Exercise Strategies to Prevent the Development of the Anterior Pelvic Tilt: Implications for Possible Prevention of Sports Hernias and Osteitis Pubis

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SUMMARY

SPORTS HERNIAS AND OSTEITIS PUBIS HAVE BEEN HYPOTHESESIZED TO BE A RESULT OF A STRENGTH IMBALANCE BETWEEN ABDOMINAL AND HIP MUSCULATURE. AN ANTERIOR PELVIC TILT IS A POSTURAL ALIGNMENT THAT ACCENTUATES THIS MUSCLE IMBALANCE. STRENGTH AND CONDITIONING PROGRAMS NEED TO FOCUS ON BALANCED STRENGTH AND FLEXIBILITY TO PREVENT THESE INJURIES.

INTRODUCTION

Groin pain accounts for approximately 5% of patient visits to sports injury clinics (1). Groin pain is commonly thought of as pain in the area of the inguinal canal, pubic symphysis, and acetabular ball-and-socket joint. Crowninshield et al. (3) showed that loads of up to 8 times body weight can be distributed to the hips during activities such as jogging. With greater force generated during more stressful activities comes the increased risk of injury if the body is unable to distribute these forces appropriately.

Sporting activities with side-to-side ambulation, sudden changes of direction, and repetitive twisting and turning such as in ice hockey, field hockey, and soccer increases the risk of groin injuries in athletes (21). Professional ice hockey players often develop hip and low back strains, which may be in part because of the shortening of the iliopsoas that can cause loss of hip extensibility (27). Adding low levels of training involving the abdominals throughout off-season training potentially can result in a two-third reduction in the risk of lower abdominal muscle strains in ice hockey players (21). Emery et al. (17) performed a retrospective case study of National Hockey League (NHL) players to analyze groin and abdominal strain injuries over 6 NHL seasons from 1991 to 1997. The study revealed a significant increase in groin and abdominal strain injuries progressively to 1997 in these elite athletes. A conservative estimate of the impact on time lost to injury is approximately 25 player games per year lost per NHL team (7). In the fall of 1999, there were more than 20 players on the injured list because of groin injuries in the NHL (1). The increased incidence of groin pain can partially be attributed to increased physician and athletic trainer awareness. In hockey players, it has been postulated that equipment use and proper ice skate positioning result in biomechanical alterations to posture. Good puck control requires that the blade of the stick stays completely on the ice; this requires that the hips have

KEY WORDS:
prehabilitation; sports hernia; groin pain; pelvic imbalance; osteitis pubis; athletic pubalgia
some degree of flexion (27). Limited range of motion about the ankle because of ice skates causes the player to flex both knee and hip to compensate for the shift in the center of gravity anteriorly because ice skates only allow for ankle movement from neutral to dorsiflexion (27).

Anderson et al. (1) postulated that the increase in the use of unbalanced strength and conditioning programs may lead to alterations in the biomechanics of the hip/pelvic musculature. Programs focusing on increasing strength in the lower extremities without adequate programming for the abdominal musculature may lead to a pelvic imbalance. Such imbalance may cause slight contractures of the hip flexors and/or hip adductor muscles (1). Musculoskeletal conditions specific to athletes that have a relationship to pelvic imbalance are osteitis pubis and sports hernias/athletic pubalgia. With an understanding of the biomechanical imbalance about the pubic bone, the strength and conditioning professional can adapt the training regimen to ensure that exercises are included that offset the natural tendency of the athlete to develop an anterior pelvic tilt in sports such as ice hockey where there is overdevelopment of the hip adductors and flexors with weak abdominal musculature.

ANTERIOR PELVIC TILT AND ANATOMY

The anterior pelvic tilt occurs when the pelvis rotates anteriorly around the hip joint’s transverse axis, resulting in lumbar extension and hip flexion (11). The paraspinal muscles are typically too short and the rectus abdominis is long or weak if there is an anterior pelvic tilt. In converse, a posterior pelvic tilt results in hip extension and lumbar flexion because the pelvis rotates posteriorly around the transverse hip joint (11). Rectus abdominis weakness leads to an anterior pelvic tilt and lordotic posture (28). When positioned in prone hip extension, stiff hip flexors, weak glutus maximus, deficient abdominals, and dominant activity of the erector spinae lead to excessive anterior pelvic tilt. Poor flexibility of the hip extensors is also a perceived cause of the anterior pelvic tilt (25). Decreased low back muscle flexibility because of strong back extensors can cause the trunk flexors to shorten, which also can cause an anterior pelvic tilt (8).

