Deep Gluteal Pain Syndrome

Endoscopic Technique and Medium-Term Functional Outcomes

Dante Parodi, MD, Diego Villegas, MD, Gonzalo Escobar, MD, José Bravo, MD, and Carlos Tobar, MD

Investigation performed at Clínica RedSalud Providencia, Santiago, Chile

Background: Sciatic nerve entrapment is an entity that generates disabling pain, mainly when the patient is sitting on the involved side. According to some studies, the presence of fibrovascular bands has been described as the main cause of this pathology, and the sciatic nerve's decompression by endoscopic release has been described as an effective treatment generally associated with a piriformis tenotomy. The aim of this study was to present the medium-term functional results of endoscopic release of the sciatic nerve without resection of the piriformis tendon.

Methods: This prospective, observational study included 57 patients who underwent an endoscopic operation for sciatic nerve entrapment between January 2014 and January 2019. In all cases, a detailed medical history was obtained and a physical examination and a functional evaluation were performed using the modified Harris hip score (mHHS), the 12-item International Hip Outcome Tool (iHOT-12), and the visual analog scale (VAS) for pain. All patients had pelvic radiographs and magnetic resonance imaging (MRI) scans of the hip on the involved side and underwent a prior evaluation by a spine surgeon.

Results: This study included 20 male and 37 female patients with a mean age of 43.6 years (range, 24 to 88 years) and a mean follow-up of 22.7 months. The median mHHS improved from 59 to 85 points. The median iHOT-12 improved from 60 to 85 points. The median VAS decreased from 7 to 2. Postoperative complications occurred in 12% of patients: 1 patient with extensive symptomatic hematoma, 3 patients with hypoesthesia, and 3 patients with dysesthesia.

Conclusions: Endoscopic release of the sciatic nerve by resection of fibrovascular bands without piriformis tenotomy is a technique with good to excellent functional results comparable with those of techniques in the literature incorporating piriformis tenotomy.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Deep gluteal pain syndrome is an entity first described by Robinson in 1947. Classically, its etiology has been attributed to compression of the piriformis tendon, but, because it is a condition that is often underdiagnosed, its real prevalence is unknown. Studies of cadaveric pieces have shown a prevalence ranging from 5% to 17%[1,2]. Currently, the term deep gluteal syndrome is used to characterize the presence of pain caused by extra-pelvic and non-discogenic entrapment of the sciatic nerve, which can occur in any anatomic region of the gluteus[3-9], a concept emerging from the greater knowledge of this pathology, the anatomical variation of entrapment, and the possibility of identifying different etiological agents, such as fibrovascular processes, entrapments at the level of the external rotator complex, vascular anomalies, insertional hamstring disease, or even ischiofemoral impingement[4-10].

Deep gluteal pain syndrome is characterized by the presence of posterior gluteal pain with an inability to sit for >30 minutes, posterior hip pain radiating to the posterior thigh, and paresthesia of the involved limb[1,3-5,8-10]. The physical examination is aimed at performing maneuvers that attempt to reproduce compression of the sciatic nerve, such as the Freiberg test, abduction and external rotation against resistance, activation and stretches of the piriformis, and the seated piriformis stretch test[11,12]. Magnetic resonance imaging (MRI) allows the identification of the sciatic nerve as well as fibrous bands and changes in the normal muscle characteristics, but its usefulness is debatable according to some reports[13]. Electromyography and conduction velocity are complementary tools that make it possible to exclude lumbosacral root disease[14-16]. When dealing with a patient experiencing posterior hip pain, both lumbar spinal pathology and pain referred from the sacroiliac joint should be considered at the time of evaluation and a complementary study of these structures is always necessary[17-21].

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (http://links.lww.com/JBJS/H470).

J Bone Joint Surg Am. 2023;105:762-70 • http://dx.doi.org/10.2106/JBJS.22.00394

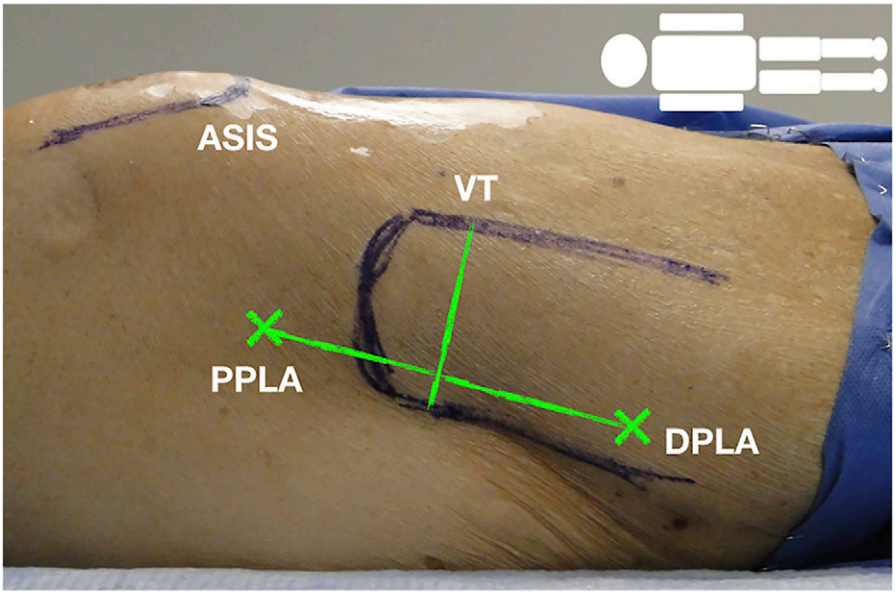

Fig. 1
Location of portals and access to both lateral and subgluteal compartments in a cadaveric study. ASIS = anterior superior iliac spine, VT = vastus tuberosity, PPLA = proximal posterolateral accessory portal, and DPLA = distal posterolateral accessory portal.

Despite the lack of studies and controlled trials that evaluate the effectiveness of surgical management, there have been several reports describing fibrous or fibrovascular formations in the subgluteal area that limit the excursion of the sciatic nerve[9,10,22]. These inflammatory processes that produce fibrovascular bands are often associated with hypertrophic bursae in the peritrochanteric region and a taut iliotibial band with associated pain[17,18,23-26]. The aims of this study were to describe the endoscopic technique developed for the release and exploration of the sciatic nerve in the deep gluteal compartment without piriformis tenotomy and to report the medium-term functional results in the group of patients who underwent this technique.

