Evaluation of the Athlete With Buttock Pain

John M. Vasudevan, MD[1,2]; Matthew Smuck, MD[2]; and Michael Fredericson, MD, FACSM[1,2,3,4]

Abstract
Buttock (gluteal) pain is commonly experienced by athletes of all ages and activity levels. Evaluation of buttock pain can be challenging because the differential diagnoses are extensive. Symptoms may originate from the pelvis or hip or be referred from the lumbosacral spine or neurovascular structures. Few articles in the literature are dedicated to the primary complaint of buttock pain. The purpose of this article is to provide a clinical algorithm to assist the sports clinician in reaching an accurate diagnosis and initiating the appropriate treatment.

Introduction

Athletes frequently experience pain in the buttock, but evaluating the pain can be challenging. Buttock (gluteal) pain is not always due to local damage; it is often generated from structures outside the gluteal region, including the lumbosacral spine, sacroiliac joint, and hip. Activities featuring running, sprinting, kicking, and jumping are most commonly associated with the development of buttock pain. This article will review causes of buttock pain and provide a clinical approach to reach an accurate diagnosis and design a treatment plan to quickly and safely return athletes to their desired activities.

Differential Diagnosis

The differential diagnosis for buttock pain is extensive, but the practitioner can narrow the possibilities by answering these three questions: 1) Is there concomitant back pain? 2) Is there an alteration of strength or sensation? 3) And is the pain primarily located in the posterior, lateral, medial, or anterior aspect of the pelvis and thigh?

Pathologic disease in the buttock itself rarely radiates cephalad, so the presence of low back pain suggests an abnormality in the lumbosacral spine or its supporting tissues. While a deficit in strength or sensation, particularly in a dermatomal or myotomal pattern, signals nerve root damage, the same is not always true of pain radiating toward the buttock from the lumbosacral spine. Such pain may be related to facet arthropathy, discogenic pain, spondylolysis, spondylolisthesis, or lumbar spinal stenosis. Low back pain without a neurologic deficit may be generated from the sacroiliac joint, iliolumbar ligament, sacral stress fracture, or an active trigger point (20).

Pain limited to the buttock is most often due to damage to its supporting tissues. As with the low back, a strength or sensory deficit may indicate damage to the lumbosacral plexus, sciatic nerve, or peripheral nerves as they travel through the pelvis. Diffuse or vague pain, as opposed to focal and specific pain, is more likely referred from elsewhere. Pain with active contraction or passive stretch may indicate a muscle tear or tendinopathy (1). Pain with direct palpation over a taut band of muscle that replicates the pain is consistent with an active trigger point (110).

Posterior pain over the ischial tuberosity is most likely related to proximal hamstring tendinopathy or ischial bursitis. Posterior pain above the level of the ischial tuberosity is likely due to piriformis or gluteus maximus strain. Posterior compartment syndrome of the thigh can occur but is rare. Lateral pain may originate from greater trochanteric bursitis or from tendinopathy or strain of the gluteus medius (GM), gluteus minimus, or tensor fascia lata. Pain between the greater trochanter and the lateral knee is consistent with tightness or strain of the iliotibial band (ITB). Medial buttock pain may represent damage to the gluteus maximus or adductor muscle group or sprain of the sacrotuberus ligament. Pain in the anterior side of the hip is most often generated from intra-articular hip processes (*e.g.*, osteoarthritis, labral tears, femoroacetabular impingement, femoral stress fracture) or dysfunction of the iliopsoas or rectus femoris muscles. It also should be noted that while hip joint disorders refer to the groin in up to 88% of athletes, pain also may radiate posteriorly to the buttock in 15% to 38% of cases (21,39,71). Tears of the posterior labrum, more commonly seen in Asian populations, have been associated with reports of deep buttock pain. However, buttock pain in the absence of hip joint pain is rare (21,54).

[1]PM&R Sports Medicine Service, Stanford University, Redwood City, CA; [2]Division of Physical Medicine & Rehabilitation, Department of Orthopaedic Surgery, Stanford University, Redwood City, CA; [3]Stanford Athletics, Stanford University, Redwood City, CA; and [4]School of Medicine, Stanford University, Redwood City, CA

Address for correspondence: Michael Fredericson, MD, FACSM, Stanford Medicine Outpatient Center, 450 Broadway Street, MC 6342, Redwood City, CA 94063-6342 (E-mail: mfred2@stanford.edu).

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General Treatment Principles

Regardless of diagnosis, the treatment of buttock pain should follow a three-phase plan: reduction of pain, remobilization, and rehabilitation.

Reduction of pain may include modalities such as ice or heat, manual therapy or massage, and a short course of nonsteroidal anti-inflammatory drug (NSAID) or analgesic medication. Remobilization includes maintaining functional range of motion, correction of muscle imbalances with appropriate stretching and strengthening, and progression of exercise from isometric to concentric to eccentric and from static to dynamic and functional.

Rehabilitation is tailored to the patient to restore proper spine, pelvic, and lower limb biomechanics and prevent recurrence of symptoms. Core stabilization exercises are strongly recommended to reduce lumbar lordosis, normalize segmental loading, open the neural foramina in the lumbosacral spine, and restore pelvic mobility and muscle balance (2). Motions enforced in core strengthening stress functional movement over individual muscle training. Additional aspects of treatment for individual diagnoses are discussed in greater detail below.

Management of Specific Disorders

Buttock Pain With Back Pain and With Neurologic Deficit

Radiculopathy. Radiculopathy is damage or dysfunction of a nerve root as it leaves the spine, due to direct mechanical compression and/or chemical irritation (47,51). Approximately 90% of all disc herniations occur at the L4-L5 or L5-S1 level (69). Nearly a third of collegiate football players and up to 40% of men's professional tennis players report episodes of back pain that interrupt their participation in their sport (119). One study found an increased relative risk of lumbar radiculopathy in bowling but no increased risk with weightlifting (81). Golfers and baseball players undergo extreme torsional stresses on the spine, which makes them more susceptible to radiculopathy than most other sports athletes (114). Up to 10% of back pain in adolescent athletes is due to radiculopathy, but symptoms may not demonstrate the typical or expected distribution as in adults (63,109). The majority of radiculopathies can be managed conservatively. Surgical referral is necessary for a progressive neurologic deficit, bladder or bowel dysfunction, sexual dysfunction, or saddle hypesthesia (109). A recent literature review of athletes with radiculopathy found a favorable percentage for return to baseline activity (85% by 6 months) and no significant outcome difference between conservative management and microdiscectomy (56).