Magnetic resonance imaging (MRI) has shown that fibers of the rectus abdominis and adductor longus blend to form a common aponeurosis (21). This rectus abdominis-adductor longus aponeurosis attaches to the periosteum of the anterior pubic body. It may merge with the anterior pubic ligament and the interpubic disk (21). Because of this relationship of the rectus abdominis and adductor longus, injury to the opposing tendon alters the biomechanics and leads to instability of the pubic symphysis (21). The lateral border of the rectus abdominis-adductor longus aponeurosis and the external/superficial inguinal ring are separated by only 2–5 mm, which makes this an intimate relationship (21) (Figure). The rectus abdominis muscle and adductor longus muscle have antagonistic actions of each other during lumbar extension and rotation (21). The force vector of the adductor longus muscle is in the anterior inferior direction (Figure) (21). Studies of cadavers have shown that if the rectus abdominis is transected, there will be a downward tilt of the anterior pelvis and a resulting pressure increase in the adductor compartment (21). An excessive anterior pelvic tilt can develop when there is a weakening of the rectus abdominis in comparison with the hip adductor muscles (16).

Tightness of the hip flexors may also reduce hip extension range of motion, leading to another cause of increased anterior pelvic tilt and lumbar lordosis during running (25). Static hip extension flexibility measured by the Thomas’ test does not appear to be predictive of the dynamic flexibility of the hip during extension (25). The hip flexors are described by Schache et al. (25) to be the iliopsoas, tensor fascia lata, rectus femoris, and the hip joint capsule. There may be advantages to having an anterior pelvic tilt. These advantages may be related to the increased ability for hip extension, which allow for improved power production in running, jumping, and kicking (12).

DIFFERENTIAL DIAGNOSIS OF GROIN PAIN

Groin pain in the athlete can be attributed to both orthopedic and nonorthopedic injuries (Table 1). All health care professionals and strength coaches must be aware of the serious acute causes of groin pain, some of which can be life threatening. Table 1 is a list of some possible causes of groin pain. The causes of groin pain can be classified by either abdominal or musculoskeletal/neurovascular/ connective tissue (Table 1). More acute onset medical causes include ovarian or testicular torsion or tumor, abdominal aortic aneurysm, appendicitis, diverticulitis, incarcerated/strangulated hernias, infections, or active intra-abdominal bleeding. These require immediate evaluation by a medical professional. More common orthopedic causes include osteitis pubis, sports hernias/athletic pubalgia, labral tears, bursitis, muscle strains, contusions, dislocation/subluxation, referred pain, and osteoarthritis (1,13,16,18).

OSTEITIS PUBIS

Osteitis pubis is the result of repetitive twisting and cutting movements that initiate a lytic response in bone at the pubic symphysis (4). This area of bone lysis can be visualized on bone scan and MRI. The para-articular bone edema is remote from the attachment of the adductors (4). Adductor dysfunction has been identified as microscopic tears, which presents itself as a more frequent MRI finding than osteitis pubis and therefore most likely precedes the development of osteitis pubis (4,22). Pain is located at the symphysis pubis or medial groin that intensifies when hip adduction is resisted (1). The bony stress reaction of osteitis pubis is similar to the palpable tenderness of...
the medial border of the tibia in tibial stress syndrome (30).

There are 4 stages of clinical presentation of osteitis pubis described by Rodriguez et al. (23). Stage 1 is groin pain on the kicking side that subsides during warm-up but reappears after training. Stage 2 is bilateral, inguinal, and adductor pain that is increased after training. Stage 3 is bilateral, inguinal, adductor, and abdominal pain with kicking, sprinting, changing direction, moving from sitting to standing, and with prolonged walking. At this stage, the athlete is unable to train or play. Stage 4 is adductor and abdominal pain that is referred to the lumbopelvic region with the Valsalva maneuver and other sources of increased intra-abdominal pressure (defecation, coughing, sneezing, and walking on uneven surfaces). Activities of daily living cause symptoms (23).