Materials and Methods

Surgical Technique

With the patient in the supine position and under anesthesia, without traction, and with the limb crossing the surgical field for control and manipulation during the surgical procedure, 2 endoscopic portals are made. The distance between the anterior and posterior borders of the greater trochanter at the level of the vastus tuberosity (VT) is demarcated, and the length of this distance is projected lengthwise in the posterior third of the femur, delineating the proximal posterolateral accessory (PPLA) and distal posterolateral accessory (DPLA) that will be used. The locations of these portals and access to both the lateral and subgluteal compartments, as well as anatomical landmarks and their relationship with the sciatic nerve, were evaluated through a cadaveric study performed by one of the authors of the current investigation (Fig. 1). The first portal, the DPLA portal, is made by incising the skin and opening the iliotibial band and then introducing a blunt trocar to reveal the lateral area using a physiological solution at a constant flow of 0.7 L per minute and pressure of 40 mm Hg per pump. Using endoscopic assistance with 70° optics, the second portal, the PPLA portal, is made by inserting a needle according to the demarcation described above and oriented 60° in the proximal-distal direction and 15° in the posteroanterior direction at the height of the posterior limit of the lateral space and the anterior limit of the deep gluteal space, crossing the aponeurotic junction of the gluteus maximus and the fascia lata. The lateral compartment and the characteristics of the superficial and deep trochanteric bursa are assessed, as well as the septa and/or any extension of a hypertrophic nature, and a wide bursectomy is performed.

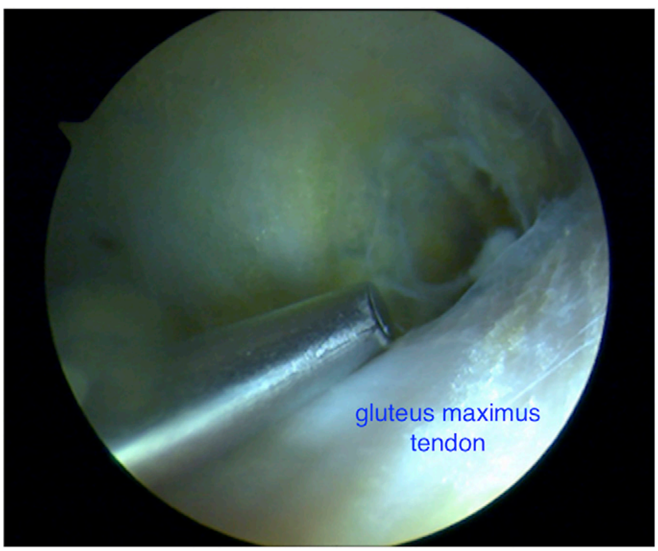

Fig. 2
The insertion of the gluteus maximus tendon is identified as an anatomical landmark to access the deep gluteal space.

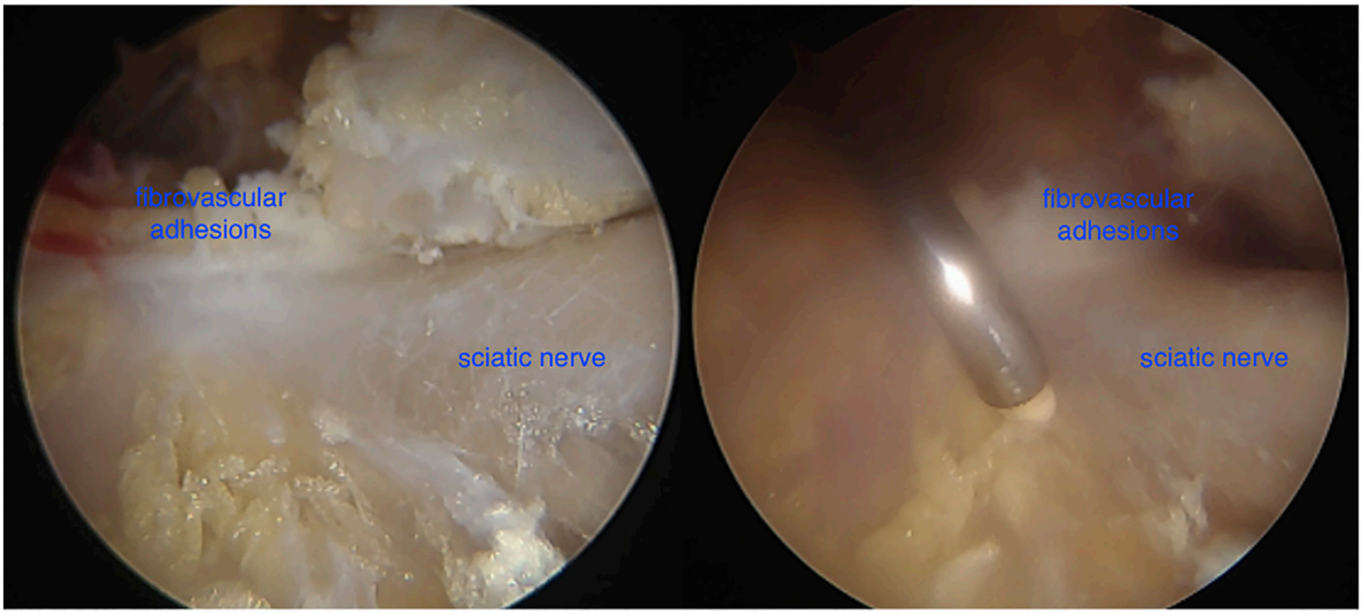

Fig. 3

Left: Presence of fibrovascular bands causing sciatic nerve entrapment. *Right:* Fibrovascular adhesions released with blunt and controlled radiofrequency dissection maneuvers.