Buttock Pain With Back Pain and Without Neurologic Deficit

Muscle strain and ligamentous sprain. Soft tissue injury with strain of the lumbar muscles, sprain of ligaments, or damage to fascial tissue is the most common cause of back pain in athletes, representing up to 97% of all acute back injuries (109). Strains are commonly caused by excessive eccentric contraction and occur near the myotendinous junction more often than within the muscle belly (4). Sprain of the iliolumbar ligament may cause low back and buttock pain that resembles sacroiliac joint pain.

Zygapophyseal (facet) joint arthropathy. Pain from zygapophyseal joint (Z-joint) is more likely in athletes older than 40 years. Also termed facet joints, Z-joints are the articulations between the posterior elements of adjacent vertebrae. Injuries that involve a twisting (axial) rotation of the spine followed by sudden severe pain that radiate caudally (often to the upper buttock) suggest injury to this joint (51).

Spondylolysis and spondylolisthesis. Spondylolysis is a defect in the pars interarticularis within the neural arch of a vertebra. The etiology is classified as dysplastic, isthmic, degenerative, traumatic, or pathologic (76). The overall incidence in athletes ranges from 8% to 15%, nearly twice the incidence in the general population (101). Traumatic spondylolysis is common in athletes who perform repetitive spine extension such as gymnasts, divers, soccer, ballet dancers, weightlifters, and football lineman (63,109), and it accounts for up to 50% of back pain in adolescent athletes (78,94). Spondylolisthesis is a slippage of one vertebra over another. Athletes with bilateral spondylolysis are at risk for developing spondylolisthesis. During the preadolescent growth spurt, it occurs most commonly at the L5-S1 level (94,106). Radicular pain may occur as a result if there is consequent narrowing of the foramina or central canal. An anterior spondylolisthesis of greater than 25% is frequently associated with pain (92).

Although there is no standard treatment algorithm for spondylolysis, conservative management provides a successful long-term outcome in 90% of cases (79). There is conflicting evidence as to the effectiveness of a thoracolumbosacral orthotic brace and no strong controlled trials to demonstrate efficacy. Bony healing has been demonstrated in studies with a rigid brace, soft brace, and no brace (93). The most important aspect of rehabilitation is relative rest and avoiding activities that reproduce the pain. Healing takes about 3 months and may be evaluated with a dedicated level computed tomography (CT). Although desired, complete bony healing is not necessary to achieve a successful clinical outcome (101). A formal rehabilitation process should start once painful symptoms have resolved and should progress from general reconditioning to sport-specific activity. If the athlete is without symptoms, has evidence of bony healing, and has completed a rehabilitation program, return to sport occurs between 4 and 6 months. Surgery may be required in 9% to 15% of cases for intractable pain beyond 6 months or neurologic deficit or spinal instability (101).

Ankylosing spondylitis. Ankylosing spondylitis (AS) represents nearly half of all cases of spondyloarthropathy, which has a prevalence of 1.2% (50). The disease may cause restrictive lung disease as a result of limited chest expansion from fixed ribs, as well as osteoporosis, spinal fracture, atlantoaxial subluxation, and cauda equina syndrome (50). The classic presentation of AS is chronic, dull pain in the back, hip, and buttock, associated with morning stiffness that lasts more than 30 min and improves with activity. Up to two-thirds of athletes with AS reported limiting their activities by age 23 (vs 29 years in controls without AS), and the most common complaints were low back pain (44%) and sciatica (25%) (57). In addition, associated Achilles enthesopathy can limit runners. On examination, the Schober test demonstrates the loss of mobility as measured by less than a 5-cm increase between a mark over the spine at the level of the iliac crest and a mark 10 cm cephalad when the patient flexes forward maximally. Common radiographic findings in the spine include joint erosions, ankylosis ("bamboo spine"), and sclerosis of the sacroiliac joint. Laboratory testing for HLA-B27 is positive in 90% of patients with AS (90).

Treatment options include NSAIDs and disease-modifying antirheumatic drugs. Patients with AS who exercise at least 200 $min \cdot wk^{-1}$ and at least 5 $d \cdot wk^{-1}$ experience a significant decrease in pain, stiffness, and disability (73). Home exercise programs that improve posture and avoid excessive bending have been shown to improve function and mobility (50). When counseling regarding sports participation, contact sports are discouraged because of the increased risk of spinal fracture (average incidence 4.6% at 24.6 years after disease onset) (107). Fractures of the dens and cervical spine increase the risk of spinal cord injury. Sports with the highest risk include American football, ice hockey, wrestling, diving, skiing, snowboarding, rugby, cheerleading, and baseball (50). In addition to the spinal precautions, a careful cardiac physical examination and baseline electrocardiography should be performed to screen for cardiac complications including conduction abnormalities and valvular heart disease.

Sacroiliac joint pain. The sacroiliac joint (SIJ) allows for flexion and extension, superior and inferior glide, with an average 2° of rotation, and 0.5 mm of anterior and posterior translation (104). This minimal motion is necessary to help absorb stresses between the spine and the pelvis (35). Hypermobility or hypomobility of the SIJ can lead to painful symptoms in the low back, medial buttock, posterolateral hip and thigh (rarely beyond the knee), and, occasionally, groin (20,22). More patients with SIJ dysfunction have pain referred to the buttock (94%) than to the lower back (72%) (99). The SIJ has a broad distribution of innervation, which may account for its variable pain patterns (6,37,38). About 44% of patients with SIJ pain have a history of a specific trauma, 20% a repetitive strain injury, and 35% are idiopathic (99). Various athletic activities can provoke SIJ pain, including walking, running, jumping, leaping, and squatting (22). Pain from the SIJ is especially common in rowing, where the prevalence among high-end athletes can exceed 50% (19). SIJ dysfunction disrupts the kinetic chain and hinders performance, as it plays a unique role in coupling forces transmitted among the spine and the lower limbs.