Pizzari et al. (22) identified some possible internal and external risk factors in the Australian Football League for the development of osteitis pubis. Internal risk factors include immature skeleton, hypermobility (generalized ligamentous laxity), inability to recruit appropriate muscles for stability and function, intrapelvis asymmetry, and technique deficits. External risk factors included training intensity, training volume, kicking, trauma, change of direction, recovery time, ground hardness, and number of games played. Prevention programs are widely used and successful, which focus on tight joint and muscles around the trunk, pelvis, and lower extremities (22).

SPORTS HERNIAS/ATHLETIC PUBALGIA

The term sports hernia has been poorly defined in the literature. “Gilmore’s Groin” was defined by a dilated superficial inguinal ring with the possible additional pathology of a torn external oblique aponeurosis, torn/disrupted conjoined tendon, and a dehiscence between the conjoined tendon and inguinal ligament (19). The “sportsman” hernia is defined as a bulge in the posterior inguinal wall that represents an incipient inguinal hernia or a tear in the transversalis fascia in the posterior inguinal floor (19). Medical professionals and literature refer to sports hernia and athletic pubalgia interchangeably. There has been a movement to replacing the term sports hernia to athletic pubalgia because of the lack of a true hernia. For the time being, they can continue to be used interchangeably (15).

It has been hypothesized that an imbalance in the hip adductor and lower abdominal musculature leads to a weakening, laxity or tearing of the structures in the inguinal region that results in the physical examination finding of tenderness over the inguinal canal and conjoined tendon that is worsened by a resisted sit-up (1,16). A sports hernia is therefore a term applied to a variety of different anatomical causes of groin pain. A sports hernia does not involve a true herniation of intestine and tends to imply that the treatment should be the same; however this is not the case (15). The theory around the connection between the rectus abdominis and the adductor dysfunction is that rectus abdominis weakness leads to an overcompensation by the adductors, resulting in a compartment-like syndrome as the anterior tilt of the pelvis increases that compresses the adductor compartment (5).

There may be around 20 syndromes of anatomic deficit combinations that fall under the umbrella term athletic pubalgia/sports hernia (15). Any adductor muscle can be involved (gracilis, adductor magnus, obturator externus, adductor longus, adductor brevis, and/or pectineus) (15). Most commonly the rectus abdominis with or without the adductor longus/pectineus is involved; however the sartorius, iliopsoas, or rectus femoris may be the source of dysfunction (15).

Symptoms are typically vague and gradual in onset over 1–6 months (5). The pain can be exacerbated by coughing, straining, twisting, turning, pivoting, or palpating (5). Physical examination of sports hernia reveals pain with resisted
Abdominal tissue
Abdominal aortic aneurysm
Adhesions
Appendicitis
Diverticular disease
Endometriosis
Femoral hernia
Inflammatory bowel disease
Inguinal hernia (direct or indirect)
Obturator hernia
Ovarian pathology
Perforated viscous
Pelvic inflammatory disease
Prostatitis
Urinary tract pathology (infection, pyelonephritis, nephrolithiasis)
Testicular/epididymis pathology
Musculoskeletal, neurovascular, and connective tissue
Acetabular labral tears
Arterial/venous pathology
Avulsions, apophyseal injuries, and fractures
Bursitis
Compression neuropathies
Contusions (hip pointer) or hematomas
Hip dislocation/subluxation
Legg-Calve-Perthes disease
Lumbar spine abnormalities
Lymphadenopathy/lymphadenitis
Muscle strains
Myositis ossificans
Osteitis pubis
Osteoarthritis
Osteochondral loose bodies
Postpartum pubic symphysis separation
Proximal femur fracture (skier's hip)
Sacroiliac joint abnormalities
Seronegative spondyloarthropathies
Slipped capital femoral epiphysis
Snapping hip syndrome
Sports hernia/athletic pubalgia
Stress fracture

Data compiled from Anderson et al. (1), LeBlanc and LeBlanc (13), Meyers et al. (16), and Morelli and Smith (18).