Once the examination of the lateral compartment is finished, the insertion of the gluteus maximus tendon is identified, which we consider to be the landmark to access the deep gluteal space (Fig. 2). From this location, the medial femorogluteal bursa is resected using radiofrequency dissection, following the plane formed by the posterolateral aspect of the quadratus femoris muscle. In this procedure, the second surgeon holds the lower extremity and the foot during the surgical procedure, detecting any direct motor stimulation of the nerve or any contiguous stimulation, which may occur within approximately 20 mm of the nerve[27]. If the second surgeon detects movement of the leg, the second surgeon immediately informs the operating surgeon. Once the sciatic nerve has been identified, its adjoining fibrovascular adhesions are released (Fig. 3) with blunt and controlled radiofrequency dissection maneuvers, performing this procedure from distal to proximal and then to the sciatic notch, with special caution regarding the piriform branch of the inferior gluteal artery, which usually crosses the nerve at this location and can be confused with a fibrovascular band (Fig. 4). As an additional procedure, we verified the relationship of the sciatic nerve to the piriformis tendon, taking care not to damage the vascular branch previously described. This verification is performed through flexion, extension, and rotation maneuvers of the hip, observing the free excursion of the sciatic nerve and using a palpator to pull the portion of the piriformis tendon in contact with the sciatic nerve. Finally, free mobilization of the nerve is assessed and the epineural circulation is observed (Fig. 5). Once this objective has been achieved, the procedure is concluded by removing the instruments, evacuating the remaining liquid from the virtual space, and closing the portals.

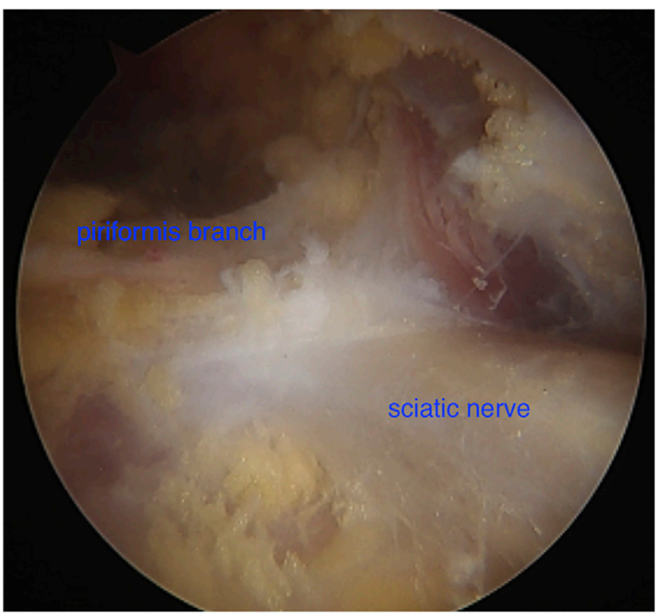

Fig. 4

The piriformis branch of the inferior gluteal artery, which often crosses the nerve at this location. This branch requires special caution when involved in a radiofrequency bursal resection.

Study Patients

In this prospective, observational study, a group of patients who were diagnosed with deep gluteal pain syndrome underwent an operation, between January 2014 and January 2019, performed by the same surgeon, using an endoscopic technique. There were 57 patients who met the inclusion criteria and were recruited for the surgical procedure. The inclusion criteria were non-discogenic posterior sciatic pain radiating to the posterior thigh and paresthesia; an inability to sit on the involved side due to poorly defined pain, which, in some cases, was associated with paresthesia on the back of the thigh and subsided with a change of position; a pain duration of >6 months; and an inadequate response to conservative treatment. The surgery exclusion criteria used were a diagnosis of lumbosacral pathology, concomitant femoroacetabular impingement, hip osteoarthritis, and diagnosed ischiofemoral syndrome and/or associated gluteus medius tendon detachment. In all cases, a detailed clinical history, physical examination, and functional evaluation using the modified Harris hip score (mHHS), 12-item International Hip Outcome Tool (iHOT-12), and visual analog scale (VAS) for pain were obtained. Pelvic radiographs and hip MRI scans of the involved side were made in all patients. In addition, all patients underwent a prior evaluation by a spinal surgeon and/or a neurosurgeon that included an imaging study and corresponding electromyography, to rule out lumbosacral pathology. All patients provided written informed consent. Clinical evaluation was performed and outcome scores (mHHS, iHOT-12, and VAS) were assessed on the first postoperative day and then at 3 months and at the end of the follow-up period.

Statistical Analysis

Statistical analysis was conducted using SPSS (version 23.0; IBM). Normality was assessed with the Kolmogorov-Smirnov test, which indicated that all of the variables exhibited a nonparametric distribution. The Wilcoxon rank-sum test was therefore used to assess differences between the paired preoperative and postoperative values. The necessary sample size was calculated as 28 using G*Power (version 3.1.9.2; University of Dusseldorf) on the basis of statistical power of 80%, an alpha error of 0.05, a moderate estimated effect size (0.5), and a Wilcoxon test of the difference between groups of paired samples.

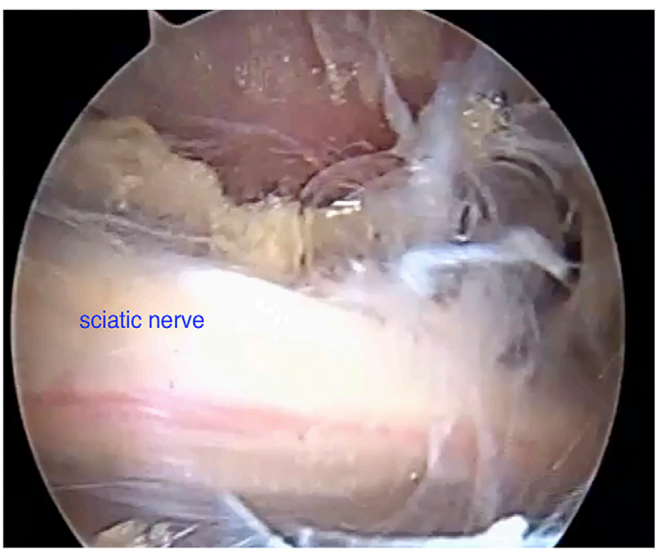

Fig. 5
Sciatic nerve after release. Epineural circulation is observed.

TABLE I Demographic Characteristics

No. of patients	57
No. of hips	57
Female sex	65%
Body mass index* *(kg/m²)*	26.7 (21.2 to 42.7)
Age* *(yr)*	43.6 (24 to 88)
Follow-up* *(mo)*	22.7 (12 to 44)

*The values are given as the mean, with the range in parentheses.