Examination of the patient with suspected SIJ dysfunction begins with observation for altered pelvic tilt, spine curvature, leg length discrepancy, and exaggerated pelvic motions during gait. While no single muscle acts on the SIJ in isolation, weakness or tightness of key muscles can alter the biomechanics of the joint, including the GM, piriformis, and hamstrings. Tenderness is often elicited over the sacral sulcus, and a careful examination may reveal active trigger points in the overlying musculature. Neurologic testing and neural tension tests are negative. Provocative maneuvers include the Patrick or the FABERE (flexion, abduction, external rotation, and extension) test, posterior pelvic thigh thrust, the Gaenslen test, the stork (Gillet) test, and the standing and sitting forward flexion (19). However, none of these maneuvers have been shown to be a reliable and specific test for SIJ pain (29,108). Imaging studies, including x-ray, CT, and magnetic resonance imaging (MRI) are rarely diagnostic because degenerative changes are commonly seen in asymptomatic patients (15). The gold standard for diagnosis is injection of anesthetic under fluoroscopic guidance, preferably with a controlled block technique (22).

Treatment of SIJ pain relies heavily on a rehabilitation program that focuses on mobilization, strengthening, and stabilization. Strengthening exercises most commonly focus on the hip muscles, especially the abductors. Manual mobilization of the SIJ may reduce pain and muscle overactivity (22). Pelvic belts may be offered as an adjunct to help reduce pain, may limit SIJ motion by up to 30%, and encourage patient mobility (108). Foot orthoses are helpful to correct a true anatomic leg length discrepancy. Therapeutic injection of corticosteroid into the SIJ may be beneficial for pain that does not resolve with a month of conservative measures or if pain is so significant as to preclude participation in therapies (18,28,59,74,96).

Sacral stress fractures. Stress fractures account for anywhere from 1% to 20% of sports medicine injuries and often involve a failure of weakened or fatigued muscle to provide external support to a bone subjected to repeated force (26,42). Sacral stress fractures are most often observed in young female runners during a period of increased training intensity and are associated with nutritional deficiencies (*e.g.*, calcium and vitamin D) and menstrual irregularities (*e.g.*, oligomenorrhea or amenorrhea) (13,20,45,108). Sacral stress fractures also have been documented in male soldiers (58,95,113). Patients typically complain of localized pain that may radiate to the medial buttock and worsens with walking, running, or hopping. A proper history must include questions pertaining to the female athlete triad (disordered eating, amenorrhea, and osteoporosis). The largest published case series of female runners with sacral stress fractures found that 75% had a history of amenorrhea, nearly two-thirds had osteopenia, and one-sixth had osteoporosis (45). Notably, two of the six men studied also had osteopenia. Examination reveals point tenderness directly over the sacrum, and pain may be provoked by maneuvers used for SIJ dysfunction. Bone edema on MRI and increased tracer uptake on technetium Tc 99m bone scan are most sensitive to detect early fracture, as early as 72 h after fracture onset (13,58). MRI and bone scan may both be negative in the early phase after injury, and imaging should be repeated in a few weeks if clinical suspicion remains high (43).

If a sacral stress fracture is detected or strongly suspected, a non-weight bearing restriction should remain until the patient can functionally ambulate without pain (generally 1 to 2 wk but may be longer with concomitant osteoporosis) (20,58). Core and limb strengthening correct mechanics and reduce the forces to the underlying bone (45). Exercise should start with swimming, water running, and cycling and slowly progress to weight bearing and sport-specific activities. The use of an anti-gravity treadmill is another way to accelerate progression to a partial weight bearing activity.

A full return to sport typically takes approximately 12 wk, although an accelerated return may be possible in those without underlying issues related to the female athlete triad. Use of supplemental calcium and vitamin D assists in improving bone density (45).

Buttock Pain Without Back Pain and With Neurologic Deficit

Injury to the lumbosacral plexus or sciatic nerve. Injury to the lumbosacral plexus or sciatic nerve is extremely rare in athletes. In a case series of 216 peripheral nerve injuries in athletes, 31 involved the lower limbs and only 2 involved the sciatic nerve (64). Trauma to the pelvic ring is more likely to injure the L4-L5 portions of the plexus, which cross anterior to the sacral ala and SIJ. Injury to the plexus is less likely related to athletic activity and is more suspicious for intrapelvic disease such as neoplasm, endometriosis, or visceral disease. Injury to the sciatic nerve as it crosses the sciatic notch is more likely to affect the peroneal division because it is situated medially against the notch. Any clinical evidence of nerve injury requires removal from activity until further investigation can be performed. Electromyography (EMG) provides excellent sensitivity and specificity to localize and characterize nerve injury (115), and MRI may be required to evaluate for an anatomic abnormality within the pelvis.

Buttock Pain Without Back Pain and Without Neurologic Deficit

GM dysfunction and ITB syndrome. The GM contributes to hip abduction, as well as hip internal (anterior fibers) and external rotation (posterior fibers). The functional consequence of GM weakness is decreased running speed, jumping distance, and limb stability when lunging or landing (86). GM dysfunction is most commonly seen in martial arts, cycling, aerobics, running, and dancing (76). Up to 14% of patients with lateral hip, buttock, or groin pain will have tendinopathy of the GM or gluteus minimus tendons (60). Trendelenburg gait may be observed, in which the weakened muscle fails to elevate the contralateral pelvis during single-leg stance over the weakened limb. GM dysfunction is frequently associated with tightness of the ITB, which produces impingement over the lateral femoral condyle during the stance phase of gait (86). Increased tension of the ITB is a common cause of external snapping hip. Weakness of the GM also may contribute to patellofemoral pain syndrome because the increased hip adduction produces a greater valgus angle at the knee and greater force on the patella as it tracks in the femoral groove (30,52).

Patients may report soreness or pain in the lateral hip and buttock and may notice increased pain in single-leg stance on the affected side during walking or running. Radiation of pain only above the greater trochanter suggests GM dysfunction, whereas extension distally along the lateral leg to the knee implicates ITB syndrome. Examination should include strength testing of hip abduction with the patient lying on their unaffected side, as well as hip external and internal rotation with the patient seated. The Trendelenburg test requires the patient to stand on one leg and raise the other leg to 90° hip and knee flexion; lateral pelvic shift, pelvic drop, or trunk sway all indicate GM weakness with 72% sensitivity and 76% specificity (11,117). A single-leg squat is a more complex and dynamic test. Additional testing is performed by standing in single-leg stance and reaching the ipsilateral arm overhead in the direction of the lifted leg, noting for pelvic shift or drop (41). This test is particularly useful because it requires an eccentric contraction of the GM to slow the arm movement.

