the external factors that contribute to pain and overload in the region and be able to modify them as required to minimize injury risk.

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