EXERCISES TO PREVENT PELVIC IMBALANCE
Strength and conditioning professionals can create programs that focus on the prevention or correction of biomechanical imbalance of the anterior pelvic tilt to reduce the risk of sports hernias and osteitis pubis (Table 2). These programs should focus on abdominal strength and hip flexibility, while still incorporating power, strength, and dynamic flexibility in the lower extremities. These exercises and stretches serve as potential prehabilitation for osteitis pubis and sports hernias. Prehabilitation is defined as using specific exercise programs to prevent injury (29). Preventive exercise programs have been used successfully in Australian Football League for osteitis pubis (22). No specific recommendations are given for a prehabilitation or preventive program. However, exercises are rather suggested to be included in a general strength and conditioning program (Table 2). A focus on strengthening of the abdominals, hamstrings, hip abductors, and hip adductors with flexibility of the hip sit-up, resisted hip adduction, and/or focal tenderness at the pubic attachment of the rectus abdominis and adductor longus or at the external/superficial inguinal ring (21).

Treatment is usually initially conservative including rest, nonsteroidal anti-inflammatories, massage, physical therapy, and/or oral or injected corticosteroids (5). Defects in the inguinal region have been repaired by conventional surgical methods for inguinal hernias aimed at strengthening the inguinal defect specifically around the internal inguinal ring including placement of a mesh (19). Occasionally, during surgical exploration of a suspected sports hernia, a small inguinal hernia will be found and repaired, leading to an alleviation of symptoms (19). Physical therapy designed to increase pelvic stability can reduce symptom recurrence (5). The treatment with mesh may stabilize the superficial inguinal ring, which in turn may address the rectus abdominis-adductor longus aponeurosis indirectly (21).

Other surgeons have advocated the use of a different approach to treatment termed a “pelvic floor repair.” The pelvic floor muscles anatomically are the coccygeus and levator ani with the main action to support the pelvic viscera and resist increases in intra-abdominal pressure (17). The pelvic floor repair involves reattaching the inferolateral margin of the rectus abdominis to the fascia that overlies the anterior pubic ligament and anterior pubis (5,16). Other repairs have focused on surgical repair of possible entrapped nerves (ilioinguinal or genital branch of genitofemoral nerve) (21). There is currently no general consensus on the best surgical approach to repair of a sports hernia.

If there is a microtear present in the adductor attachment to the pubis, symptoms should resolve after a corticosteroid injection to the symphyseal cleft. If refractory to therapy, a surgical tenotomy where the adductor tendon is divided from the pubic attachment is performed (4). A tenotomy may be protective of a pelvic floor repair (19). No intervention is done to the muscle body (5). Approximately 60% of athletes may potentially return to play in 3 months after the tenotomy (21). A tenotomy alone may not prevent progressive injury or address the underlying instability about the pubic area (21).
### Table 2
Exercises focusing on prevention of anterior pelvic tilt and dysfunctions of osteitis pubis and sports hernias

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Description</th>
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| **Dynamic warm-up**           | Any general dynamic warm-up designed by the strength coach or certified athletic trainer focusing specifically on dynamic hip adductor flexibility and dynamic hip flexor flexibility.  
Sample Dynamic Warm-up from Waryasz and McDermott (29): high knee march, toe jogging, straight leg jogging, “butt-kickers,” high knee skip, side shuffles, forward lunge walk, high knee run, increasing intensity 65–100% 10-yd sprints. |
| **Abdominal exercises**       |                                                                              |
| Abdominal crunches            | The athlete lies supine with the knees in flexion approximately 90 deg       |
|                               | The athlete elevates the trunk to where the scapula is lifted off the floor.|
|                               | The athlete can choose to place the fingers behind the ears with the elbows in flexion if desired; however, this is not mandatory. |
|                               | The athlete then descends the trunk back to the starting position.          |
| Medicine ball/Russian twists  | The athlete can use a back extension setup.                               |
|                               | Hips are placed into flexion.                                             |
|                               | The ball is stabilized in front of the anterior chest.                     |
|                               | The athlete rotates the torso from side to side while keeping the lower extremity stationary. |
| Overhead medicine ball throws | The athlete begins seated on the floor with hips flexed and knees flexed.  |
|                               | A partner throws a medicine ball to the athlete’s chest.                   |
|                               | The athlete stabilizes the ball then performs descent phase of a sit-up with the ball in the overhead position with arms in extension. |
|                               | The athlete then begins the ascent phase of the sit-up and throws the ball back to the partner. |
| Posterior pelvic tilt         | The athlete lies supine with feet off the ground by flexing the hip and knee to 90 deg. |
|                               | The thighs are held still throughout the exercise                         |
|                               | The athlete contracts the abdominal muscles and pulls the pubic symphysis up to the chest. |
|                               | The lumbar region stays in contact with the mat.                          |
|                               | The sacrum, iliac crest, and buttocks are raised from the mat.             |
| Rotation medicine ball throws | The athlete begins with the right side or left side facing a partner with the ball held at the level of the nipples. |
|                               | The athlete rotates the trunk away from the partner with the ball held at the level of the nipples. |
|                               | The athlete then begins to rotate the torso to the start position then throws the ball to the partner. |
|                               | A set is completed then the athlete is instructed to face the partner with the opposite side. |

