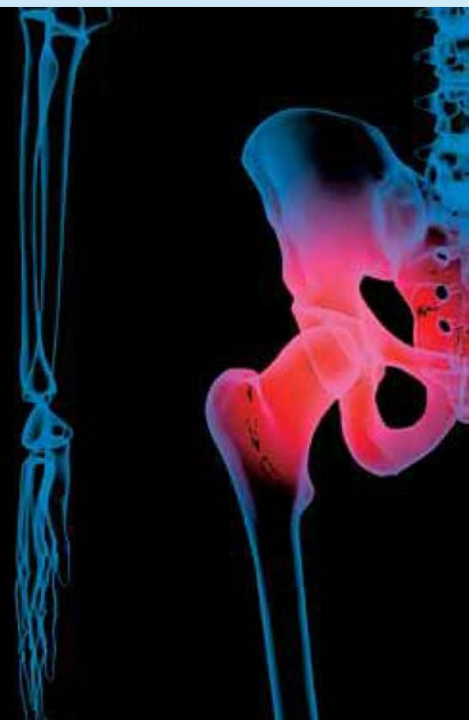


# LATERAL HIP PAIN

This article provides a review of the common diagnoses of lateral hip and ITB pain and rehabilitation techniques with reference to the anatomical structures involved.



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## COMMON DIAGNOSES

Pain over the lateral aspect of the hip around the greater trochanter (GT) is a common clinical occurrence, with incidence in industrialised societies being put as high as 25% of the population (1). Typical titles in the literature include iliotibial band syndrome (ITBS), external snapping hip, gluteus medius tendinopathy, greater trochanteric pain syndrome (GTPS) and trochanteric bursitis. These diagnoses broadly represent pathology to the same structures and may occur separately or in association with femoroacetabular impingement (FAI), degenerative changes to the joint, and labral pathology, all of which may change the quality of movement at the hip and alter muscle function. This can give

rise to primary pain anteriorly and secondary pain laterally. Low back conditions may also refer into the lateral thigh so screening tests should rule out the low back as a cause of pain. Compression of the lateral cutaneous nerve of the thigh (meralgia paraesthetica) close to the attachment of the inguinal ligament into the anterior superior iliac spine (ASIS) can refer pain into the lateral thigh. Impact to this area in sport (hip pointer) presenting as altered sensation warrants further investigation. To understand lateral hip pain and treat it successfully we need to examine the structure and function of the area.

