ELSEVIER

Operative Techniques in
Sports Medicine

Piriformis Syndrome

J.W. Thomas Byrd, MD

Piriformis syndrome is an elusive clinical entity. It is likely that this condition is overlooked and overdiagnosed with equal propensity. It is characterized by buttock pain with a variable component of sciatic nerve irritation and probably represents the most common cause of extraspinal sciatica. Systematic clinical assessment will generally lead to the correct diagnosis. Most cases can be managed with conservative treatment. Judicious use of local injections around the piriformis can have both diagnostic and therapeutic benefits. Surgical release of the piriformis and decompression of the sciatic nerve may be indicated for select recalcitrant cases. With careful patient selection, successful outcomes have been recorded in the majority of cases. Details of the assessment, anatomy, and management of this condition are outlined.
Oper Tech Sports Med 13:71-79 **© 2005 Elsevier Inc. All rights reserved.**

KEYWORDS **piriformis syndrome, evaluation, surgical treatment, surgical results**

Piriformis syndrome is an elusive condition, and the literature is often inconsistent in its description. It is likely that piriformis syndrome is overlooked and overdiagnosed with equal propensity. Reports variously cite that the piriformis may be responsible for between 0.33% and 6% of all cases of low back pain and/or sciatica.[1,2] Thus, although this condition is uncommon, it is not rare.

The first mention of the piriformis muscle as a culprit in the cause of sciatica is attributed to Yeoman in 1928.[3] He postulated that, because of its anatomic proximity to both the sciatic nerve and sacroiliac joints, fibrosis of the piriformis associated with sacroiliac periarthritis could cause sciatica. This was before Mixter and Barr's landmark article in 1934 that first recognized rupture of the intervertebral disk as a leading cause in many cases of radicular pain.[4] After this report, other causes of sciatica generally fell out of favor. In 1937, Freiberg[5] proposed the following characteristic features of sciatic pain caused by compression from the piriformis: (1) positive Lasegue sign, (2) tenderness at the sciatic notch, and (3) relief of symptoms with traction. He also described alleviation of sciatica by myofascial procedures that included release of the piriformis.

In 1947, Robinson[6] coined the term piriformis syndrome and proposed 6 cardinal features: (1) a history of trauma to the sacroiliac and gluteal region; (2) pain in the sacroiliac joint, greater sciatic notch and the piriformis muscle, extending down the leg and causing difficulty walking; (3) acute exacerbations brought on by stooping or lifting and relieved by traction on the affected leg; (4) presence of a tender, palpable, sausage-shaped mass over the piriformis muscle; (5) a positive Lasegue sign; and (6) Gluteal atrophy.

Anatomy

The piriformis muscle has a flat pyramidal shape. Its origin is from the anterior surface of the second through fourth sacral vertebrae, the sacrotuberous ligament, and the superior margin of the sciatic notch. It exits the pelvis through the sciatic notch and inserts on the superior aspect of the greater trochanter at its posteromedial corner (Fig. 1). The function of the piriformis changes depending on the position of the hip. This observation is important for understanding various examination findings. In extension, the piriformis externally rotates the hip, whereas in flexion, it becomes an abductor. Also, as observed by Freiberg and Vinke,[7] the action of the piriformis changes when the insertion is fixed, as in standing. Its attachment site at the trochanter becomes its origin and the muscle functions to pull the pelvis forward, elevating the opposite side. They also observed that the piriformis is the only muscle that bridges the sacroiliac joint.

The sciatic nerve forms from the lumbosacral plexus and includes fibers from the L4-S1 nerve roots. Distally, it divides to form the tibial and perineal nerves. As the sciatic nerve exits the sciatic notch, it lies below (anterior) to the muscle belly of the piriformis. Numerous variations of the anatomy in this region have been described (Fig. 2A-D).[8] These include separate perineal and tibial portions of the sciatic nerve

Nashville Sports Medicine and Orthopaedic Center, Nashville, TN.
Address reprint requests to J.W. Thomas Byrd, MD, Nashville Sports Medicine and Orthopaedic Center, 2011 Church Street, Suite 100, Nashville, TN 37203. E-mail: info@nsmoc.com

1060-1872/05/$-see front matter © 2005 Elsevier Inc. All rights reserved.
doi:10.1053/j.otsm.2004.09.008

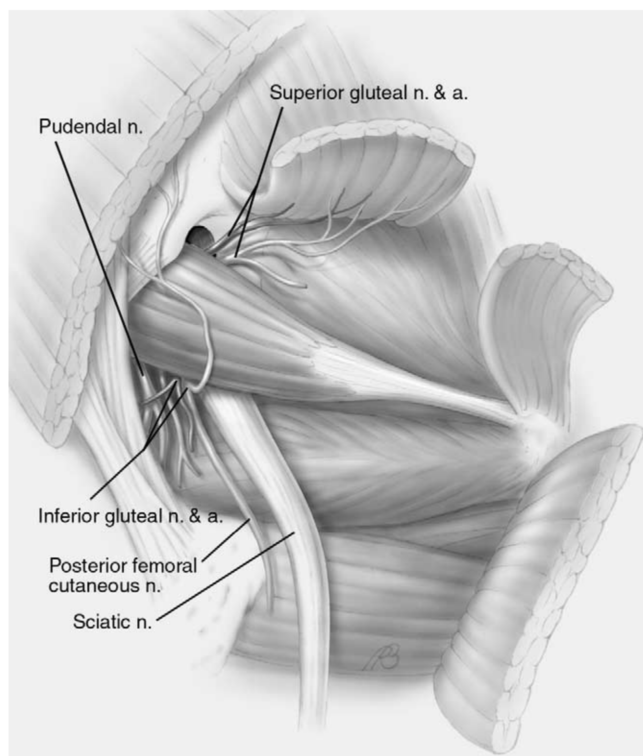

Figure 1 The sciatic nerve normally exits the sciatic notch underneath the piriformis muscle. Exiting the sciatic notch above the piriformis are the superior gluteal nerve and artery. Other structures that exit the notch underneath the piriformis include the inferior gluteal nerve and artery, pudendal nerve, internal pudendal artery (not shown), nerve to the obturator internus (not shown), posterior femoral cutaneous nerve, and nerve to the quadratus femoris (not shown).

passing above or below the piriformis or through a bifid muscle belly. Additionally, this author has observed a specimen in which the nerve coalesced from 3 separate trunks distal to a bifid piriformis muscle (Fig. 3). The sciatic nerve is susceptible to entrapment anywhere along its course from the lumbar spine through the posterior thigh.[9,10] Other structures that exit the sciatic notch include the superior gluteal nerve and artery above the piriformis and below the piriformis are the inferior gluteal nerve and artery, pudendal and posterior femoral cutaneous nerves, and the internal pudendal vessels.