Treatment includes strengthening of the GM from open-chain side-lying to closed-chain pelvic drop exercises, working up toward three sets of 30 repetitions. Gentle stretching and myofascial release of the ITB should be included if tightness is present. Inciting activities, such as running, should be discontinued during this program, but cross-training, such as swimming, may be allowed if they do not provoke symptoms. Most athletes have a full return to sport by 6 wk (41). Persistent pain may require further diagnostic workup, including the use of MRI or musculoskeletal ultrasound (US), to evaluate and treat tendinopathy. The use of platelet-rich plasma (PRP) injections to treat tendinopathy has been increasing in recent years with some promising results, but more rigorous studies of techniques and outcomes are needed (31).

Piriformis syndrome. The term *piriformis syndrome* was first coined by Daniel Robinson (91) in 1947 to describe buttock and posterior leg sciatica pain secondary to compression of the sciatic nerve by an enlarged or inflamed piriformis muscle (PM). Up to 5% of all cases of low back, buttock, and leg pain are attributed to piriformis syndrome (85). However, there is significant controversy as to the true definition and treatment of this syndrome because most patients given the diagnosis of piriformis syndrome have no clinical or electrodiagnostic evidence of a neurologic deficit (102). These authors believe that this syndrome is piriformis myalgia secondary to weakness in the larger and more functionally significant gluteal muscles. Skiing, skating, gymnastics, and dance are all susceptible sports because they feature frequent hip flexion, internal rotation, and adduction (17). Cyclists with piriformis myalgia may not tolerate prolonged sitting.

On examination, concordant pain occurs with activation against resistance (*i.e.*, hip external rotation and extension) or passive stretch (*i.e.*, hip internal rotation and flexion). Special clinical tests of the PM include ones described by Freiberg (passive internal rotation of hip with extended leg; patient supine), Pace (active abduction of hip; patient seated with leg flexed), Beatty (active abduction of hip with flexed leg; patient in lateral decubitus position, affected side up), and FAIR maneuvers (passive flexion, adduction, and internal rotation of hip; patient supine) (8,33,46,83). However, none of these maneuvers have shown reproducible validation in the literature.

The diagnosis of piriformis syndrome is one of exclusion, and other causes of proximal sciatic neuropathy, such as tumor, aneurysm, endometriosis, abscess, and surgical adhesions, should be ruled out. Rehabilitation should include stretching of the PM in flexion and internal rotation. Spray and stretch techniques, massage, and ultrasound for deep heat are useful adjuncts. Strengthening exercises should focus not only on the PM but also on the gluteal muscles because they provide the bulk of power in hip rotation, abduction, and extension compared to the PM alone (33). Failure of symptomatic relief after 6 wk of rehabilitation may require consideration of more invasive treatments, such as guided injections (fluoroscopy, EMG, CT, MRI, or US) of the muscle with anesthetic, corticosteroid, or botulinum toxin, although the evidence for such interventions is currently preliminary or limited (32,34,48,49,53,68,89,100,118). Surgical treatment by open or arthroscopic release has been described with success in very small, uncontrolled studies and only should be considered with caution in refractory cases (9,27,80).

Hamstring tendinopathy, tear, or avulsion. High hamstring tendinopathy is an overuse injury most often seen in middle- and long-distance runners. Patients report vague, deep buttock, and posterior thigh pain, often with acceleration or at higher speeds (44). Weakness or fatigue with eccentric contraction during the late swing phase of running gait predisposes to injury (61). Pain may be reproduced by direct palpation over the ischial tuberosity or provocation with passive hip flexion, with resisted hip extension or knee flexion, or with a supine plank test. Pain concentrated distal to the ischium may reflect a proximal muscle tear rather than tendon injury. Pain above the ischial tuberosity is more consistent with gluteal or piriformis disorders. Pain in children and adolescent athletes should raise concern for apophysitis or avulsion due to incomplete closure of growth plates (20,105). The term *hamstring syndrome* also has been used to describe irritation of the sciatic nerve secondary to fibrous adhesions noted in chronic hamstring tendinopathy (87).

Evaluation with x-ray may reveal abnormal bony morphology, calcific tendinopathy, or bony avulsions (24,65). MRI is the preferred imaging modality (111,120). Separate studies of Australian rules football players and high-speed sprinters revealed a positive correlation with severity of MRI findings and days of lost competition (112). The long head of the biceps femoris was most commonly injured, and proximal injuries near the ischial tuberosity insertion had a worse outcome than those within the muscle belly (5,111).

Friction treatments with transverse glides are recommended for tissue mobilization (including anterior innominate rotation) (20,23,24). Signs of pelvic malalignment should be treated early. Flexibility exercises should include both limbs and antagonist muscle groups to ensure muscle balance. Exercise progresses from non-weight bearing to weight bearing to functional. Strengthening progresses from double-limb to single-limb and from static to dynamic to plyometric. Eccentric exercises have been demonstrated with US to normalize tendon morphology and thickness (82). Furthermore, athletes who achieve less than a 5% strength deficit with eccentric exercises on the affected side return to play at preinjury functional level and avoid injury during the following year (25). Pool running is a nonimpact exercise that will allow runners to remain physically active until they are able to resume running near the end of rehabilitation (116). Core strengthening exercises with coactivation of gluteal and hamstring muscles have been shown in small studies to decrease hamstring stiffness and the rate of recurrent injury (44,66,98). Return to running occurs with return of full range of motion and pain-free strength testing (mild weakness is acceptable), and distance and incline are gradually increased each week as long as pain does not recur.

Treatment options for recalcitrant pain include US-guided corticosteroid peritendinous injection near the tendinous insertion, extracorporal shockwave therapy, platelet-rich plasma, and surgical debridement (44). In one study of outcomes of 38 patients receiving US-guided peritendinous corticosteroid injection, 50% had symptomatic relief during 1 month and 24% had symptomatic relief longer than 6 months (120). Surgical outcomes for repair of proximal hamstring injuries are more likely effective when performed early on severe injuries (*i.e.*, complete tendon rupture or avulsion with displacement of at least 2 cm, performed within first 4 to 6 wk) (4,24,39,70,93,97).