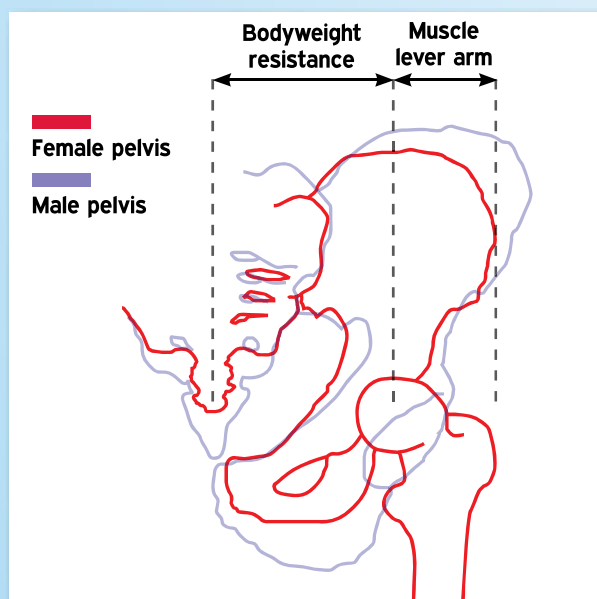
## APPLIED ANATOMY

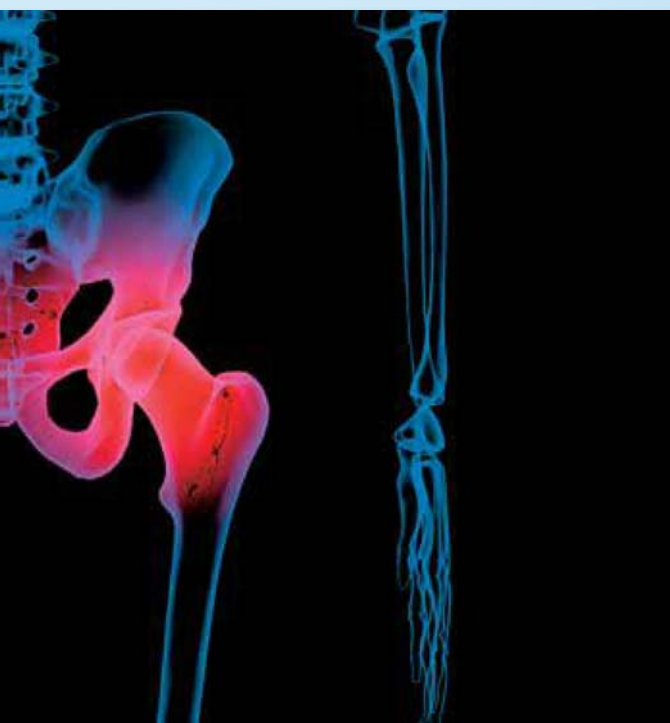
### Hip joint

Alignment of the pelvis on the femur (femoropelvic alignment) in the frontal plane during single-leg stance is maintained by an equilibrium between the compression forces created by weight-bearing activities, and those of the lateral hip structures. The body weight acts on a resistance arm from the gravity line passing through the centre of the sacrum to the hip joint axis. This is countered by muscle force acting on a lever from the lateral hip musculature to the hip joint axis.

This set-up subjects the hip joint to considerable forces when weight-bearing. In single-leg standing, hip joint forces between 1.8–3.0 times body weight occur; while in walking these increase to 3.3–5.5 times body weight (2). The femoral head is smaller in females while the pelvis is wider. The resistance arm from the body's line of gravity to the pelvis is therefore larger in the female (Fig. 1) while the lever arm from the lateral musculature to the centre of the hip joint is smaller. The combination of these two features significantly reduces the mechanical advantage of the abductor muscles. With a lower mechanical advantage the muscles must work harder to maintain femoropelvic alignment, and this increased muscle work acting over a smaller head size results in

**Figure 1: Effect of pelvic width on resistance acting over the hip. Leverage generated by bodyweight is greater than that produced through the laterally placed hip muscles.**





greater femoral head pressures in females (3). In addition, the incidence of GTPS is four times greater in females than males (1).

### Lateral musculature

The lateral muscles are arranged in three layers (Table 1) and function to control the femoral head within the acetabulum and/or to control the pelvis on the femur. Joint stability is better produced by those muscles lying close to the axis of rotation of the joint (4). Shearing (translation) force on the femoral head is therefore reduced by the deep lateral rotators (obturator externus, gemelli, quadratus femoris), gluteus minimus, iliacus and iliocapsularis. The iliacus muscle consists of two sets of fibres with the lateral portion more active in torque production and the medial (deep) fibres being linked to stability. The iliocapsularis (also called iliacus minor) lies beneath the rectus femoris and attaches directly to the joint capsule. It functions to tighten the joint capsule and has been shown to hypertrophy and have less fatty infiltration in cases of hip dysplasia (5,6). Failure to control translation of the head of the femur especially in an anterior direction (anterior laxity and posterior tightness) may increase the risk of FAI particularly where an underlying bony anomaly (joint dysplasia) exists.

The gluteus medius has three distinct fascial layers (7) each with a separate nerve supply. The anterior and posterior portions lie deep to the middle portion. Although the gluteus medius is often considered the primary hip stabiliser and targeted by clam shell type actions, physiologically it is unable to stabilise the pelvis on the femur in single-leg standing by itself. It has been calculated (8) that the abduction forces responsible for this are divided between the gluteus medius (70%) and the muscles attaching to the ITB (30%). The upper portion of gluteus maximus (see below) and the tensor fascia lata (TFL) both attach into the ITB and

**TABLE 1: MUSCLE LAYERS OF THE LATERAL HIP**

Layer	Muscles	Function
1. Deep	Gluteus minimus	<ul style="list-style-type: none"> <li>Primary stabiliser functioning to control femoral head within acetabulum</li> <li>Proprioceptive role</li> </ul>
2. Intermediate	Gluteus medius, piriformis	<ul style="list-style-type: none"> <li>Significant torque producers</li> <li>Secondary stabiliser</li> <li>Low load control of pelvis on femur</li> </ul>
3. Superficial	Tenor fascia lata (TFL), gluteus maximus, vastus lateralis	<ul style="list-style-type: none"> <li>Primary torque producers</li> <li>High load control of pelvis on femur</li> </ul>

the vastus lateralis may also be considered through its fascial attachment (9).