Etiology

The symptoms associated with piriformis syndrome occur from compression of the sciatic nerve by the piriformis muscle. The cause of this compression and subsequent nerve irritation is variable.

Piriformis syndrome can result from overuse or repetitive trauma. During the stance phase of gait, the hip internally rotates, stretching the piriformis muscle. Then, as the hip enters the swing phase, the muscle contracts to assist in external rotation of the limb. Thus, the piriformis muscle is under strain during the entire gait cycle and it is postulated that it may be more prone to hypertrophy than other muscles in the region. Gait abnormalities may accentuate this, especially if they result in increased internal rotation or adduction such as with a leg length discrepancy.[11] It is believed that the muscle hypertrophies or becomes inflamed, although this observation has never been documented. Overtraining may be implicated as well as repetitive trauma, whether from exercise or sitting on hard surfaces ("wallet neuritis").[12]

Acute trauma has been described in numerous cases of piriformis syndrome.[2,6,13] A blunt blow to the buttock is believed to result in hematoma formation and subsequent scarring between the sciatic nerve and the short external rotators.

Anomalous anatomic relationships of the sciatic nerve with the piriformis muscle have also been implicated in the development of piriformis syndrome.[14,15] It is postulated that the nerve is more susceptible to compression by the muscle because of the variant anatomy. It is difficult to confirm this causative relationship because, in some studies, the incidence of these anomalies in patients with piriformis syndrome is the same as the incidence reported in normal anatomic series.[16,17] However, understanding and inspecting for these anomalies is important during surgery for this condition. If a portion of the nerve passes through a bifid muscle belly, then simply releasing the tendon would allow the muscle to retract, further entrapping the nerve and worsening the condition. Thus, at surgery, it is imperative to explore the relationship of the sciatic nerve and the muscle at the level of the sciatic notch to assure complete decompression.

Numerous case reports show a variety of other conditions that have been associated with piriformis syndrome including patent sciatic vessels, myositis ossificans, pyomyositis, aberrant fibrous bands, and pseudoaneurysm, among others.[18-25] Regardless of the etiology, most studies report a greater incidence among females, with a ratio as high as 6:1.[26]

Assessment

The evaluation begins with an inquiry of potential etiological factors, either trauma or precipitating activities. Sitting for prolonged periods of time is typically uncomfortable and becomes increasingly intolerable. The patient will characteristically describe posterior hip and buttock pain and a variable pattern of radicular symptoms. These distal symptoms may be spotty and ill defined but will follow the pattern of the sciatic distribution. These sensations may range from numbness and paresthesias to just a cramping sensation.

Gait, posture, and alignment should be carefully checked. Pelvic obliquity or leg length discrepancy may be a contributing factor, potentially correctable with therapy or inserts. Thorough assessment for lumbar spine disease is mandatory because this is the most likely origin for the sciatica-type symptoms. Careful examination of the hip, pelvis, and sacroiliac joint is also important. These could prove to be the primary pain generator, or piriformis syndrome may coexist with pathology from these other sites. Anatomically, the piriformis is intimately associated with the sacroiliac joint, a joint that remains a diagnostic dilemma.[27] Motor, sensory, and