Source of Funding

There was no outside source of funding for this study.

Results

The 57 patients undergoing sciatic nerve release who met the inclusion criteria were evaluated. There were no patients with piriformis compression in this series. The mean age at the time of the surgical procedure was 43.6 years (range, 24 to 88 years), and the mean follow-up was 22.7 months (range, 12 to 44 months). Demographic data are presented in Table I.

The median mHHS improved from 59 points (interquartile range [IQR], 55, 76 points) preoperatively to 85 points (IQR, 79, 88 points) at the latest follow-up ($p < 0.01$) (Fig. 6, Table II). This difference was maintained when separating the groups by sex ($p < 0.01$) (Table III). Based on the mHHS, 17% had excellent results (≥90 points), 53% had good results (80 to 89 points), 28% had fair results (70 to 79 points), and 2% had poor results (<70 points) (Fig. 7). The median iHOT-12 score also improved from 60 points (IQR, 50, 70 points) preoperatively to 85 points (IQR, 80, 95 points) at the latest follow-up ($p < 0.01$) (Fig. 8, Table II). There was a significant improvement ($p < 0.01$) in the median VAS score in the total sample from 7 (IQR, 7, 8) preoperatively to 2 (IQR, 1, 2) postoperatively (Fig. 9, Table II). There were no differences in VAS improvement between patients who had a final follow-up of 12 to 24, 24 to 36, and 36 to 44 months (Fig. 10). At the end of the follow-up period, 19% of the patients reported a VAS score of 0. When separating the groups by sex, this significant improvement was maintained ($p < 0.01$) (Table III).

The following complications took place. An 88-year-old patient with an extensive symptomatic hematoma required selective embolization of the inferior gluteal artery. Three male patients (34, 43, and 45 years of age) presented with hypoesthesia in the gluteal posteroinferior sensory area that resolved between 6 and 12 weeks. Three patients (45, 46, and 54 years of age), 2 of whom were male, presented with dysesthesia that subsided between 4 and 12 weeks postoperatively. Two of these patients had an mHHS of 69 and 77 points at the end of the follow-up period. One patient who did not exhibit neurological alterations or identifiable complications had an mHHS of 78 points at the end of the follow-up period.

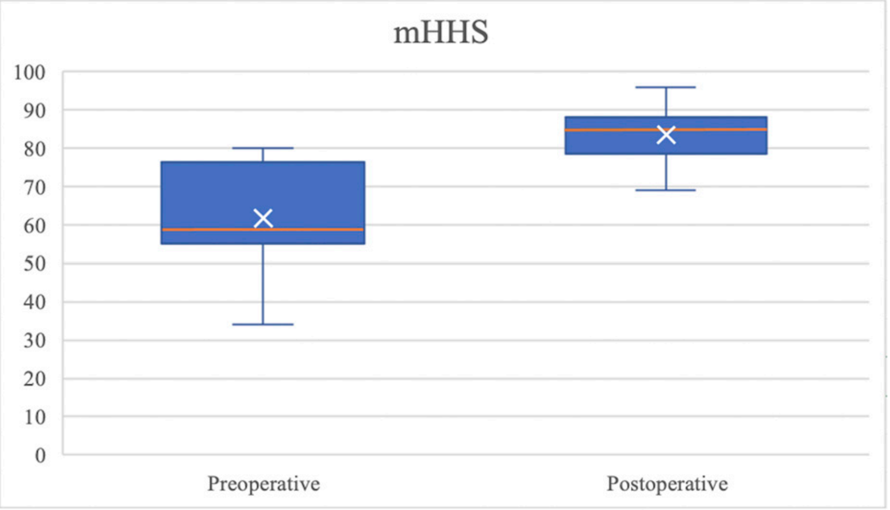

Fig. 6
The median mHHS was 59 points (IQR, 55, 76 points) preoperatively and 85 points (IQR, 79, 88 points) postoperatively. The x indicates the mean, the orange bar indicates the median, the box indicates the IQR, and the whiskers indicate the range.

Discussion

There is currently consensus that deep gluteal pain syndrome is caused by the entrapment of the sciatic nerve in the subgluteal space[28,29], with the presence of fibrovascular bands being relevant in its etiology, according to various reports[4,9,10,22]. This syndrome has an important association with peritrochanteric inflammatory pathology, especially if we consider the repetitive microtrauma that can be caused by the tensor fasciae latae, the gluteus maximus, and the iliotibial band on the greater trochanter and the adjacent bursa, so we believe that it is necessary to consider both compartments together to achieve an optimal result and avoid recurrences[23,25].

We observed a recovery of the excursion of the sciatic nerve after the resection of these fibrovascular bands in 100% of the patients studied. In our experience, this surgical option is the best treatment of this pathology, in contrast to the literature that has described routine resection of the piriformis muscle[6,7,9,12,30-32]. The prevalence of anatomical variants of the piriformis muscle in our study did not differ from that estimated for the general population[22], suggesting that anatomical variants do not explain the chronic symptoms of this condition. Consequently, we consider that the morphological variants would not be the only causes in the pathogenesis of this syndrome.

Piriformis microtrauma can trigger a chronic inflammatory process that eventually results in the development of fibrovascular bands extending up from the piriformis bursa. The same can happen with the external rotator complex. In our experience, a thorough bursectomy associated with band resection yields complete excursion of the nerve without the need for additional procedures. Previous studies have indicated that fibrovascular bands are present in 45% to 100% of cases of deep gluteal pain syndrome and that bursectomy and release of these bands, using one of the several described techniques, should be performed[6-10,22]. Consequently, we do not perform additional surgery on structures that we do not believe are involved in the etiology of the condition, in order to minimize the possibility of postoperative fibrosis. The literature contains

TABLE II Preoperative and Postoperative Outcome Scores*

Test	Preoperative Score*	Postoperative Score*	P Value
mHHS *(points)*	59 (55, 76)	85 (79, 88)	<0.01†
iHOT-12 *(points)*	60 (50, 70)	85 (80, 95)	<0.01†
VAS	7 (7, 8)	2 (1, 2)	<0.01†

*The values are given as the median, with the IQR in parentheses.
†Significant.