Of the hip lateral rotator group the quadratus femoris (QF) has been shown to demonstrate the greatest differential atrophy with prolonged bed-rest. In the 2nd Berlin bed-rest study for example, the QF was shown to lose 9.8% volume after 28 days and 18.1% volume after 56 days of head-down tilt bed-rest (10). The gluteus medius reduced its volume by only 3.7% and no change was seen in the obturators or piriformis muscles.

The lateral muscles are separated from each other and underlying structures by four main bursae (Table 2) each with deep, superficial and/or secondary portions. In total synovial lined bursae around the GT have been found at ten different locations on dissection (11).

### Iliotibial band

The deep fascia of the lower limb is collectively called the fascia lata. It attaches to the outer lip of the iliac crest along its full length, and throws branches to the sacrotuberous ligament, the ischial tuberosity, and the pubis, effectively surrounding the upper thigh. On the lateral aspect of the thigh, this fascia is thickened into two distinct layers forming a non-elastic collagen cord, the iliotibial band (ITB).

The gluteus maximus and gluteus medius muscles insert into the ITB posteriorly and the TFL muscle inserts anteriorly. Some of the TFL fibres travel one third of the way down the ITB.

As the ITB travels down the lateral side of the thigh its deep fibres form inwardly directed sheets which attach to the linea aspera of the femur, forming the medial and lateral intermuscular septa. The superficial fibres of the ITB continue

**TABLE 2: BURSAE AROUND THE GREATER TROCHANTER (GT)\***

Name of bursa	Position relative to GT	Approximate size (cm <sup>2</sup> )
Gluteus maximus	Lateral	10–15
Gluteofemoral	Caudal	10–15
Gluteus medius	Anterior to apex	1.0–1.7
Gluteus minimus	Anterolateral	2.7–4.4

\*Data modified from Woodley et al., 2008 (26) and Williams and Cohen, 2009 (2)



# “TO UNDERSTAND LATERAL HIP PAIN AND TREAT IT SUCCESSFULLY WE NEED TO EXAMINE THE STRUCTURE AND FUNCTION OF THE AREA”



**Figure 2:** The Trendelenburg test is often used in the clinic to assess control of the pelvis on the femur in single-leg standing, so is perhaps the most relevant test to lateral hip pain. With a positive test, as body weight is taken through one leg, the pelvis dips downwards away from the weight-bearing leg.



**Figure 3:** A compensated positive result occurs if the body is tilted (side flexed) towards the weight-bearing leg.



**Figure 4:** A further modification of the test is to ask the client to elevate the non-weight-bearing side of the pelvis.

downwards to attach to the lateral femoral condyle, lateral patellar retinaculum and anterolateral aspect of the tibial condyle (Gerdy's tubercle). A large amount of the lateral retinaculum of the patella actually arises from the ITB to form the iliopatellar band (12) having a direct effect on patellar tracking.

In standing, the ITB lies posterior to the hip axis and anterior to the knee axis and therefore helps to maintain hip and knee extension, reducing the muscle work required to sustain an upright stance. In running, during the swing phase the ITB lies anterior to the GT and hip flexion/extension axis, reducing the workload required for hip flexion.

The contraction of the gluteus medius and the TFL is transmitted by the ITB to control and decelerate adduction of the thigh (13). Where the gluteus medius shows poor endurance and control, gait alteration may occur leading to lateral pain. In a study of distance runners (14 male, 10 female) with ITBS significant weakness of the gluteus medius was found on the symptomatic side. Strengthening the muscle over a 6-week period resulted in 92% of the runners being pain free (14).

Muscle balance tests for the lower limb (4,15) often show a reduction in abduction endurance by the gluteus medius and compensation by over activity of the tightening of the TFL-ITB. Although both the gluteus medius and the TFL are able to abduct the femur, the TFL will also medially rotate the hip while the postural posterior portion of the gluteus medius is a lateral rotator (16). As a consequence, dependence on the TFL alone for abduction power during gait causes excessive medial rotation and adduction of the hip increasing the valgus stress on the limb and therefore increasing passive tension in the ITB

## MOVEMENT DYSFUNCTION

### Association with joint degeneration

Studies on subjects with hip joint degeneration have shown a functional division of the gluteus maximus into upper and lower portions (17) with the upper fibres (UGM) grouped with the TFL as superficial abductors as the 'deltoid of the hip'. These muscles maintain their size when the joint degenerates in contrast to the lower portion of the gluteus maximus (LGM) which can be categorised as a hip extensor and shows significant atrophy. Average values of a 19.7% smaller cross sectional area were recorded. Although both sections of the gluteus maximus are external rotators, the UGM has a primary abduction function while the LGM has a primary extension function.