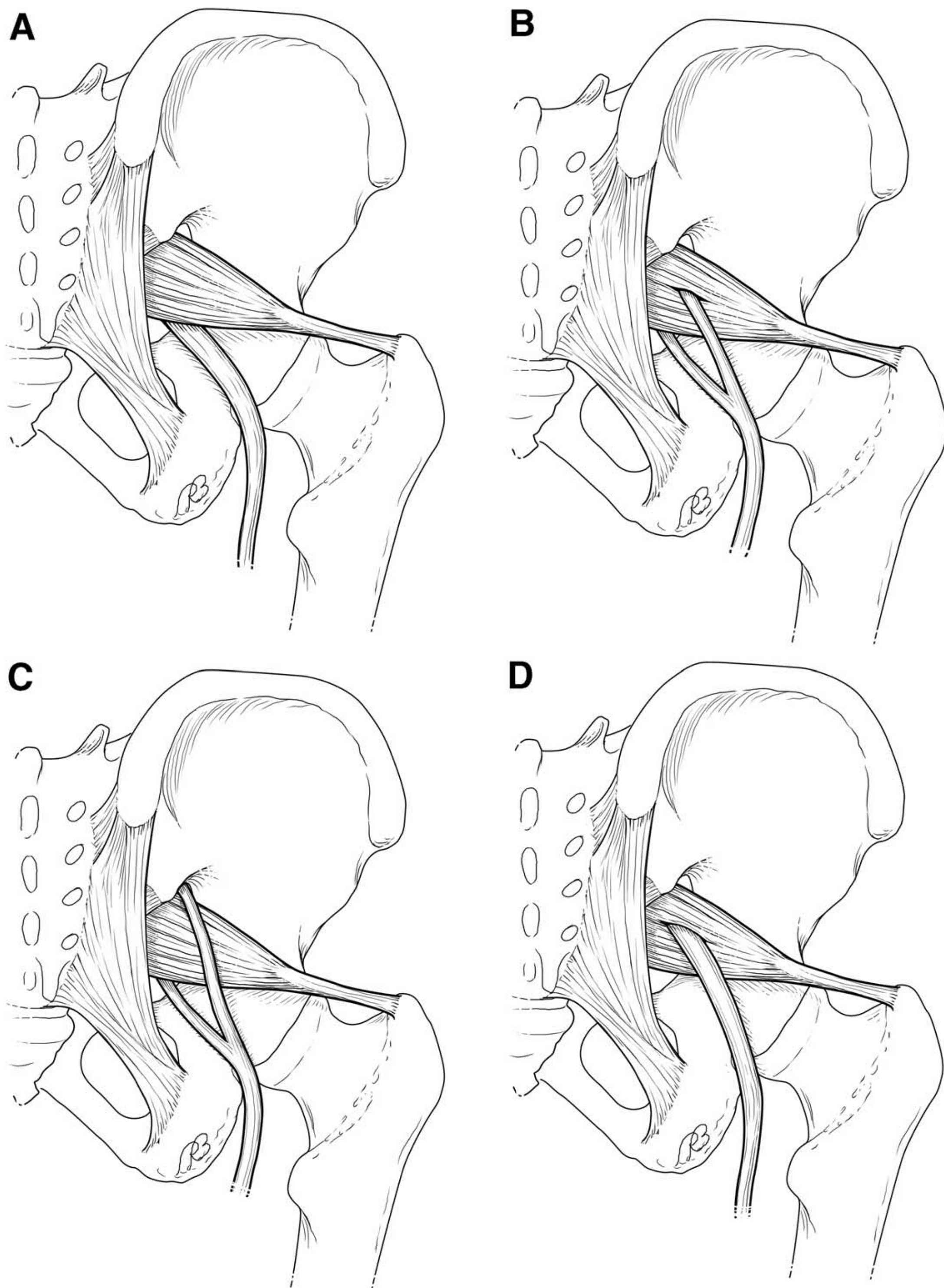

Figure 2 Various relationships of the piriformis muscle and the sciatic nerve as described by Beaton and Anson. (A) Most commonly, the undivided nerve exits the greater sciatic notch below the piriformis muscle (84.2%). (B) Second most common, divisions of the sciatic nerve pass between and below the bifid muscle belly of the piriformis (11.7%). (C) Divisions of the nerve pass above and below an undivided muscle (3.3%). (D) An undivided nerve passes between the bifid muscle bellies of the piriformis (0.8%).

deep tendon reflex examinations are routinely performed. However, objective deficits are uncommon in association with piriformis syndrome.

Numerous examination maneuvers have been described to assess for piriformis syndrome. No single finding is reliable in all cases, but a careful systematic examination should provide a reasonable clinical picture.

Posterior pain is nonspecific. The overlying gluteus maximus and other closely related soft-tissue structures can be painful to palpation. Palpation for the piriformis should be

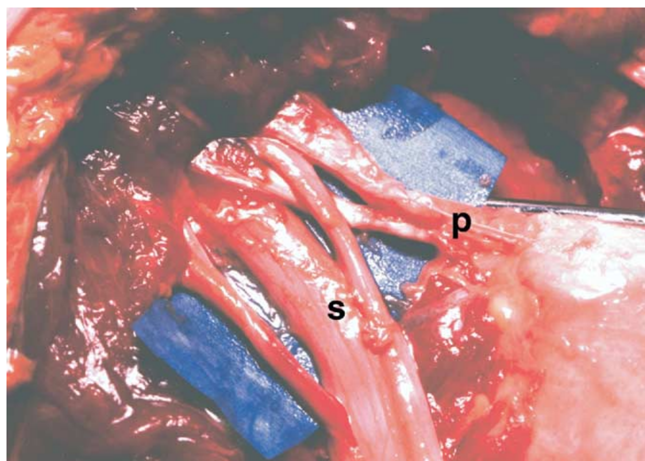

Figure 3 An anatomic specimen showing an anomaly in which the sciatic nerve coalesces from three separate trunks distal to a bifid piriformis with the superior trunk passing between the bifid muscle bellies. (Figure © J.W. Thomas Byrd.)

localized directly posterior to the hip joint, close to the sciatic notch (Fig. 4). It is easier to differentiate this from symptoms localized to the trochanteric insertion site of the gluteus maximus, the sacroiliac joint, or the ischium. In addition to pain, focal palpation may also recreate some of the patient's radicular symptoms.

Straight-leg raise findings are variable. Some studies report this to be a cardinal finding in piriformis syndrome. However, a positive straight leg raise recreating radicular pain is more likely to be indicative of lumbar nerve root irritation. Typically, straight-leg raise may produce localized posterior hip discomfort, but this is often nonspecific for a variety of conditions.

With the hip extended, passive internal rotation (Freiberg sign) and resisted external rotation of the leg are both maneuvers that may reproduce pain around the area of the piriformis (Fig. 5A&B). In flexion, the piriformis becomes an abductor, so resisted abduction of the flexed hip is another provocative test (Pace sign) (Fig. 6). Also at 90° of flexion passive adduction and internal rotation can produce symptoms. This is the maneuver referred to as the piriformis stretch (Fig. 7).

Compression by the piriformis with irritation of the sciatic nerve occurs where these structures exit the pelvis through the sciatic notch. External palpation of this area is obscured by the dense overlying gluteus maximus. This is most reliably assessed by palpating the sciatic notch from inside the pelvis, necessitating a rectal or vaginal examination.[2,11,26] Palpation of this area is normally uncomfortable, so it is important to compare the asymptomatic to the symptomatic side. A positive finding is elicited if this recreates the characteristic symptoms that the patient experiences with activities, both the buttock and radicular component. Reproduction of these symptoms is typically quite demonstrable. Absence of symptoms or equivocal findings should cause one to question the diagnosis of piriformis syndrome. Conversely, this author has observed that proximal lumbar nerve root irritation may sensitize the nerve distally and can result in a false-positive finding.

Investigative Studies

Plain radiographs, including an anteroposterior pelvis and lateral of the affected hip are routinely performed. There are no specific radiographic features associated with piriformis syndrome, but this is important to rule out other radiographically identifiable processes. For recalcitrant cases when surgery is contemplated, magnetic resonance imaging of the pelvis is prudent to rule out a mass effect within the sciatic notch or intrapelvic lesion (Fig. 8). Investigation of the lumbar spine will often include radiographs and even magnetic resonance imaing to assess for lumbar nerve root pathology.