(continued)
### Bridges

- Athlete lies supine on 2 benches separated so that the scapula and calcaneus are in contact with separate benches.
- A light weight can be centrally placed over the pelvis resting on the bony prominence of the anterior superior iliac spine bilaterally.
- The rectus abdominis is contracted isometrically to support the lumbar spine.

### Swiss ball bridges

- The athlete flexes the knees and maintains the hips in extension, while balancing the upper back on a Swiss ball.
- This position is held for a set amount of time.
- The athlete is then able to disengage from the bridge position.

### Hamstring exercises

#### Modified extensions

- Athlete uses back extension apparatus with ventral surface of hands placed behind the region of the C1 vertebrae but not touching.
- Athlete starts at 0 deg of hip flexion and maintains isometrically contracted abdominals.
- Athlete ascends to 0 deg of hip flexion using the hamstrings and gluteus maximus as prime movers.

#### Romanian dead lift

- Starting position is hips externally rotated 30–45 deg (10 o’clock and 2 o’clock) and feet apart so that the medial malleolus is in line with the greater trochanter of the femur. The knee and hip are flexed to enter the “scoop” phase of the power clean.
- The bar is descended from the proximal one-third of anterior thigh to the tibial tubercle as the hip flexes and the knee extends with the feet remaining firmly planted on the platform. The athlete’s back should remain flat without excessive lumbar curvature. This is done by hip flexion and not flexion of the vertebral column. The bar should travel within 1–2 inches of the leg at all times during the descent phase.
- The bar then ascends from the tibial tubercle to the starting point, the proximal one-third of the anterior thigh using the hamstrings to pull as the knee flexes and the hips extend in simultaneously.

### Hip abduction exercises

#### Manual hip abduction

- Athlete lies in decubitus position.
- Athlete performs set of resisted hip abduction through full ROM with pressure applied from a partner at the region of the lateral epicondyle.

#### Resistance band hip abduction

- The athlete stands feet slightly apart with the physical therapy band fastened around the lower leg about the level of the lateral epicondyle.
- The athlete performs a set of resisted hip abduction through a full ROM.

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**Table 2**

(Continued)
## Hip extension exercises

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Description</th>
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<tbody>
<tr>
<td>Manual hip extension</td>
<td>Athlete lies in prone position. Athlete performs set of resisted hip extension through full ROM with pressure applied from a partner at the region of the knee posteriorly.</td>
</tr>
<tr>
<td>Resistance band hip extension</td>
<td>The athlete stands feet slightly apart with the physical therapy band fastened around the lower leg about the level of the knee. The athlete performs a set of resisted hip extension through a full ROM.</td>
</tr>
</tbody>
</table>