The gluteus medius and piriformis muscles both show a reduction in cross sectional area in subjects with advanced joint degeneration. While the gluteus medius appears to atrophy in subjects with advanced pathology, those with mild degenerative changes show hypertrophy with average values of a 16% increase (18).

### Trendelenburg test

The Trendelenburg test is often used in the clinic to assess control of the pelvis on the femur in single-leg standing, so is perhaps the most relevant test to lateral hip pain. With a positive test, as body weight is taken through one leg, the

pelvis dips downwards away from the weight-bearing leg (Fig. 2). This is known clinically as an uncompensated positive result. A compensated positive result occurs if the body is tilted (side flexed) towards the weight-bearing leg (Fig. 3). A further modification of the test is to ask the client to elevate the non-weight-bearing side of the pelvis (Fig. 4) and to hold this position for 30 seconds. This modification assesses the postural endurance of the lateral hip muscles. The test is positive if the client is unable to maximally elevate the pelvis or maintain the elevation for the 30 seconds (19). The test can be refined by using goniometry to measure the pelvic to femur angle taking a line horizontally across the ASIS and vertically down the shaft of the femur. Changes in the pelvic–femur angle can occur if the hips dips downwards (lateral pelvic tilt) or moves horizontally to the side (lateral pelvic shift). Normal values of 5° increase in hip adduction have been reported when moving from double to single-leg standing (20).

The Trendelenburg test is not muscle-specific but it does give information about the clients self-selected movement pattern which will be influenced by factors such as pain, habit and energy expenditure as well as muscle performance. Where subjects habitually hang on the hip (single-leg dominant swayback posture) the hip abductors muscles will lengthen. The shift in to length–tension curve which occurs with posturally lengthened muscles [see Norris, 2011 (15) for further details] means that the muscle is effectively stronger in its lengthened position (peak torque at greater joint angle). As a consequence the Trendelenburg test will likely see a greater angle of hip adduction in those who demonstrate a swayback posture and favour one leg. Interestingly, in cases of hip joint degeneration peak acetabular loading occurs at maximum gluteus medius activity rather than at peak ground reaction force, so lateral trunk movement (also called Duchenne limping) has been proposed as an offloading strategy to minimise muscle contraction (21). Optimisation of the Trendelenburg test in the clinic has been proposed (19) with actions shown in Table 3.

### Strength tests

Strength tests of isolated hip abduction are often used to determine muscular function of the abductor muscles (isometric using a hand held myometer). Whilst isometric testing is reliable (22), it is common for muscle synergy to change while power of abduction remains the same. In the case of hip abduction, reduced action of the gluteus medius may be accompanied by increased action of the TFL resulting in no measurable change to isometric muscle power. Failure to maintain optimal frontal plane alignment when performing a single-leg abduction action in side lying has also been used as a predictor of low back pain in prolonged standing activities within an occupational health environment (23).

## REHABILITATION

### Treatment aims and planning

Rehabilitation aims to redress the movement dysfunction which may be considered as a major factor in the development of lateral hip pain. Initially our treatment aim is

**TABLE 3: OPTIMISATION OF THE TRENDLENBURG TEST IN THE CLINIC**

- Non-weight-bearing leg held in 0°–30° flexion
- Arms across the chest or against the body
- Quantify trunk translation in the frontal plane
  - measure movement of the sternal notch from the body midline (midpoint of ASIS).
- Ask subject to correct body-sway to assess compensatory mechanism(s)
  - Is correction painful (acetabular loading/tendinopathy/bursal compression)
  - Is correction not possible due to muscle condition (poor strength / inner range holding)
  - Is correction simple (habitual pattern).