Neurodiagnostic studies are often important, mostly to

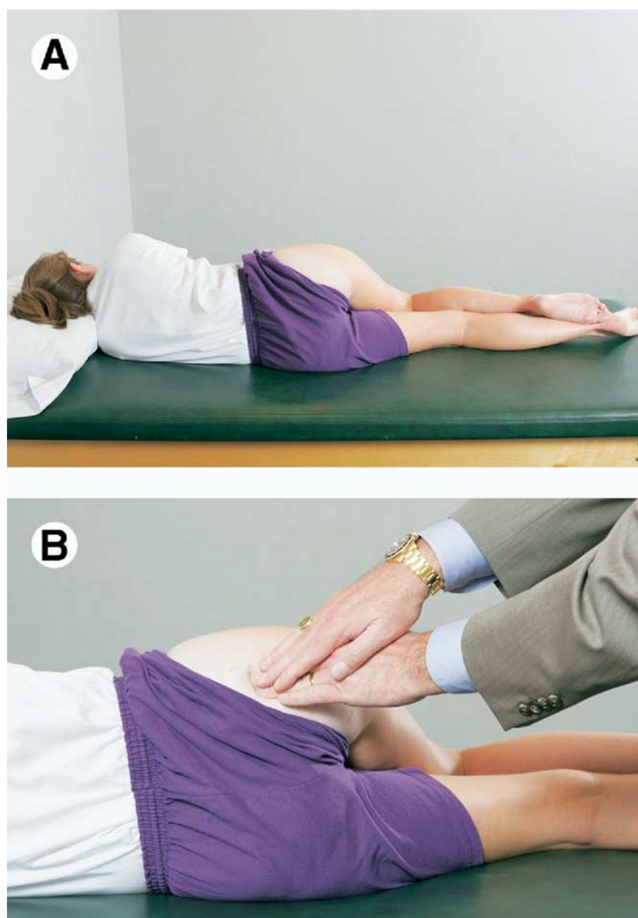

Figure 4 This right hip is examined with the patient on their side. Palpation is performed to elicit the site of maximal tenderness. The piriformis is palpated through the muscle of the gluteus maximus. (A) This is facilitated by placing the right leg on the examination table in front of the left. This creates slight flexion, adduction, and internal rotation, which places a slight stretch on the piriformis muscle. (B) The site of tenderness is medial to the posterior hip joint, close to the sciatic notch. Palpation often produces localized pain as well as recreating the patient's radicular symptoms. (Figure © J.W. Thomas Byrd.) (Color version of figure is available online.)

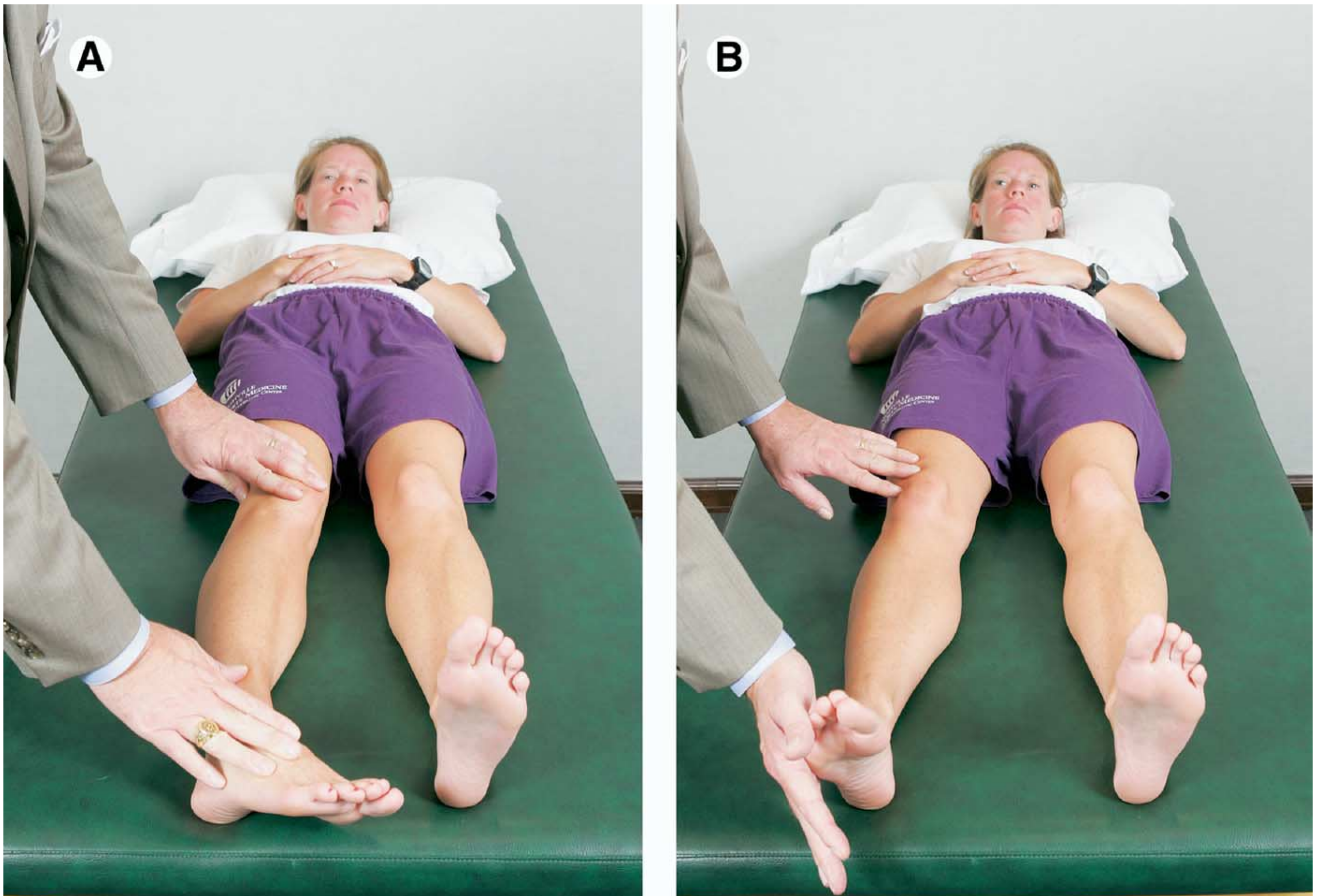

Figure 5 In the supine position, with the hip extended. (A) The leg is internally rotated by the examiner, passively stretching the piriformis muscle. (B) Active external rotation is resisted by the examiner, causing the piriformis muscle to fire. (Figure © J.W. Thomas Byrd.) (Color version of figure is available online.)

rule out other forms of pathology. If abnormalities are noted, there should be selective preservation of the superior gluteal nerve, which exits the notch above the piriformis muscle.[13,18] It is rare that piriformis syndrome will result in measurable electromyogram or conduction deficits. Fishman et al[16] have proposed that prolonged H:-reflex latency may be indicative of piriformis syndrome and this finding is accentuated if the hip is placed in a position of flexion, abduction, and internal rotation. However, their criteria for the diagnosis of piriformis syndrome were not very strict.