TABLE III Preoperative and Postoperative Outcome Scores According to Sex

Test	Preoperative Score*	Postoperative Score*	P Value
mHHS *(points)*			
Male	60 (46, 78)	85 (79, 89)	<0.01†
Female	58 (55, 71)	83 (79, 88)	<0.01†
iHOT-12 *(points)*			
Male	60 (50, 80)	90 (80, 95)	<0.01†
Female	60 (50, 70)	85 (80, 90)	<0.01†
VAS			
Male	7 (7, 8)	2 (1, 2)	<0.01†
Female	7 (7, 8)	2 (1, 2)	<0.01†

*The values are given as the median, with the IQR in parentheses.
†Significant.

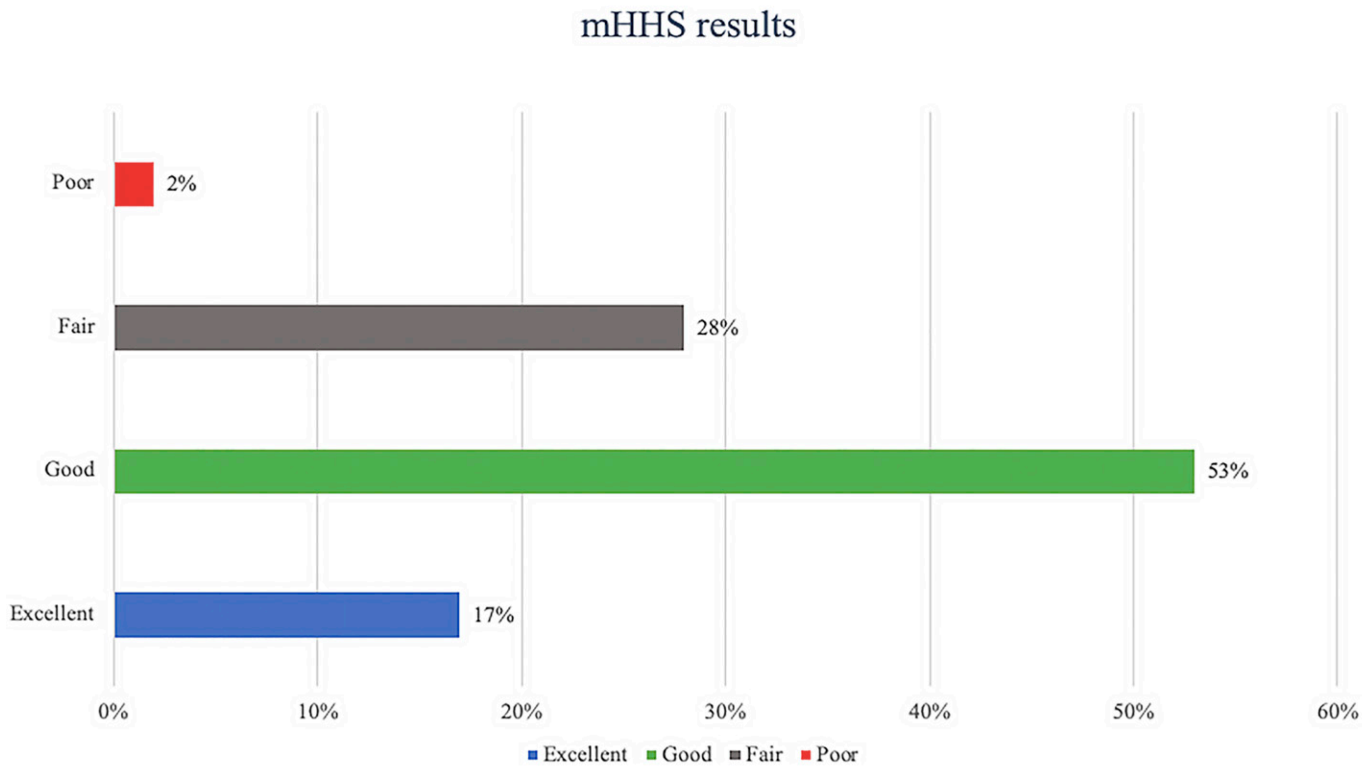

Fig. 7
The distribution of mHHS results.

descriptions of recurrence of symptoms after open surgery, although they are generally based on anecdotes and personal, general estimates, rather than on objective, published data[4]. In any case, we believe that open procedures could be one of the factors directly related to such recurrences, through the generation of a major inflammatory response.

According to various reports, endoscopic decompression of the sciatic nerve by the resection of fibrovascular bands is generally associated with surgical procedures on the piriformis tendon. Martin et al.[6] described a series of 35 patients who underwent endoscopic operations and had a decrease in the VAS pain score from 6.9 to 2.4 and an improvement in the mHHS

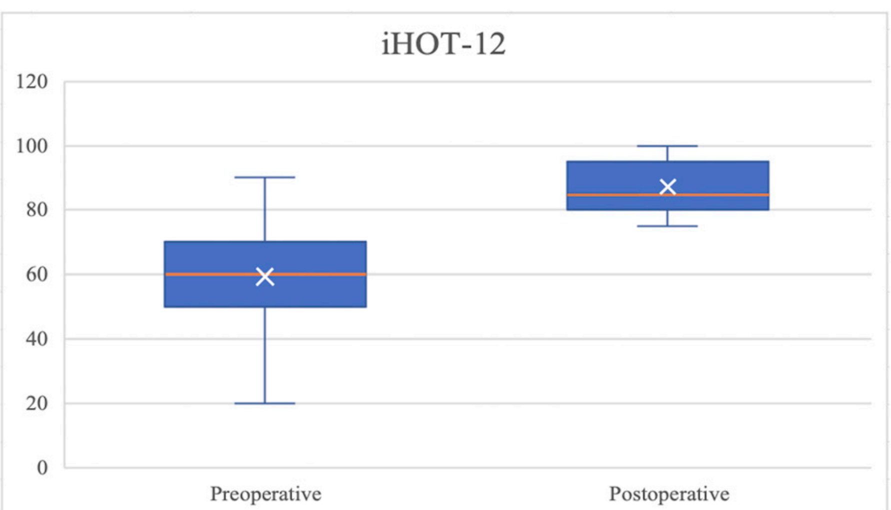

Fig. 8
The median iHOT-12 was 60 points (IQR, 50, 70 points) preoperatively and 85 points (IQR, 80, 95 points) postoperatively. The x indicates the mean, the orange bar indicates the median, the box indicates the IQR, and the whiskers indicate the range.