[After Grimaldi, 2011 (19)]

to lengthen the tight lateral structures and begin building the endurance of the hip stabilising muscles. Next general hip and lumbo–pelvic alignment is enhanced with an emphasis on controlling the weight shift, especially during single-leg standing. Finally more sport-specific actions are used to build control of the hip in functional sports actions. Clinically there is much overlap between each rehab stage and the order of exercise application will be dictated by your client's symptoms.

Rehabilitation can focus on pain relief, lengthening tight tissues which restrict correct movement, re-training muscle which is underperforming (strength/endurance/power), and enhancing whole body and segmental alignment. Where pain is a dominant feature its relief is vital as it will have a significant effect on the quality of movement. In many cases trigger points within a tight muscle may be a dominant feature in the production of pain and so tightness is targeted in this case. Overload of tissues and/or joints can lead to inflammation and pain making posture the lead feature.

### TARGETING THE ITB

Often with lateral hip pain the ITB becomes the focus of attention. Stretching the ITB is a subject of considerable debate. As the band attaches directly to the femur via the intermuscular septa, lengthening it would seem impossible (24). However, clinically, patients with ITBS do respond to stretching exercises showing increased range of motion, reduced pain and an alteration in tissue tension to palpation. It is suggested therefore that the superficial portion has some independence from the deeper portions.

An effective ITB stretch must combine movement in three regions, the pelvis, hip, and knee. In order to stretch the ITB, hip adduction and extension on a fixed pelvis must be combined with knee extension. Justification for this joint positioning is that ITBS occurs when the gluteus medius shows poor endurance, and single-leg standing is supported by action of the TFL. This muscle is overworked and develops painful trigger points. To limit the pelvis tipping laterally, the muscle tone increases and the muscle 'shortens', or more accurately becomes overactive in its outer range. As the TFL is placed anteriorly, a position of hip extension will stretch it. The ITB passes over the knee to attach into the head of the fibula and lateral fascia covering the knee. This tissue is



placed on stretch when the knee is extended and tension is taken from it as the knee is flexed. Combining hip adduction-extension with knee extension will therefore optimally stretch the ITB. Stretch will however be taken off the fascia if false hip adduction is performed. This can occur in the side lying position (Fig. 5) if the pelvis tilts laterally allowing the ASIS to move caudally.

To perform an effective ITB stretch the pelvis must remain fixed. The Ober test position (25) is chosen in the first instance, with the affected leg uppermost. Initially the leg is abducted ( $45^{\circ}$  to the horizontal) and extended (10–15° behind the bodyline). The underside of the trunk is then pressed into the floor and kept in this position throughout the exercise. The upper leg is then lowered back towards the horizontal while maintaining the extended leg position. A useful visual cue is for the subject to look down towards their foot. If they can see their patella, the extension has been lost, if they cannot, the leg is extended and the view of the patella is blocked by the front of the pelvis. A tactile cue which may be used is to place a folded towel between the floor and the side of the body, just above the pelvis. The aim is to press down hard on the towel throughout the exercise.

The Ober stretch targets the whole of the ITB. However, where trigger points are present within the TFL–ITB, the tissue may be placed on stretch and a self massage technique employed. Now, the starting position is for the subject to lie on the back and to flex both the hip and knee of both legs. The unaffected leg is crossed over the affected one and the hip pulled into adduction. This places some stretch on the upper portion of the ITB and allows the subject to press into the painful area 15–25 cm below the GT. Where a painful trigger point is found, firm pressure should be applied and held for 30–40 seconds until the pain begins to subside. This form of self treatment, called 'ischaemic compression' is an accepted method of management an active trigger point (see 26).

### Working the lateral stabilising muscles

In parallel with stretching the TFL–ITB, the lateral stabilising muscles including gluteus medius muscle must be enhanced. Several authors have described lack of inner range holding to be the major dysfunction of this area (16,27). Here, the muscle is unable to hold the femur in a fully abducted (inner range) position over a prolonged period of time, normally up to 10 repetitions holding each for 10 seconds. To enhance this

ability the subject begins lying on the side with the affected leg uppermost, hip and knee flexed. Keeping the feet together, the aim is to lift the knee without allowing any trunk rotation. Many subjects with ITBS find this end position of the exercise difficult to achieve. In this case, a training partner is used to lift the leg into position and the subject tries to slowly lower the leg back to the starting position (eccentric control). Once this can be performed in a controlled fashion for 5 repetitions, the subject should begin the movement by holding the leg in the upper position (full inner range) again for 5 seconds (isometric control). Finally, the subject lifts the leg (concentric control) holds it in its upper position (isometric control) and lowers it slowly (eccentric control). Once this movement can be performed for 5–10 repetitions, the subject can progress to phase (II) of the rehabilitation programme. This clam shell position has both advantages and disadvantages. By flexing the knee and hip the lever arm of the leg is reduced making the action easier to achieve for the client. However the non-weight-bearing starting position with the hip–knee flexion does not mimic the functional straight-leg weight-bearing position. It is important therefore to progress from the clam shell muscle isolation action to weight-bearing whole-body movement as soon as the client is able.