Conservative Treatment

Initial assessment should include a general evaluation of the spine and hip and surrounding soft-tissue structures. This preliminary evaluation may include piriformis syndrome as part of the differential diagnosis. The patient is counseled on lifestyle modifications to avoid offending activities. Oral anti-inflammatory medications are usually useful as well. Supervised physical therapy by a knowledgeable clinician is the most important component. A general program is implemented for both the back and hip.

Specific stretching of the piriformis is performed in addition to modalities for pain control. It is also important to include an assessment for core strength deficits and a conditioning program directed at core stability. As the therapist works with the patient, this has diagnostic as well as therapeutic benefits, localizing the origin of the patient's symptoms while reducing discomfort and improving function. Follow-up by the physician is important for reassessment. Often a patient's findings may change simply from 1 examination to the next. Depending on these findings and the patient's response to conservative measures, further investigation may be necessary.

If the clinical impression remains recalcitrant piriformis syndrome unresponsive to conservative measures, then an intrapelvic examination to substantiate the diagnosis may be the next step, anticipating a subsequent injection. If the diagnosis is confirmed, an injection is performed with corticosteroid mixed with short- and long-acting anesthetic. With the patient on their side, the injection is directed to the point of maximal tenderness in the area of the piriformis, medial to the posterior hip joint, approaching the sciatic notch (Fig. 9). Although it is important to deliver the injection to the area of the piriformis over the sciatic nerve, it is critical not to inject the nerve itself. As the injection is slowly begun, the patient is queried about any acute radiating leg pain, which might be indicative that the needle is too close to the nerve. The opti-

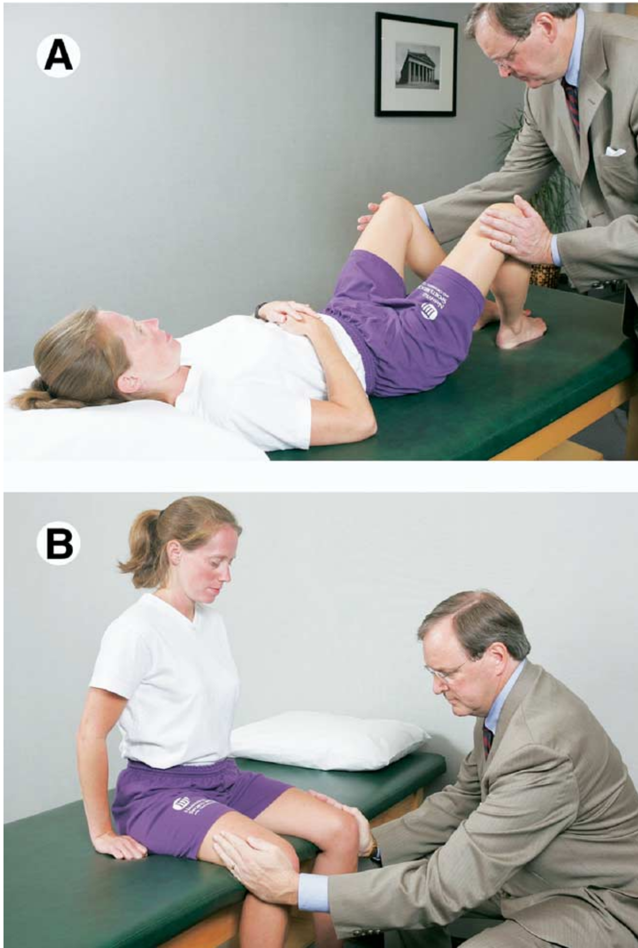

Figure 6 Resisted abduction with the hip flexed can be checked. (A) With the patient lying supine. (B) In the seated position. (Figure © J.W. Thomas Byrd.) (Color version of figure is available online.)

mal confirmation that the injection is in the right area is when the patient gets a transient anesthetic block in the sciatic distribution. Otherwise, the patient should at least experience alleviation of pain from the anesthetic effect of the injection. For some patients, the injection may be curative. In this author's experience, one fifth of all cases achieved long-term relief.

The injection is also an important diagnostic tool. If the relief is temporary, it at least helps to substantiate the diagnosis of piriformis syndrome. However, it can be difficult to reliably infiltrate the injection to the deep-lying piriformis muscle. If the clinical findings still suggest piriformis syndrome, in absence of a positive response to the injection, then this author has subsequently performed a computed tomog-

Figure 7 Passive piriformis stretching is a useful therapeutic maneuver but may also elicit symptoms. This includes hip flexion, adduction, and internal rotation. (Figure © J.W. Thomas Byrd.) (Color version of figure is available online.)

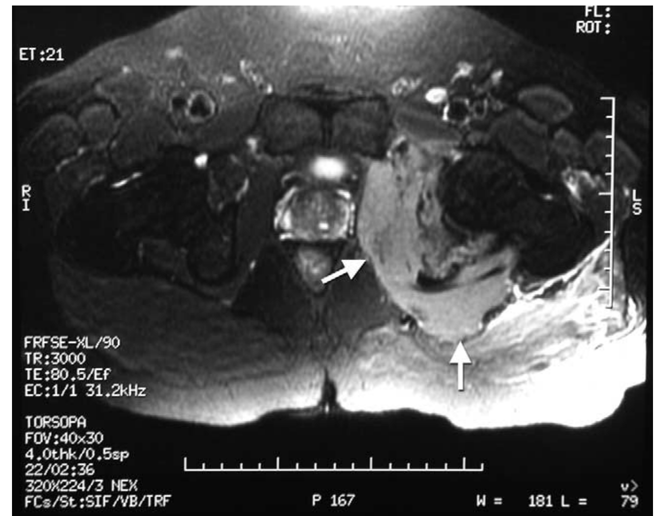

Figure 8 A 43-year-old man with painful limited motion and sciatica. An axial T-2 fat suppressed image with IV gadolinium enhancement demonstrates a large neoplastic lesion (arrows) within the pelvis, exiting the sciatic notch and encasing the posterior hip region. (Figure © J.W. Thomas Byrd.)