Bursitis. The two most common bursae to become inflamed and cause buttock pain are those at the greater trochanter and ischial tuberosity. Dancers who adduct beyond midline, runners with a crossover-style gait, and runners who train on road in a single direction on sloped roads are prone to greater trochanteric bursitis due to the additional stretch placed on the ITB (77). In many cases, bursitis is a secondary inflammation caused by abnormal forces applied on the bursa (103,108). One study of patients with greater trochanteric bursitis documented MRI evidence of GM and gluteus minimus tendinopathy in 62.5% and 45.8%, respectively (11).

Patients will complain of pain when lying or sitting directly over the inflamed bursa, especially on hard surfaces (16,84). Examination will reveal tenderness directly over the greater trochanter or ischial tuberosity. The preferred imaging modalities are MRI and US, which may both demonstrate increased fluid in the bursae; US allows for better visualization of calcific tendinosis and is useful in guiding needles to the affected site for treatment (62). Most patients respond to a 6- to 8-wk course of conservative therapy, including NSAIDs, modalities, gentle stretching of the ITB, and strengthening of the hip abductors (77,103). Corticosteroid injections help to reduce inflammation with an average 60% to 80% success rate in a small case series (3,103). If the primary issue is in the tendon, other interventions include needle tenotomy with or without PRP (62). Once pain subsides, a rehabilitation program should be initiated to prevent further injury and should stress treatment of the muscles and tendons that overlie the inflamed bursa.

Rare disorders. Although uncommon, a few other diagnoses must be considered. Acute posterior compartment syndrome presents with pain and a feeling of tightness provoked with exercise. The syndrome usually is accompanied by a history of trauma and may be associated with a hamstring avulsion fracture (67). Examination reveals tense soft tissues that are difficult to manipulate relative to the unaffected limb. Compartment testing may reveal elevated pressures, and MRI helps to confirm the diagnosis (14,40). Atraumatic gluteal compartment syndrome also has been described (55).

Rare diseases that may involve the gluteal region include myositis ossificans, lipoma, myxoma, rhabdomyosarcoma, and osteochondroma in the bone of children (12). Entrapment of the superior or inferior gluteal nerves has been reported after local buttock trauma, pelvic fractures, hip surgery, and local injections (75,88).

Thrombosis of the gluteal vasculature with consequent claudication may occur, especially with a history of peripheral vascular disease, coronary artery disease, or smoking. Evaluation with ankle-brachial index, duplex ultrasound, or angiography may confirm the diagnosis (7,10). A common cause of exercise-induced lower limb claudication in as much as 10% to 20% of elite-level cyclists is external iliac endofibrosis, in which luminal narrowing of the artery occurs as a result of repeated kinking by the psoas muscle (36,72). This also has been documented in other endurance athletes whose activities include repeated extreme hip flexion (36).

Conclusions

Buttock pain in athletes may arise from the gluteal region itself or be referred from the lumbosacral spine, pelvis, hip, or thigh. The muscles of the hip and buttock play an important role in transmitting forces of the kinetic chain between the lower limb and torso, and injuries that hinder this force transmission have a detrimental effect on athletic performance. Evaluation of pain requires knowledge of the differential diagnoses, a thorough clinical evaluation, and appropriate diagnostic studies. Treatment requires practitioners of sports medicine to address deficiencies in muscle balance and core strength. Adhering to the general principles of pain reduction, remobilization, and rehabilitation leads to a safe and productive return to sport.