### Weight-bearing actions

Rehabilitation in phase (II) sees the introduction of weight-bearing activities maintaining lumbo–pelvic alignment as the weight is taken onto the affected leg. Exercises begin with weight shift actions (Fig. 6) moving the pelvis to the affected side while keeping it level and avoiding any hip 'dipping'. Once the weight can be shifted in a controlled fashion, the knee on the unaffected leg is bent to take the weight off this side and leave the affected leg taking full bodyweight. Again control is the focus here. As the weight is shifted over the affected leg the pelvis should remain level, and as the unaffected leg is bent the pelvis must not dip towards this side or 'hitch' upwards. Lower limb alignment must also be emphasised as both excessive pronation and leg length discrepancy have been linked to ITBS in lateral hip pain (28,29). The knee should remain directly over the centre of the foot, avoiding a pronation (foot flattening) and hip adduction. The aim is to maintain precise alignment and to build muscle endurance. Progression is made of holding time therefore, holding the correct alignment for 20–30 seconds and performing 5–10 repetitions.

The next stage is to perform the same alignment pattern but to allow controlled bending of the knee on the affected side using the mini-dip exercise. The subject stands with the foot of the affected leg on a small (5 cm) block. Keeping the pelvis horizontal the weight is shifted towards the affected leg and then lowered into a single-leg squat controlling the action and maintaining lower limb alignment throughout the movement. This mini-dip is performed for 5–8 reps emphasising timing of the eccentric lowering aspect (5–10 seconds) rather than just the concentric lifting (2–3 seconds).

### Reducing hip joint forces when exercising

Open chain prone hip actions are often used in popular exercise situations to strengthen the hip extensor muscles. However this joint position represents a non-functional

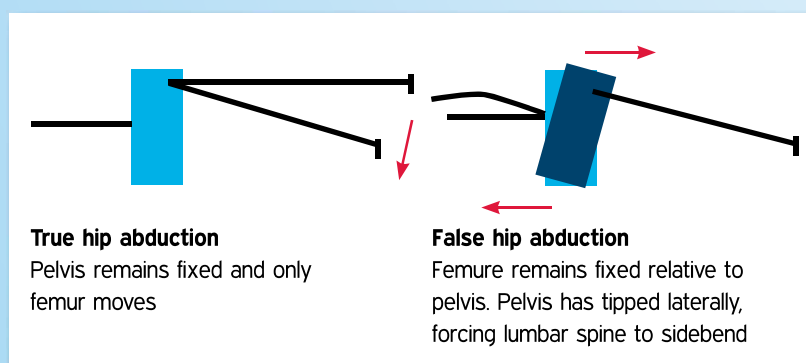


Figure 5: False hip abduction in side lying. [Figure taken from Norris, 2004 (35)]

## “IN A STUDY OF DISTANCE RUNNERS WITH ITBS SIGNIFICANT WEAKNESS OF THE GLUTEUS MEDIUS WAS FOUND ON THE SYMPTOMATIC SIDE.”

*Figure 6: Exercises begin with weight-shift actions moving the pelvis to the affected side while keeping it level and avoiding any hip 'dipping'.*



**6a: Weight shift – normal standing**



**6b: Weight shift to left leg**



**6c: Weight shift to left leg, right leg bends**



**6d: Weight shift to left leg, left hip beginning to dip**



**6e: Close up of pelvis in normal alignment in standing**



**6f: Close up of weight shift – normal pelvic alignment**



**6g: Close up of weight shift – pelvis dips down on the right**

muscle isolation exercise which has been shown to significantly increase forces over the hip joint. Force increase of this type may not be appropriate to the rehabilitation of lateral hip pain where patients have co-morbidity with hip joint pathology. An increase of 22.7% bodyweight has been shown with a hip joint angle changing from 10° hip flexion to 30° hip extension (30). If this prone hip extension is to be chosen, the hip should start in flexion and finish in the neutral position, avoiding an extended hip position beyond the body plane (hyperextension). More functionally relevant closed chain actions include bridging actions performed with either one or both legs, initially with the feet on the floor progressing to feet on a mobile platform (Fig. 7). A slide board or horizontal leg press machine may be used later to provide body weight or weight-stack resistance (Fig. 8).