Figure 9 With the patient on their side, again placing the right leg on the table in front of the left places slight tension on the piriformis, improving access for the injection site. Using a 22-gauge, 1½-inch needle, an ad-mixture of 1 mL corticosteroid, 2 mL lidocaine, and 2 mL bupivacaine is injected into the tender spot over the muscle belly of the piriformis. The injection is begun slowly, and the patient is instructed to respond if any severe or radiating pain is encountered, which might indicate placement of the needle too close to the sciatic nerve. (Figure © J.W. Thomas Byrd.) (Color version of figure is available online.)

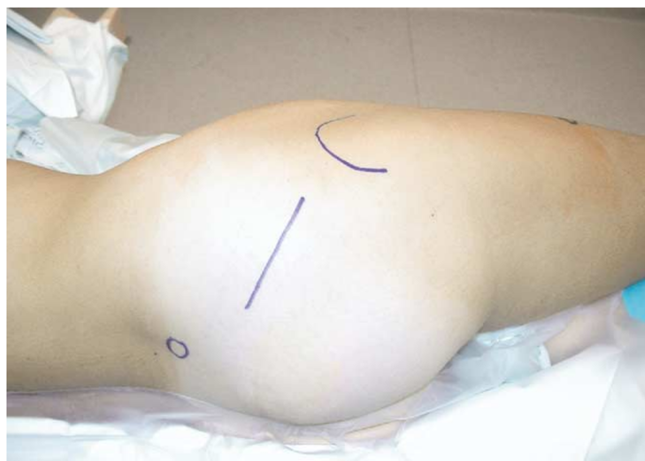

Figure 10 On this right hip, markings illustrate the incision and its relationship to pertinent topographical landmarks, including the greater trochanter and the posterior superior iliac spine. (Figure © J.W. Thomas Byrd.) (Color version of figure is available online.)

raphy–guided injection. This assures that the injection is in the desired spot and may yet substantiate the diagnosis.

If the patient gets prolonged relief, then another injection would be an appropriate consideration. However, if the response is of short duration, surgical decompression may be an appropriate alternative rather than attempting repeated injections of the area.

Operative Treatment

Surgical release of the piriformis and decompression of the sciatic nerve is a technically straightforward procedure. With thoughtful attention to a few details, the operation can be successfully performed. However, the clinical success of the procedure is clearly most dependent on careful patient selection. This includes 3 factors. First is a thorough clinical assessment to substantiate the diagnosis of piriformis syndrome, as reliably as possible. Second is an assessment of the patient's motivation and interest in recovery. Third, the patient must have reasonable expectations of what can be accomplished with the procedure. The results of this operation can be remarkably good. However, the diagnosis can still be a challenge and this condition may coexist with other pathology, including disorders of the lumbar spine and hip. Thus, the response may sometimes be incomplete. However, if the patient has exhausted conservative treatment, the symptoms are incapacitating, and a careful survey of comorbid conditions is complete, then surgery is certainly an appropriate alternative to otherwise resigning the patient to exist with their symptoms.

The procedure is a standard posterior approach to the hip, modified only by reducing the length of the incision necessary to expose the piriformis (Fig. 10).[28] Under anesthesia, the patient is positioned on their side with well-padded pelvic supports and the affected hip up. The proximal portion of a posterior incision is used. The incision is made in the direction of the gluteus maximus fibers, extending from the sciatic notch just below the posterior superior iliac spine medially, toward the greater trochanter laterally. Extension of the incision beyond the trochanter is not necessary for adequate exposure. The fascia overlying the gluteus maximus is incised in line with its fibers. The muscle belly is then bluntly separated for exposure of the posterior hip and the piriformis. A self-retaining retractor holds the muscle separated, maintaining exposure.

The tendinous insertion of the piriformis at the greater trochanter is isolated (Fig. 11A and B). A no. 1 tag suture is placed and the tendon is then sharply released from its insertion. Using the tag suture for traction, the piriformis is then dissected back to the sciatic notch for thorough inspection of the anatomic relationship between its muscle belly and the sciatic nerve (Fig. 12A and B). Particular attention is given to whether a portion or all of the nerve passes through a bifid muscle belly. Inspection is also made for any other anomalies that might create a soft-tissue mass effect within the sciatic notch.

Once the dissection and inspection is complete, 1.5 to 2 cm of the distal stump of the piriformis is resected. The site of the resection is within its muscle fibers but does not need to extend so far medially that the remaining muscle might retract inside the pelvis. If a bifid muscle belly is present, the separation between these must be completed so that there is no risk of retracted muscle further entrapping the nerve.

Meticulous hemostasis is maintained. If the wound is dry, routine closure is performed without drains. If in doubt, a drain can be placed and removed the following day. It is important to minimize the risk of significant hematoma formation, which can lead to various complications including persistent drainage, difficulty with wound healing, infection, reoperation, scar formation, myositis ossificans, and excessive postoperative pain. Normally, the procedure can be performed on an outpatient basis or with an overnight stay in an ambulatory surgery setting.

Postoperatively, the patient is weight bearing as tolerated but uses crutches for approximately 2 weeks to normalize gait and protect the wound during early healing. Additionally, the patient is instructed to avoid prolonged sitting over the area of the hip. The patient needs to be a little cautious during the first 4 to 6 weeks after surgery to lessen the likelihood of any setbacks. Gradual resumption of activities is then dictated by their symptoms and functional response to physical therapy.

Often, the symptomatic improvement is immediate. The response may be similar to a patient undergoing diskectomy for an entrapped lumbar nerve root. The patient will note postsurgical discomfort but elimination of the intractable pain that had precipitated surgery. Although this is an immediate indication of the success of the procedure, it is still important to be careful during the early postoperative recovery. Sometimes the response may be more gradual, but usually within 4 to 6 weeks, the patient will begin to experience symptomatic improvement. Incisional discomfort associated with the operation can be expected and will improve over several months.