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References

1. Adkins SB, Figler RA. Hip pain in athletes. *Am. Fam. Physician.* 2000; 61:2109–20.
2. Akuthota V, Ferreiro A, Moore T, Fredericson M. Core stability exercise principles. *Curr. Sports Med. Rep.* 2008; 7:39.
3. Alvarez-Nemegyei J, Canoso JJ. Evidence-based soft tissue rheumatology. III. Trochanteric bursitis. *J. Clin. Rheumatol.* 2004; 10:123.
4. Anderson K, Strickland SM, Warren R. Hip and groin injuries in athletes. *Am. J. Sports Med.* 2001; 29:521.
5. Askling CM, Tengvar M, Saartok T, Thorstensson A. Acute first-time hamstring strains during high-speed running. *Am. J. Sports Med.* 2007; 35:197.
6. Atlihan D, Tekdemir I, Ates Y, Elhan A. Anatomy of the anterior sacroiliac joint with reference to lumbosacral nerves. *Clin. Orthop. Relat. Res.* 2000; 376:236.
7. Batt M, Baque J, Bouillanne PJ, *et al.* Percutaneous angioplasty of the superior gluteal artery for buttock claudication: a report of seven cases and literature review. *J. Vasc. Surg.* 2006; 43:987–91.
8. Beatty RA. The piriformis muscle syndrome: a simple diagnostic maneuver. *Neurosurgery.* 1994; 34:512.
9. Benson ER, Schutzer SF. Posttraumatic piriformis syndrome: diagnosis and results of operative treatment. *J. Bone Joint Surg. Am.* 1999; 81:941.
10. Berthelot JM, Pillet JC, Mitard D, *et al.* Buttock claudication disclosing a thrombosis of the superior left gluteal artery: report of a case diagnosed by a selective arteriography of the iliac artery, and cured by per-cutaneous stenting. *Joint Bone Spine.* 2007; 74:289–91.
11. Bird PA, Oakley SP, Shnier R, Kirkham BW. Prospective evaluation of magnetic resonance imaging and physical examination findings in patients with greater trochanteric pain syndrome. *Arthritis Rheum.* 2001; 44:2138–45.
12. Blitman NM, Pandya D, Thornhill BA, *et al.* Pain in the butt: spectrum of gluteal region abnormalities in children. *AJR Am. J. Roentgenol.* 2009; 192:1286.
13. Bottomley MB. Sacral stress fracture in a runner. *Br. J. Sports Med.* 1990; 24:243.
14. Brandser EA, El-Khoury GY, Kathol MH, *et al.* Hamstring injuries: radiographic, conventional tomographic, CT, and MR imaging characteristics. *Radiology.* 1995; 197:257.
15. Braun J, Sieper J, Bollow M. Imaging of sacroiliitis. *Clin. Rheumatol.* 2000; 19:51–7.
16. Braun P, Jensen S. Hip pain: a focus on the sporting population. *Aust. Fam. Physician.* 2007; 36:406–13.
17. Bravman JT, Mejia H, Patel VV, Akuthota V. Lumbar radicular and referred pain in the athlete. In: *Nerve and Vascular Injuries in Sports Medicine*, Akuthota and Herring, Eds. New York:Springer;2009.
18. Broadhurst NA, Bond MJ. Pain provocation tests for the assessment of sacroiliac joint dysfunction. *J. Spinal Disord.* 1998; 11:341–5.
19. Brolinson PG, Kozar AJ, Cibor G. Sacroiliac joint dysfunction in athletes. *Curr. Sports Med. Rep.* 2003; 2:47.
20. Brukner P, Khan K. *Clinical Sports Medicine*, 3rd Revised Ed. Sydney: McGraw Hill; 2010.
21. Burnett RSJ, Rocca G, Prather H, *et al.* Clinical presentation of patients with tears of the acetabular labrum. *J. Bone Joint Surg. Am.* 2006; 88:1448.
22. Chen YC, Fredericson M, Smuck M. Sacroiliac joint pain syndrome in active patients: a look behind the pain. *Phys. Sports Med.* 2002; 30:30.
23. Cibulka MT, Rose SJ, Delitto A, Sinacore DR. Hamstring muscle strain treated by mobilizing the sacroiliac joint. *Phys. Ther.* 1986; 66:1220.
24. Clanton TO, Coupe KJ. Hamstring strains in athletes: diagnosis and treatment. *J. Am. Acad. Orthop. Surg.* 1998; 6:237.
25. Croisier JL, Forthomme B, Namurois MH, *et al.* Hamstring muscle strain recurrence and strength performance disorders. *Am. J. Sports Med.* 2002; 30:199.
26. Delvaux K, Lysens R. Lumbosacral pain in an athlete. *Am. J. Phys. Med. Rehabil.* 2001; 80:388.
27. Dezawa A, Kusano S, Miki H. Arthroscopic release of the piriformis muscle under local anesthesia for piriformis syndrome. *Arthroscopy.* 2003; 19:554–7.
28. Dreyfuss P, Cole AJ, Pauza K. Sacroiliac joint injection techniques. *Phys. Med. Rehabil. Clin. North Am.* 1995; 6:785–814.
29. Dreyfuss P, Michaelsen M, Pauza K, *et al.* The value of medical history and physical examination in diagnosing sacroiliac joint pain. *Spine.* 1996; 21:2594.
30. Earl JE, Hertel J, Denegar CR. Patterns of dynamic malalignment, muscle activation, joint motion, and patellofemoral-pain syndrome. *J. Sport Rehabil.* 2005; 14:215.
31. Engebretsen L, Steffen K, Alsousou J, *et al.* IOC consensus paper on the use of platelet-rich plasma in sports medicine. *Br. J. Sports Med.* 2010; 44:1072.
32. Finnoff JT, Hurdle MF., Smith J. Accuracy of ultrasound-guided versus fluoroscopically guided contrast-controlled piriformis injections: a cadaveric study. *J. Ultrasound Med.* 2008; 27:1157.
33. Fishman LM, Dombi GW, Michaelsen C, *et al.* Piriformis syndrome: diagnosis, treatment, and outcome — a 10-year study. *Arch. Phys. Med. Rehabil.* 2002; 83:295–301.
34. Fishman LM, Konnoth C, Rozner B. Botulinum neurotoxin type B and physical therapy in the treatment of piriformis syndrome: a dose-finding study. *Am. J. Phys. Med. Rehabil.* 2004; 83:42.
35. Foley BS, Buschbacher RM. Sacroiliac joint pain: anatomy, biomechanics, diagnosis, and treatment. *Am. J. Phys. Med. Rehabil.* 2006; 85:997.
36. Ford SJ, Rehman A, Bradbury AW. External iliac endofibrosis in endurance athletes: a novel case in an endurance runner and a review of the literature. *Eur. J. Vasc. Endovasc. Surg.* 2003; 26:629–34.
37. Fortin JD, Washington WJ, Falco FJ. Three pathways between the sacroiliac joint and neural structures. *AJNR Am. J. Neuroradiol.* 1999; 20:1429.
38. Fortin JD, Kissling RO, O'Connor BL, Vilensky JA. Sacroiliac joint innervation and pain. *Am. J. Orthop. (Belle Mead, N.J.).* 1999; 28:687.
39. Frank RM, Slabaugh MA, Grumet RC, *et al.* Posterior hip pain in an athletic population: differential diagnosis and treatment options. *Sports Health.* 2010; 2:237.
40. Franklyn-Miller A, Falvey E, McCrory P. The gluteal triangle: a clinical patho-anatomical approach to the diagnosis of gluteal pain in athletes. *Br. J. Sports Med.* 2009; 43:460.
41. Fredericson M, Cookingham CL, Chaudhari AM, *et al.* Hip abductor weakness in distance runners with iliotibial band syndrome. *Clin. J. Sport Med.* 2000; 10:169.
42. Fredericson M, Jennings F, Beaulieu C, Matheson GO. Stress fractures in athletes. *Top. Magn. Reson. Imaging.* 2006; 17:309.