### Choice of exercise

Classic gym-based exercises such as squats, lunges and deadlifts are useful and may be modified if required. Squat exercises may be performed free standing (classic barbell squat) or using a frame (Smith frame) to guide the bar. Modifications include squatting with the patient's back resting on a gym ball placed on a wall, squatting onto a chair, and using dumb-bells held in each hand to the side of the hip rather than a barbell held across the shoulders (dumb-bell squat). In the classic squat the knee passes over the toes as the ankle dorsiflexes. Restricting this transverse knee movement by trying to keep the tibia vertical has been shown to reduce torque at the knee (mean value 117.3N·m compared to 150.1N·m) but increase it at the hip (mean value 302.7N·m compared to 28.2N·m). In addition restricting anterior knee motion produces a greater anterior angulation of the trunk (31). Performing a squat on a linear frame enables users to better maintain trunk alignment as the bar is unable to move forwards. In addition the action may be changed to a semi-recumbent starting position where the knee stays over the foot and the users sits back rather than



“THE TRENDELENBURG TEST IS OFTEN USED IN THE CLINIC TO ASSESS CONTROL OF THE PELVIS ON THE FEMUR IN SINGLE-LEG STANDING, SO IS PERHAPS THE MOST RELEVANT TEST TO LATERAL HIP PAIN”



**Figure 7:** More functionally relevant closed chain actions include bridging actions performed with either one (a) or both (b) legs, initially with the feet on the floor progressing to feet on a mobile platform.



**Figure 8:** A slide board or horizontal leg press machine may be used later to provide body-weight or weight-stack resistance.

downwards (Hack squat). When performing this type of squat the knee moment has been shown to be greater than the hip moment with more muscle work on the knee extensors (quadriceps) than the hip extensors (gluteals and hamstrings). As the foot is moved forwards into a Hack squat position, the hip moment increases and the knee moment reduces, effectively reversing the muscle emphasis placing significantly greater work on the hip extensors compared to the knee extensors (32).

Clam shell exercises are typically used to target the gluteus medius muscle, and are appropriate for early stages of rehab. Although muscle isolation exercises have been shown to be superior to whole body exercise at targeting this muscle it is the side lying hip scissor which gives the greatest work when measured as mean EMG (electromyography) signal amplitude expressed as a percentage of maximal voluntary isometric contraction (MVIC). Looking at 12 rehabilitation exercises for the hip, Distefano et al. (33) found the hip scissor to give a mean of 81% compared to 40% for the clam. Single-leg squat and single-leg deadlift produced values of 64 and 58% respectively. For the gluteus maximus both the single-leg squat and single-leg deadlift gave values of 59% with the lunge scoring 44% and the clam 39%. The forward lunge action using a forward angulation of the trunk to bring the chest close to the thigh and hands towards the floor has been shown to increase the workload on the hip extensors. Comparing a neutral lunge (NL) with a lunge placing the trunk forwards (LTF) Farrokhi et al. (34) showed mean values of 18.5 and 11.9 for the gluteus maximus and biceps femoris respectively in the NL compared to 22.3 and 17.9 for the LTF with each score expressed as a percentage of MVIC.

In conclusion, effective management of lateral hip pain depends on accurate assessment and identification of movement dysfunction prior to the use of exercise therapy to re-establish muscle balance around the hip.

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#### GLOSSARY

ASIS	anterior superior iliac spine
FAI	femoroacetabular impingement
GT	greater trochanter
GTPS	greater trochanteric pain syndrome
EMG	electromyography
ITB	iliotibial band
ITBS	iliotibial band syndrome
LGM	lower gluteus maximus
LTF	lunge placing the trunk forwards
MVIC	maximal voluntary isometric contraction
NL	neutral lunge
QF	quadratus femoris
TFL	tensor fascia lata
UGM	upper gluteus maximus

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