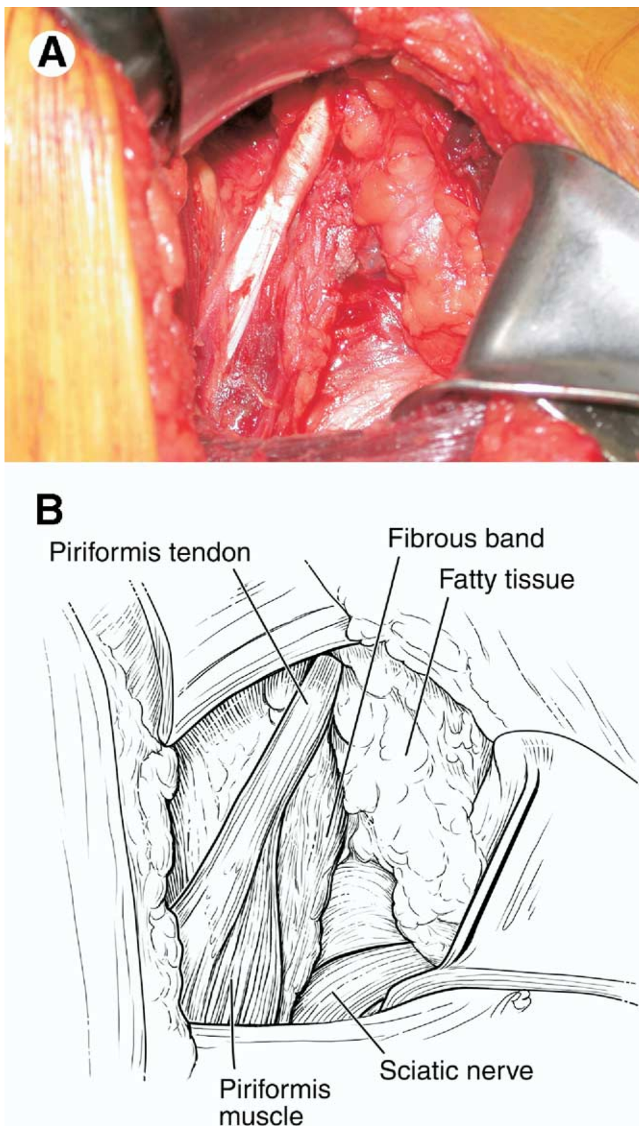

Figure 11 (A and B) The gluteus maximus muscle fibers have been split in line with the incision and are retracted, revealing the underlying structures. The piriformis tendon is isolated, and its muscular fibers are seen overlying the sciatic nerve. In this case, an aberrant fibrous band parallels the piriformis on its deep surface, contributing to compression of the sciatic nerve. Distally, the layer of fat that normally overlies the nerve is seen. This tissue is preserved to reduce the risk of perineural adhesions. (Figure 11A © J.W. Thomas Byrd.)

Results

The reported success of surgical release of the piriformis and decompression of the sciatic nerve are generally good but variable. The literature is replete with numerous case reports and small case series, but the largest cohorts were published by Fishman et al (n = 43),[13] Indrekvam and Sudmann (n = 19),[16] and Benson and Schutzer (n = 15).[17] The spectrum of results from these 3 studies respectively ranged from 68.8% achieving >50% relief, two thirds improved, and 100% excellent or good results. The varied nature of these success rates partly reflects the difficulty in making the diagnosis of piriformis syndrome, but 4 other inconsistencies between these studies make it even more difficult to compare data in the literature. These inconsistencies include (1) diagnostic criteria for piriformis syndrome, (2) role of conservative treatment before surgery, (3) indication for surgery, and (4) the methods for measuring outcomes.

This author's experience includes 15 cases of piriformis syndrome that failed initial forms of conservative treatment. The diagnosis was substantiated based on the following criteria: (1) buttock pain worse with sitting and with activity, (2) variable component of radicular symptoms, (3) pain with provocation of the piriformis (resisted external rotation, resisted abduction, and/or passive internal rotation), (4) clear reproduction of symptoms on intrapelvic palpation of piriformis exiting the sciatic notch, and (5) relief with injection in the area of the piriformis muscle. Of the 15 cases, 3 achieved prolonged relief from the injection and 12 experienced recurrence after a period of improvement. Of these 12, 4 have chosen to continue to live with their symptoms and 1 has undergone lumbar diskectomy for coexistent disk dis-

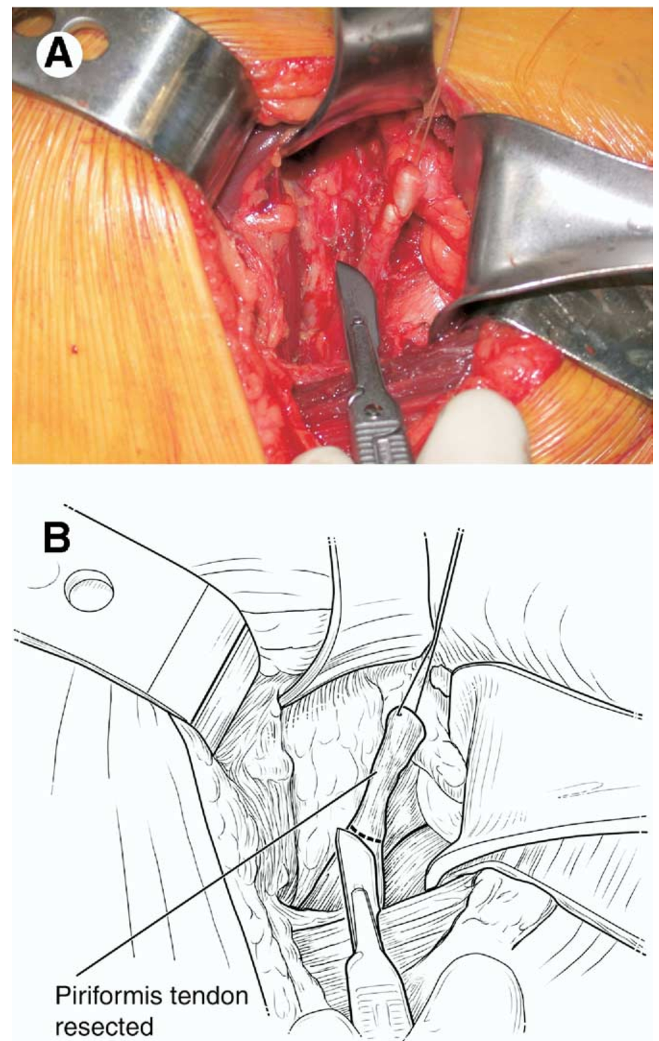

Figure 12 (A and B) The tendinous insertion of the piriformis has been released, tension is maintained with a tag suture, and a portion is resected within the muscle fibers proximal to the tendon. (Figure 12A © J.W. Thomas Byrd.)

ease. Surgical release of the piriformis and decompression of the sciatic nerve was performed in the remaining seven patients. Five patients were deemed to have an excellent result based on their extreme satisfaction because of complete alleviation of their preoperative symptoms. Two of these had occasional posterior soft-tissue tenderness or slight radicular symptoms, but this was felt by them to be inconsequential compared with their preoperative pain. Two workers' compensation cases showed steady improvement until the anticipated point of returning to full duty at 3 months after surgery. Both regressed. One was able to return to work that she was not capable of doing before surgery but still required limitations. The other felt that he was incapable of returning to his previous occupation as a crane operator.