## Hip adductor stretches

<table>
<thead>
<tr>
<th>Stretch</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Four-point stretch</td>
<td>The prone athlete starts in 90 deg of knee flexion, dorsiflexion, and maximal hip abduction. The 4 points of contact of the lower extremity with the ground are the left and right medial malleolus and the left and right medial epicondyle of the knee. Upper-body support comes from the ulnar side of each hand and medial epicondyle of the elbow being in contact with the floor. The athlete maintains a flat back by isometrically contracting the abdominal musculature.</td>
</tr>
<tr>
<td>Active isolated long adductor stretch</td>
<td>The athlete lies supine with flexed and adducted hip, extended knee, and dorsiflexed ankle. The athlete contracts the hip abductor group to attempt to touch the lateral malleolus to the ground, while stretching the hip adductor group. Maximum dynamic ROM is met and then the athlete can assist using pressure from the hands in the region of the adductor tubercle of the femur. In full ROM, the stretch is held for 2 seconds.</td>
</tr>
<tr>
<td>Active isolated short adductor stretch</td>
<td>The athlete lies supine with flexed and adducted hip, flexed knee, and dorsiflexed ankle. The athlete contracts the hip abductor group to attempt to touch the lateral malleolus to the ground, while stretching the hip adductor group. Maximum dynamic ROM is met and then the athlete can assist using pressure from the hands in the region of the adductor tubercle of the femur. In full ROM, the stretch is held for 2 seconds. The athlete then returns to start position and performs another repetition.</td>
</tr>
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## Hip flexor stretches

<table>
<thead>
<tr>
<th>Stretch</th>
<th>Description</th>
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<tbody>
<tr>
<td>Ely test stretch/prone quadriceps stretch</td>
<td>Athlete lies prone while a passive flexion of the athlete’s knee is produced for full static ROM with pressure placed on distal one-third of lower leg over the tibia.</td>
</tr>
</tbody>
</table>
Adductors and hip flexors have been suggested. Sample exercises have been given (Table 2).

Strength and conditioning programs prescribed for athletic activities with excessive twisting and turning should be balanced to ensure that the lower-body and abdominal musculature maintain the correct biomechanical alignment. To achieve this, stretching activities for the lower body must be completed both statically and dynamically. The abdominal muscles must also be exercised to ensure strength to balance any strength gains in the lower-body muscles. In a balanced program, the goal is to strengthen and increase flexibility while reducing risk of injury because of biomechanical imbalance. Table 2 contains specific exercises that can be incorporated into the exercise program to ensure a balanced routine. The dynamic warm-up should focus on dynamic flexibility of the hip adductors and flexors. The strength and conditioning professional should design a personalized warm-up program for the following activity whether it is practice, weight training, or a game. A sample program is included in Table 2. Other exercises can also be incorporated into a routine that strengthen or stretch the correct muscle groups; however, the strength and conditioning professional must focus on proper form to attain the maximal result from the exercise program. If activities are performed incorrectly, injuries are less likely to be prevented and the exercise program may cause injury.

When determining appropriate exercises for the abdominals in regards to the anterior pelvic tilt, osteitis pubis, and sports hernias, it is important to include exercises that activate the upper and the lower abdomen. Sarti et al. (24) in 1996 reported that abdominal crunch produces greater activity by the upper portion of the rectus abdominis, whereas the posterior pelvic tilt exercise is more strenuous on the lower portion of the rectus abdominis. However, Lehman et al. (14) in 2001 reported that difference in the portions of the rectus abdominis may lack clinical or therapeutic importance. Abdominal curl-up/crunch can be performed without activation of the hip flexors, therefore minimizing the anterior pelvic tilt (8). The posterior pelvic tilt exercise is important because it

<table>
<thead>
<tr>
<th>Table 2</th>
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<tbody>
<tr>
<td>Lunge stretch</td>
<td>Starting position is hips externally rotated 30–45 deg (10 o’clock and 2 o’clock) and feet less than 6 inches apart.</td>
</tr>
<tr>
<td></td>
<td>The athlete takes a step forward maintaining the hip external rotation as the torso maintains perpendicular to the platform. The trailing foot is maintained in the starting position.</td>
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<tr>
<td></td>
<td>The stretch is held with the back knee and lower leg resting on the floor.</td>
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<tr>
<td>Ober test stretch</td>
<td>Athlete lies on side holding the bottom leg around the knee in hip and knee flexion. The top leg is in hip extension with knee flexion.</td>
</tr>
<tr>
<td></td>
<td>The partner stabilizes the hip with one hand, while applying a hip extension and adduction force from the quadriceps tendon region of the top leg with the other hand.</td>
</tr>
<tr>
<td>Thomas’ test</td>
<td>Athlete lies supine on the floor or on a bench with one leg in hip/knee extension with ankle dorsiflexed. The other leg is in hip/knee flexion with ankle dorsiflexed.</td>
</tr>
<tr>
<td>stretch/single</td>
<td>The partner or athlete pushes/pulls in the region of the tibial tubercle to create greater hip flexion.</td>
</tr>
<tr>
<td>leg sprinter</td>
<td>The athlete attempts to gain greatest ROM in hip flexion, while keeping the opposite leg firmly on the ground. A partner can apply a force in region of the tibial plateau of the flexed leg toward the chest, while applying a downward force to the distal one-third of the anterior thigh to keep hip flexion from occurring. To optimize hip extension, the athlete can have this leg off of a bench.</td>
</tr>
</tbody>
</table>