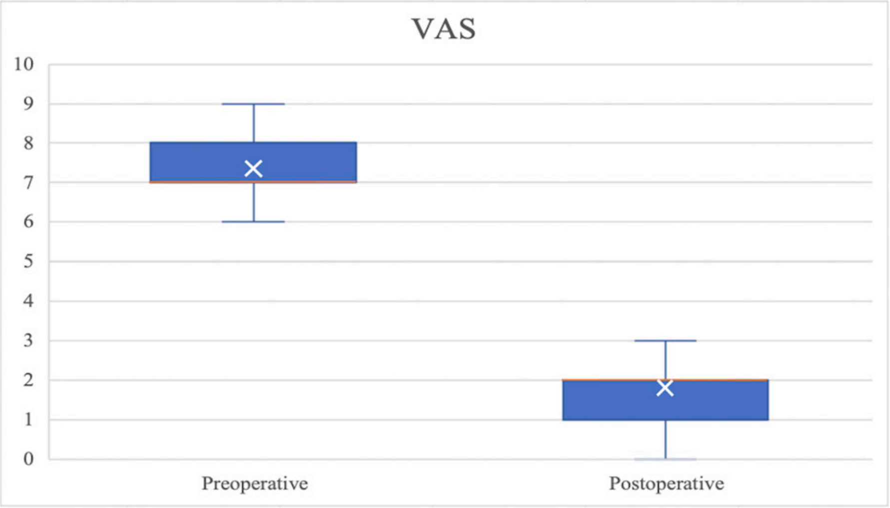

Fig. 9
The median VAS score was 7 (IQR, 7, 8) preoperatively and 2 (IQR, 1, 2) postoperatively. The x indicates the mean, the orange bar indicates the median, the box indicates the IQR, and the whiskers indicate the range.

from 54.4 to 78 points, with excellent to good results in 70% of patients with a mean follow-up of 12 months. Ilizaliturri et al. reported on 15 patients, with a mean follow-up of 30 months, who underwent endoscopic exploration of the sciatic nerve with release of the fibrovascular bands, associated with the release of the piriformis tendon; they described an improvement in the mHHS of 46.8 to 84.9 points and in the VAS score from 7.4 to 1.8[30]. Moreover, Ham et al. presented 24 cases with a mean 32-month follow-up, describing the release of fibrovascular bands and the piriformis, the internal obturator, or the quadriceps

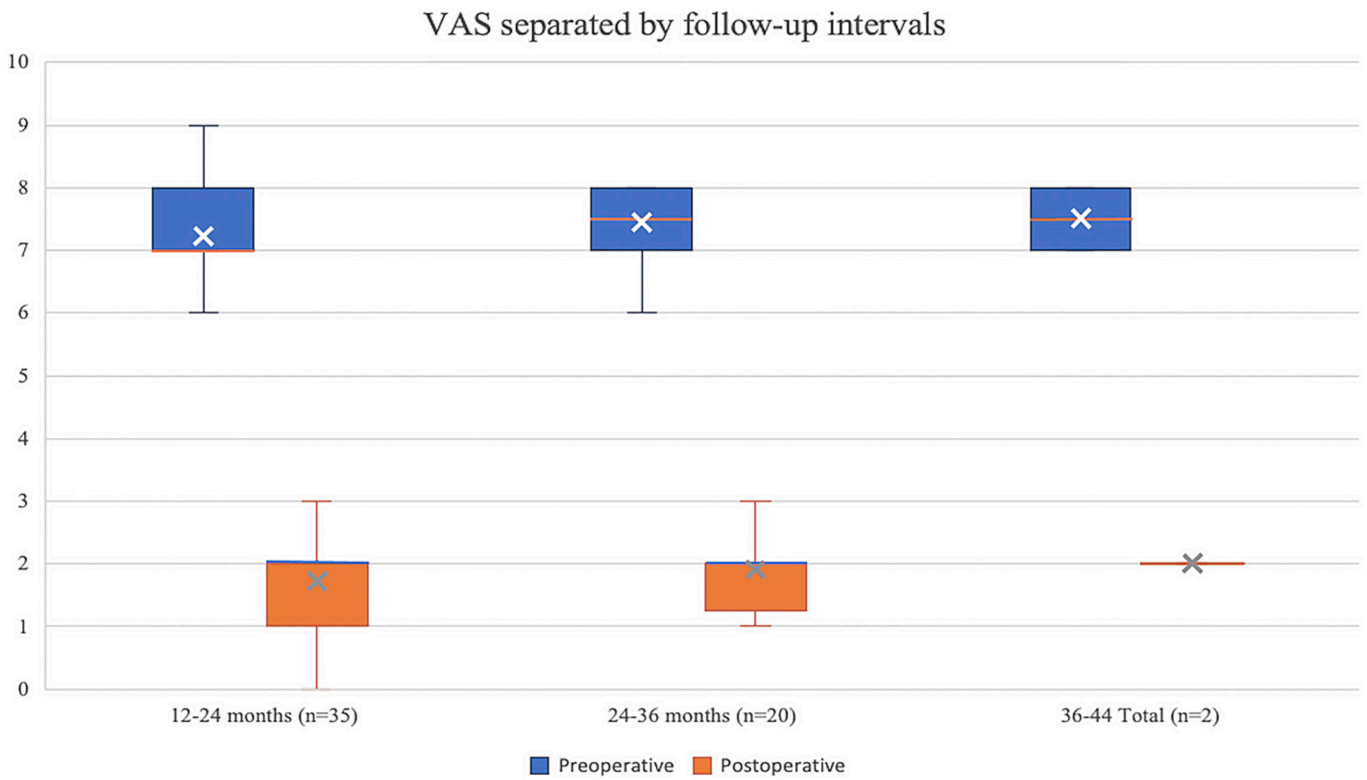

Fig. 10
The mean improvement in the VAS score according to the time until the final follow-up evaluation. The x indicates the mean, the orange bar indicates the median, the box indicates the IQR, and the whiskers indicate the range.

femoris muscle according to the location at which excursion of the sciatic nerve was compromised. The VAS score decreased from 7.1 to 2.5, and the mHHS increased from 59.4 to 85 points, with 87% of cases having no reported complications[31]. Park et al. presented a series of 45 idiopathic cases and 25 posttraumatic cases; the mHHS improved from 61.5 to 84.1 points in the trauma group and from 73.8 to 94.4 points in the idiopathic group[32].