Also among these 7 patients, 2 had associated intra-articular pathology that was addressed with arthroscopic surgery before releasing the piriformis. In both cases, the patient was noted to have symptoms of hip joint pathology as well as piriformis syndrome. Their joint symptoms seemed to be the more prominent finding, so it was elected to address the hip joint and see what remained of the piriformis symptoms. In these 2 cases, the residual piriformis symptoms remained significant enough to later warrant surgical release.

Summary

Piriformis syndrome is a useful term that characterizes the symptoms caused by compression/irritation of the sciatic nerve by the piriformis muscle as it exits the sciatic notch. The etiology is variable, and the pathomechanics are incompletely understood. Other processes may mimic this condition, and piriformis syndrome can coexist with other disorders including disease of the lumbar spine or hip joint.

It is likely that many cases of piriformis syndrome and related conditions will respond to conservative treatment. When more aggressive intervention is contemplated, the evaluation must be thorough to substantiate the diagnosis as reliably as possible. Conservative treatment should include at least one injection in the area of the piriformis muscle. If no response is achieved, then a computed tomography–guided injection can be helpful to substantiate that the injection is precisely delivered.

For recalcitrant cases, surgical release of the piriformis and decompression of the sciatic nerve can result in remarkable success, but the response for some patients may be less complete. Poor results may be attributed to the incomplete understanding of this process or sometimes concerns of patient motivation. However, with careful clinical assessment, the surgeon should be able to avoid failure due to missed diagnosis.

References

1. Bernard TN Jr, Kirkaldy-Willis WH: Recognizing specific characteristics of non-specific low back pain. Clin Orthop 217:266-280, 1987
2. Pace JV, Nagle D: The piriformis syndrome. West J Med 124:435-439, 1976
3. Yeoman W: The relation of arthritis of the sacroiliac joint to sciatica, with an analysis of 100 cases. Lancet 2:1119-1122, 1928
4. Mixter WJ, Barr J: Rupture of the intervetebral disc. N Engl J Med 211:210-215, 1934
5. Freiberg AH: Sciatic pain and its relief by operations on the muscle and fascia. Arch Surg 34:337-350, 1937
6. Robinson DR: Piriformis syndrome in relation to sciatic pain. Am J Surg 73:355-358, 1947
7. Freiberg AH, Vinke TH: Sciatica and the sacroiliac joint. J Bone Joint Surg 16:126-136, 1934
8. Beaton LE, Anson BJ: The relation of the sciatic nerve and of its subdivisions to the piriformis muscle. Anat Rec 70:1-5, 1937
9. McCrory B, McCrory P, Bell S: Nerve entrapment syndromes as a cause of pain in the hip, groin and buttock. Sports Med 27:261-274, 1999
10. Puranen J. Orava S: The hamstring syndrome. A new diagnosis of gluteal sciatic pain. Am J Sports Med 16:517-521, 1988
11. Rodrique T, Hardy RW: Diagnosis and treatment of piriformis syndrome. Neurosurg Clin North Am 12:311-319, 2001
12. Parziale JR, Hudgins TH, Fishman LM: The piriformis syndrome. Am J Orthop 25:819-823, 1996
13. Benson ER, Schutzer SF: posttraumatic piriformis syndrome: Diagnosis and results of operative treatment. J Bone Joint Surg Am 81:941-949, 1999
14. Pecina M: Contribution to the etiological explanation of the piriformis syndrome. Acta Anat 105:181-187, 1979
15. Chen WS: Bipartite piriformis muscle: An unusal cause of sciatic nerve entrapment. Pain 58:269-272, 1994
16. Fishman LM, Dombi GW, Michaelsen C, et al: Piriformis syndrome: Diagnosis, treatment, and outcome—A 10-year study Arch Phys Med Rehab 83:295-301, 2002
17. Indrekvam K, Sudmann E: Piriformis muscle syndrome in 19 patients treated by tenotomy—A 1- to 16-year follow-up study. Int Orthop 26:101-103, 2002
18. Hughes SS, Goldstein MN, Hicks DG, et al: Extrapelvic compression of the sciatic nerve, an unusual cause of pain about the hip: report of five cases. J Bone Joint Surg Am 74:1553-1559, 1992
19. Chen WS: Sciatica due to piriformis pyomyositis: Report of a case. J Bone Joint Surg Am 74:1546-1548, 1992
20. Beauchesne RP, Schutzer SF: Myositis ossificans of the piriformis muscle. An unusual cause of piriformis syndrome. A case report. J Bone Joint Surg Am 70:906-910, 1997
21. Vendertop WP, Bosma NJ: The piriformis syndrome. A case report. J Bone Joint Surg Am 73:1095-1097, 1991
22. Papadopoulos SM, McGillicuddy JE, Albert JW: Unusual cause of "piriformis muscle syndrome". Arch Neurol 47:1144-1146, 1990
23. Ku A, Kern H, Lachman E, et al: Sciatic nerve impingement from piriformis hematoma due to prolonged labor. Muscle Nerve 18:789-790, 1995
24. Gandhavadi B: Bilateral piriformis syndrome associated with dystonia musculorum deformas. Orthopedics 13:350-351, 1990
25. Peh WC, Reinus WR: Piriformis bursitis causing sciatic neuropathy. Skeletal Radiol, 24:474-476, 1995
26. Durrani Z, Winnie AP: Piriformis muscle syndrome: an underdiagnosed cause of sciatica. J Pain Symptom Manage, 6:374-379, 1994
27. Dreyfuss P, Michaelsen M, Pauza K, McLarty J, Bogduk N: The value of medical history and physical examination in diagnosing sacroiliac joint pain. Spine, 21:2594-2602, 1996
28. Hoppenfeld S, deBoer P: The hip, in Hoppenfeld S, deBoer P (eds): Surgical Procedures in Orthopaedics. The Anatomic Approach. Philadelphia, PA, Lippincott, 1984, pp 301-356