43. Fredericson M, Moore W, Biswal S. Sacral stress fractures: magnetic resonance imaging not always definitive for early stage injuries. *Am. J. Sports Med.* 2007; 35:835.
44. Fredericson M, Moore W, Guillet M, Beaulieu C. High hamstring tendinopathy in runners: meeting the challenges of diagnosis, treatment, and rehabilitation. *Phys. Sports Med.* 2005; 33:32.
45. Fredericson M, Salamancha L, Beaulieu C. Tracking down nonspecific pain in distance runners. *Phys. Sports Med.* 2003; 31:31–42.
46. Freiberg AH, Vinke TH. Sciatica and the sacro-iliac joint. *J. Bone Joint Surg.* 1934; 16:126.
47. Furusawa N, Baba H, Miyoshi N, *et al.* Herniation of cervical intervertebral disc: immunohistochemical examination and measurement of nitric oxide production. *Spine.* 2001; 26:1110.
48. Gonzalez P, Pepper M, Sullivan W, Akuthota V. Confirmation of needle placement within the piriformis muscle of a cadaveric specimen using anatomic landmarks and fluoroscopic guidance. *Pain Physician.* 2008; 11:327–31.
49. Hanania M, Kitain E. Perisciatic injection of steroid for the treatment of sciatica due to piriformis syndrome. *Reg. Anesth. Pain Med.* 1998; 23:223–8.
50. Harper BE, Reveille JD. Spondyloarthritis: clinical suspicion, diagnosis, and sports. *Curr. Sports Med. Rep.* 2009; 8:29.
51. Heck JF, Sparano JM. A classification system for the assessment of lumbar pain in athletes. *J. Athl. Train.* 2000; 35:204.
52. Hertel J, Sloss BR, Earl JE. Effect of foot orthotics on quadriceps and gluteus medius electromyographic activity during selected exercises. *Arch. Phys. Med. Rehabil.* 2005; 86:26–30.
53. Huerto AP, Yeo SN, Ho KY. Piriformis muscle injection using ultrasonography and motor stimulation — report of a technique. *Pain Physician.* 2007; 10:687.
54. Huffman GR, Safran M. Tears of the acetabular labrum in athletes: diagnosis and treatment. *Sports Med. Arthrosc. Rev.* 2002; 10:141.
55. Hynes JE, Jackson A. Atraumatic gluteal compartment syndrome. *Postgrad. Med. J.* 1994; 70:210.
56. Iwamoto J, Sato Y, Takeda T, Matsumoto H. The return to sports activity after conservative or surgical treatment in athletes with lumbar disc herniation. *Am. J. Phys. Med. Rehabil.* 2010; 89:1030.
57. Jennings F, Lambert E, Fredericson M. Rheumatic diseases presenting as sports-related injuries. *Sports Med.* 2008; 38:917–30.
58. Johnson AW, Weiss CB, Stento K, Wheeler DL. Stress fractures of the sacrum. *Am. J. Sports Med.* 2001; 29:498.
59. Kinard RE. Diagnostic spinal injection procedures. *Neurosurg. Clin. N. Am.* 1996; 7:151.
60. Kingzett-Taylor A, Tirman PF, Feller J, *et al.* Tendinosis and tears of gluteus medius and minimus muscles as a cause of hip pain: MR imaging findings. *AJR Am. J. Roentgenol.* 1999; 173:1123.
61. Koller A, Sumann G, Schobersberger W, *et al.* Decrease in eccentric hamstring strength in runners in the Tirol speed marathon. *Br. J. Sports Med.* 2006; 40:850.
62. Kong A, Van der Vliet A, Zadow S. MRI and US of gluteal tendinopathy in greater trochanteric pain syndrome. *Eur. Radiol.* 2007; 17:1772–83.
63. Kraft DE. Low back pain in the adolescent athlete. *Pediatr. Clin. North Am.* 2002; 49:643–53.
64. Krivickas LS, Wilbourn AJ. Peripheral nerve injuries in athletes: a case series of over 200 injuries. In: *Seminars in Neurology.* 2000; 20:225–32.
65. Kujala UM, Orava S, Järvinen M. Hamstring injuries. Current trends in treatment and prevention. *Sports Med. (Auckland, NZ).* 1997; 23:397.
66. Kuszewski M, Gnat R, Saulicz E. Stability training of the lumbo-pelvo-hip complex influence stiffness of the hamstrings: a preliminary study. *Scand. J. Med. Sci. Sports.* 2009; 19:260–6.
67. Kwong Y, Patel J. Spontaneous complete hamstring avulsion causing posterior thigh compartment syndrome. *Br. J. Sports Med.* 2006; 40:723.
68. Lang AM. Botulinum toxin type B in piriformis syndrome. *Am. J. Phys. Med. Rehabil.* 2004; 83:198.
69. Lawrence JP, Greene HS, Grauer JN. Back pain in athletes. *J. Am. Acad. Orthop. Surg.* 2006; 14:726–35.
70. Lempainen L, Sarimo J, Orava S. Recurrent and chronic complete ruptures of the proximal origin of the hamstring muscles repaired with fascia lata autograft augmentation. *Arthroscopy.* 2007; 23:441.e1–5.
71. Lesher JM, Dreyfuss P, Hager N, *et al.* Hip joint pain referral patterns: a descriptive study. *Pain Med.* 2008; 9:22–5.
72. Lim CS, Gohel MS, Shepherd AC, Davies AH. Iliac artery compression in cyclists: mechanisms, diagnosis and treatment. *Eur. J. Vasc. Endovasc. Surg.* 2009; 38:180–6.
73. Lim HJ, Moon YI, Lee MS. Effects of home-based daily exercise therapy on joint mobility, daily activity, pain, and depression in patients with ankylosing spondylitis. *Rheumatol. Int.* 2005; 25:225–9.
74. Maigne JY, Aivaliklis A, Pfefer F. Results of sacroiliac joint double block and value of sacroiliac pain provocation tests in 54 patients with low back pain. *Spine.* 1996; 21:1889.
75. McCrory P, Bell S. Nerve entrapment syndromes as a cause of pain in the hip, groin and buttock. *Sports Med.* 1999; 27:261–74.
76. McTimoney C, Micheli LJ. Current evaluation and management of spondylolysis and spondylolisthesis. *Curr. Sports Med. Rep.* 2003; 2:41.
77. Melamed H, Hutchinson MR. Soft tissue problems of the hip in athletes. *Sports Med. Arthrosc. Rev.* 2002; 10:168.
78. Micheli LJ, Wood R. Back pain in young athletes: significant differences from adults in causes and patterns. *Arch. Pediatr. Adolesc. Med.* 1995; 149:15–8.
79. Miller SF, Congeni J, Swanson K. Long-term functional and anatomical follow-up of early detected spondylolysis in young athletes. *Am. J. Sports Med.* 2004; 32:928.
80. Mizuguchi T. Division of the pyriformis muscle for the treatment of sciatica. Postlaminectomy syndrome and osteoarthritis of the spine. *Arch. Surg.* 1976; 111:719.
81. Mundt DJ, Kelsey JL, Golden AL, *et al.* An epidemiologic study of sports and weight lifting as possible risk factors for herniated lumbar and cervical discs. *Am. J. Sports Med.* 1993; 21:854.
82. Öhberg L, Lorentzon R, Alfredson H. Eccentric training in patients with chronic Achilles tendinosis: normalised tendon structure and decreased thickness at follow up. *Br. J. Sports Med.* 2004; 38:8.
83. Pace JB, Nagle D. Piriform syndrome. *W. J. Med.* 1976; 124:435.
84. Paluska SA. An overview of hip injuries in running. *Sports Med.* 2005; 35:991–1014.
85. Papadopoulos EC, Khan SN. Piriformis syndrome and low back pain: a new classification and review of the literature. *Orthop. Clin. North Am.* 2004; 35:65.
86. Presswood L, Cronin J, Keogh JW, Whatman C. Gluteus medius: applied anatomy, dysfunction, assessment, and progressive strengthening. *Strength Cond. J.* 2008; 30:41.
87. Puranen J, Orava S. The hamstring syndrome. *Am. J. Sports Med.* 1988; 16:517.
88. Rask MR. Superior gluteal nerve entrapment syndrome. *Muscle Nerve.* 1980; 3:304–307.
89. Reus M, de Dios Berná J, Vázquez V, *et al.* Piriformis syndrome: a simple technique for US-guided infiltration of the perisciatic nerve. Preliminary results. *Eur. Radiol.* 2008; 18:616–20.
90. Reveille JD, Arnett FC. Spondyloarthritis: update on pathogenesis and management. *Am. J. Sports Med.* 2005; 118:592–603.
91. Robinson DR. Pyriformis syndrome in relation to sciatic pain. *Am. J. Surg.* 1947; 73:355.
92. Saraste H. Long-term clinical and radiological follow-up of spondylolysis and spondylolisthesis. *J. Pediatr. Orthop.* 1987; 7:631.
93. Sarimo J, Lempainen L, Mattila K, Orava S. Complete proximal hamstring avulsions: a series of 41 patients with operative treatment. *Am. J. Sports Med.* 2008; 36:1110–5.
94. Sassmannshausen G, Smith B. Back pain in the young athlete. *Clin. Sports Med.* 2002; 21:121–32.
95. Schils J, Hauzeur JP. Stress fracture of the sacrum. *Am. J. Sports Med.* 1992; 20:769.
96. Schwarzer AC, Aprill CN, Bogduk N. The sacroiliac joint in chronic low back pain. *Spine.* 1995; 20:31.
97. Servant CT, Jones CB. Displaced avulsion of the ischial apophysis: a hamstring injury requiring internal fixation. *Br. J. Sports Med.* 1998; 32:255.
98. Sherry MA, Best TM. A comparison of 2 rehabilitation programs in the treatment of acute hamstring strains. *J. Orthop. Sports Phys. Ther.* 2004; 34:116–25.
99. Slipman CW, Patel RK, Whyte WS II, *et al.* Diagnosing and managing sacroiliac pain. *J. Musculoskeletal Med.* 2001; 18:325–32.
100. Smith J, Hurdle MF, Locketz AJ, Wisniewski SJ. Ultrasound-guided piriformis injection: technique description and verification. *Arch. Phys. Med. Rehabil.* 2006; 87:1664–7.
101. Standaert CJ, Herring SA. Spondylolysis: a critical review. *Br. J. Sports Med.* 2000; 34:415.