Three branches of the inferior gluteal artery (1 superficial branch and 2 distal deep branches) are currently recognized as representing the main anastomotic tributaries of the medial circumflex femoral artery, which contributes most of the blood supply to the femoral head, in most individuals. The trajectory of the superficial arterial branch is such that its resection is necessary during a tenotomy of the piriformis muscle[33-37].

Kalhor et al.[34] observed that, in some cadaveric preparations, either the deep distal branch (in 5 of 32 preparations) or the superficial branch (in 1 preparation) was the main arterial branch supplying the femoral head, and the medial circumflex femoral artery was an anastomotic tributary of it, and Grose et al. made similar observations[35]. Although there have been no reports of osteonecrosis as a consequence of piriformis tenotomy, those studies provide objective data that support our practice of not resecting this tendon. Finally, epineurolysis of the sciatic nerve under endoscopic magnification requires additional studies. According to our observations, the release of fibrovascular bands combined with epineurolysis may have poor results. Only 3 patients who underwent this procedure had an mHHS of <79 points at the end of the follow-up period.

We present our own technique with the use of modified portals that differ from the classic portal sites proposed in the literature[6,7,30,32,38]. These allow wide access to the peritrochanteric and deep gluteal space and the management of pathologies in both compartments. However, this technique has certain limitations. It requires a subspecialist who is trained and experienced in arthroscopic procedures, because endoscopic triangulation is difficult when performed in a virtual space consisting of soft tissues. In addition, it may be difficult to perform endoscopic repair using our procedure in patients with associated ruptures of the gluteus medius tendon, which would require the use of a third portal.

There were some limitations to this study. We did not include all patients with ill-defined posterior hip pain. We included only patients in our registry of surgical patients, and, therefore, we were unable to provide an estimate of the number of patients who did not meet the criteria for the surgical procedure. We did not have a control group because, based on previous studies and our study, we believe that there is a known benefit of resection of fibrovascular bands and that the cause of treatment failure occurs when this procedure is not performed[6]. Finally, even though the mean follow-up time was 22.7 months (range, 12 to 44 months), we believe that longer-term follow-up will be needed to evaluate our results.

To our knowledge, this is the largest reported series of endoscopic procedures to treat deep gluteal pain syndrome, and its sample size was large enough to achieve statistical power. In addition, excluding cases with intra-articular pathology of the hip and/or spine, and thus including only patients with isolated deep gluteal pain syndrome, has allowed us to more accurately assess the results of our endoscopic procedure. Because there is no gold standard for the diagnosis and treatment of this entity, it is important to point out that the results are similar to those of another case series described in the literature in which piriformis muscle tenotomy was performed. This allows us to consider the possibility that endoscopic management with resection of fibrovascular bands (without the piriformis tenotomy, unlike the technique described by Martin et al.[6]) is the treatment of choice for the management of this pathology.

In conclusion, our endoscopic technique using modified portals allows the release of the sciatic nerve through the resection of fibrovascular bands without performing a piriformis tenotomy. It is a procedure with good to excellent results in the medium term, restoring the functionality of patients regardless of sex and age. ■

Dante Parodi, MD[1,2]
Diego Villegas, MD[1,3]
Gonzalo Escobar, MD[4]
José Bravo, MD[5]
Carlos Tobar, MD[1,2]

[1]Department of Orthopaedic Surgery, Clínica RedSalud Providencia, Santiago, Chile

[2]Fundación Médica San Cristóbal, Santiago, Chile

[3]Department of Orthopaedic Surgery, Hospital Padre Hurtado, Santiago, Chile

[4]Department of Orthopaedic Surgery, Hospital Universitario Austral, Buenos Aires, Argentina

[5]Orthopaedic Residency Program, Universidad del Desarrollo, Santiago, Chile

Email for corresponding author: tobarcarlos@gmail.com

References

1. Benson ER, Schutzer SF. Posttraumatic piriformis syndrome: diagnosis and results of operative treatment. J Bone Joint Surg Am. 1999 Jul;81(7):941-9.

2. Papadopoulos EC, Khan SN. Piriformis syndrome and low back pain: a new classification and review of the literature. Orthop Clin North Am. 2004 Jan;35(1):65-71.

3. Shah SS, Consuegra JM, Subhawong TK, Urakov TM, Manzano GR. Epidemiology and etiology of secondary piriformis syndrome: a single-institution retrospective study. J Clin Neurosci. 2019 Jan;59:209-12.

4. Knudsen JS, McConkey MO, Brick MJ. Endoscopic sciatic neurolysis. Arthrosc Tech. 2015 Aug 10;4(4):e353-8.

5. Knudsen JS, Mei-Dan O, Brick MJ. Piriformis syndrome and endoscopic sciatic neurolysis. Sports Med Arthrosc Rev. 2016 Mar;24(1):e1-7.

6. Martin HD, Shears SA, Johnson JC, Smathers AM, Palmer IJ. The endoscopic treatment of sciatic nerve entrapment/deep gluteal syndrome. Arthroscopy. 2011 Feb;27(2):172-81.

7. Martin H, Hatem M, Palmer I. Endoscopic sciatic nerve decompression: operative technique. Operative Techniques in Sports Medicine. 2012;20(4):325-32.

8. Byrd JWT. Piriformis syndrome. Operative Techniques in Sports Medicine. 2005; 13(1):71-9.

9. Martin HD, Reddy M, Gómez-Hoyos J. Deep gluteal syndrome. J Hip Preserv Surg. 2015 Jul;2(2):99-107.

10. Carro LP, Hernando MF, Cerezal L, Navarro IS, Fernandez AA, Castillo AO. Deep gluteal space problems: piriformis syndrome, ischiofemoral impingement and sciatic nerve release. Muscles Ligaments Tendons J. 2016 Dec 21;6(3): 384-96.

11. Hernando MF, Cerezal L, Pérez-Carro L, Abascal F, Canga A. Deep gluteal syndrome: anatomy, imaging, and management of sciatic nerve entrapments in the subgluteal space. Skeletal Radiol. 2015 Jul;44(7):919-34.