Exercise descriptions taken from Baechle and Earle (2) and Waryasz and McDermott (29) with updates according to fit the criteria discussed in the article.

Deg = degree(s); ROM = range of motion.
will lengthen the muscles of the erector spinae and stretch the quadriceps (11). When performing all exercises, proper positioning of the pelvis is important. An abdominal drawing-in maneuver is an effective method to promote gluteus maximus and medial hamstring activation from the erector spinae muscles when the athlete is in prone position (20). It can be performed during most exercises to create a more rigid cylinder around the spine by contracting the transverse abdominis (6). This maneuver can be done during all exercises, but it is very important for squats. The athlete should be instructed to try to “draw-in” the abdominal wall without moving the spine or pelvis (6) or by having the patient bring their umbilicus superiorly and toward the spine (9). If squats are performed during the general program, care should be taken to instruct the athletes to avoid an excessive anterior pelvic tilt to reduce the workload on the erector spinae. Electromyogram activity in the erector spinae is greater when squats are performed with an anterior pelvic tilt (10). Preventing unwanted lumbar spine and pelvic movement allows the Romanian dead lift (RDL) and modified extension to focus on the hamstrings and gluteus maximus rather than the activation of the erector spinae. Activation of the erector spinae muscles actually promotes the anterior pelvic tilt (20). If the RDL or modified extension is performed incorrectly, there will be tightening of the paraspinous muscles and will go directly against the goal of preventing the anterior pelvic tilt. The anterior pelvic tilt has been postulated to be more important than stretching the hamstring for improving hamstring flexibility (26), and this leads to the necessary inclusion of hamstring strengthening exercises because if individuals have an anterior pelvic tilt, the hamstrings will usually be more flexible.

Although the dysfunction of sports hernias and osteitis pubis is related to the adductors, exercises in a general program must be done to strengthen these muscles. In preventing sports hernias and osteitis pubis, stretching the adductors are important. This can be done by the 4-point stretch, active isolated long adductor stretch, and active isolated short adductor stretch (Table 2). Because strengthening the adductor muscles reduces the occurrence of other common adductor injuries (21), it is recommended that adductor strengthening exercises be performed in a balanced way with adductor exercises. For this reason, Table 2 includes adductor exercises.

**SUMMARY**

Sports hernias and osteitis pubis are causes of groin pain in athletes and result in a significant loss of time from sports activities. These conditions result from inflexible lower extremity muscles that are excessively strengthened in comparison with the abdominal musculature, which leads to the anterior pelvic tilt. Sports hernias are the result of damage to the fascial structure of the inguinal region leading to abdominal wall laxity combined with adductor/hip flexor dysfunction. Osteitis pubis is a lytic bone response to forceful adductor movements. Both sports hernias and osteitis pubis have been proposed to occur because of some degree of adductor dysfunction due to lack of flexibility (4).

A strength and conditioning program must contain the appropriate ratio of abdominal exercises to lower extremity exercises to reduce the incidence of anterior pelvic tilt and other pelvic imbalance disorders. A focus is made on an exercise prescription to strengthen the abdominals, hamstrings, hip extensors, and hip abductors, while stretching the hip adductors and hip flexors. These exercises and stretches can help to offset the intrinsic tendencies in some sports to develop an anterior pelvic tilt. The strength and conditioning professional should include these exercises and stretches in any program design. The biomechanical alterations associated with an anterior pelvic tilt may increase the likelihood of sports hernias and osteitis pubis. By incorporating both strengthening and flexibility exercises, the strength and conditioning professional may help athletes reduce the specific risk of developing sports hernias and osteitis pubis.

**REFERENCES**