102. Stewart JD. *Focal Peripheral Neuropathies*, 3rd Ed. Philadelphia: Lippincott Williams & Wilkins; 2000.

103. Strauss EJ, Nho SJ, Kelly BT. Greater trochanteric pain syndrome. *Sports Med. Arthrosc. Rev.* 2010; 18:113.

104. Sturesson B, Uden A, Vleeming A. A radiostereometric analysis of the movements of the sacroiliac joints in the reciprocal straddle position. *Spine.* 2000; 25:214.

105. Sutton G. Hamstrung by hamstring strains: a review of the literature. *J. Orthop. Sports Phys. Ther.* 1984; 5:184.

106. Tallarico RA, Madom IA, Palumbo MA. Spondylolysis and spondylolisthesis in the athlete. *Sports Med. Arthrosc. Rev.* 2008; 16:32.

107. Thumbikat P, Hariharan RP, Ravichandran G, *et al.* Spinal cord injury in patients with ankylosing spondylitis: a 10-year review. *Spine.* 2007; 32:2989.

108. Tibor LM, Sekiya JK. Differential diagnosis of pain around the hip joint. *Arthroscopy.* 2008; 24:1407–21.

109. Trainor TJ, Trainor MA. Etiology of low back pain in athletes. *Curr. Sports Med. Rep.* 2004; 3:41.

110. Travell JG, Simons DG. *Myofascial Pain and Dysfunction: The Trigger Point Manual.* Baltimore: Lippincott Williams & Wilkins; 1992.

111. Verrall GM, Slavotinek JP, Barnes PG, *et al.* Clinical risk factors for hamstring muscle strain injury: a prospective study with correlation of injury by magnetic resonance imaging. *Br. J. Sports Med.* 2001; 35:435.

112. Verrall GM, Slavotinek JP, Barnes PG, Fon GT. Diagnostic and prognostic value of clinical findings in 83 athletes with posterior thigh injury. *Am. J. Sports Med.* 2003; 31:969–73.

113. Volpin G, Milgrom C, Goldsher D, Stein H. Stress fractures of the sacrum following strenuous activity. *Clin. Orthop. Relat. Res.* 1989; 243:184.

114. Watkins RG. *The Spine in Sports.* St. Louis: Mosby, Inc.; 1996.

115. Wilbourn AJ, Aminoff MJ. AAEM minimonograph 32: the electrodiagnostic examination in patients with radiculopathies. *Muscle Nerve.* 1998; 21:1612–31.

116. Wilder RP, Brennan DK. Fundamentals and techniques of aqua running for athletic rehabilitation. *J. Back Musculoskeletal Rehabil.* 1994; 4:287–96.

117. Wilson E. Core stability: assessment and functional strengthening of the hip abductors. *Strength Cond. J.* 2005; 27:21.

118. Yoon SJ, Ho J, Kang HY, *et al.* Low-dose botulinum toxin type A for the treatment of refractory piriformis syndrome. *Pharmacotherapy.* 2007; 27:657–65.

119. Young JL, Press JM, Herring SA. The disc at risk in athletes: perspectives on operative and nonoperative care. *Med. Sci. Sports Exerc.*1997; 29:222.

120. Zissen MH, Wallace G, Stevens KJ, *et al.* High hamstring tendinopathy: MRI and ultrasound imaging and therapeutic efficacy of percutaneous corticosteroid injection. *AJR Am. J. Roentgenol.* 2010; 195:993.