12. Martin HD, Kivlan BR, Palmer IJ, Martin RL. Diagnostic accuracy of clinical tests for sciatic nerve entrapment in the gluteal region. Knee Surg Sports Traumatol Arthrosc. 2014 Apr;22(4):882-8.

13. Petchprapa CN, Rosenberg ZS, Sconfienza LM, Cavalcanti CF, Vieira RL, Zember JS. MR imaging of entrapment neuropathies of the lower extremity. Part 1. The pelvis and hip. Radiographics. 2010 Jul-Aug;30(4):983-1000.

14. Yuen EC, So YT, Olney RK. The electrophysiologic features of sciatic neuropathy in 100 patients. Muscle Nerve. 1995 Apr;18(4):414-20.

15. Robinson LR. Traumatic injury to peripheral nerves. Muscle Nerve. 2000 Jun; 23(6):863-73.

16. Fishman LM, Dombi GW, Michaelsen C, Ringel S, Rozbruch J, Rosner B, Weber C. Piriformis syndrome: diagnosis, treatment, and outcome—a 10-year study. Arch Phys Med Rehabil. 2002 Mar;83(3):295-301.

17. Malik A, Wahl G, McMullen C. Sports medicine disorders of the hip: posterolateral. 2016 Apr 4. Accessed2023 Feb 21. https://now.aapmr.org/sports-medicine-disorders-of-the-hip-posterolateral

18. Williams BS, Cohen SP. Greater trochanteric pain syndrome: a review of anatomy, diagnosis and treatment. Anesth Analg. 2009 May;108(5):1662-70.

19. Battaglia PJ, D'Angelo K, Kettner NW. Posterior, lateral, and anterior hip pain due to musculoskeletal origin: a narrative literature review of history, physical examination, and diagnostic imaging. J Chiropr Med. 2016 Dec;15(4):281-93.

20. Prather H, Hunt D, Fournie A, Clohisy JC. Early intra-articular hip disease presenting with posterior pelvic and groin pain. PM R. 2009 Sep;1(9):809-15.

21. Sakamoto J, Morimoto Y, Ishii S, Nakano J, Manabe Y, Okita M, Tsurumoto T. Investigation and macroscopic anatomical study of referred pain in patients with hip disease. J Phys Ther Sci. 2014 Feb;26(2):203-8.

22. Park MS, Yoon SJ, Jung SY, Kim SH. Clinical results of endoscopic sciatic nerve decompression for deep gluteal syndrome: mean 2-year follow-up. BMC Musculoskelet Disord. 2016 May 20;17:218.

23. Dunn T, Heller CA, McCarthy SW, Dos Remedios C. Anatomical study of the "trochanteric bursa". Clin Anat. 2003 May;16(3):233-40.

24. Friedman MV, Stensby JD, Long JR, Currie SA, Hillen TJ. Beyond the greater trochanter: a pictorial review of the pelvic bursae. Clin Imaging. 2017 Jan-Feb;41: 37-41.

25. Woodley SJ, Mercer SR, Nicholson HD. Morphology of the bursae associated with the greater trochanter of the femur. J Bone Joint Surg Am. 2008 Feb;90(2): 284-94.

26. Heller A. Anatomy of the trochanteric bursae. Radiology. 2003 Mar;226(3):921; author reply 921-2.

27. Martin HD, Palmer IJ, Hatem M. Monopolar radiofrequency use in deep gluteal space endoscopy: sciatic nerve safety and fluid temperature. Arthroscopy. 2014 Jan; 30(1):60-4.

28. Kizaki K, Uchida S, Shanmugaraj A, Aquino CC, Duong A, Simunovic N, Martin HD, Ayeni OR. Deep gluteal syndrome is defined as a non-discogenic sciatic nerve disorder with entrapment in the deep gluteal space: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2020 Oct;28(10):3354-64.

29. Hayashi A, Maruyama Y. Lateral intermuscular septum of the thigh and short head of the biceps femoris muscle: an anatomic investigation with new clinical applications. Plast Reconstr Surg. 2001 Nov;108(6):1646-54.

30. Ilizaliturri VM Jr, Arriaga R, Villalobos FE, Suarez-Ahedo C. Endoscopic release of the piriformis tendon and sciatic nerve exploration. J Hip Preserv Surg. 2018 Jun 22; 5(3):301-6.

31. Ham DH, Chung WC, Jung DU. Effectiveness of endoscopic sciatic nerve decompression for the treatment of deep gluteal syndrome. Hip Pelvis. 2018 Mar; 30(1):29-36.

32. Park MS, Jeong SY, Yoon SJ. Endoscopic sciatic nerve decompression after fracture or reconstructive surgery of the acetabulum in comparison with endoscopic treatments in idiopathic deep gluteal syndrome. Clin J Sport Med. 2019 May;29(3): 203-8.

33. Gautier E, Ganz K, Krügel N, Gill T, Ganz R. Anatomy of the medial femoral circumflex artery and its surgical implications. J Bone Joint Surg Br. 2000 Jul;82(5): 679-83.

34. Kalhor M, Horowitz K, Gharehdaghi J, Beck M, Ganz R. Anatomic variations in femoral head circulation. Hip Int. 2012 May-Jun;22(3):307-12.

35. Grose AW, Gardner MJ, Sussmann PS, Helfet DL, Lorich DG. The surgical anatomy of the blood supply to the femoral head: description of the anastomosis between the medial femoral circumflex and inferior gluteal arteries at the hip. J Bone Joint Surg Br. 2008 Oct;90(10):1298-303.

36. Zlotorowicz M, Czubak J, Kozinski P, Boguslawska-Walecka R. Imaging the vascularisation of the femoral head by CT angiography. J Bone Joint Surg Br. 2012 Sep;94(9):1176-9.

37. Seeley MA, Georgiadis AG, Sankar WN. Hip vascularity: a review of the anatomy and clinical implications. J Am Acad Orthop Surg. 2016 Aug;24(8):515-26.

38. Voos JE, Rudzki JR, Shindle MK, Martin H, Kelly BT. Arthroscopic anatomy and surgical techniques for peritrochanteric space disorders in the hip. Arthroscopy. 2007 Nov;23(11):1246.e1-5.1