ISSN 0008-3194 (p)/ISSN 1715-6181 (e)/2023/67–76/$2.00/©JCCA 2023

Diagnosis and conservative management of sural neuropathy: a case report

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Nerve entrapments in the lower extremity are rare and can be difficult to diagnose. Here we describe a Canadian Armed Forces veteran with left posterior-lateral calf pain. The patient's condition was previously misdiagnosed as a left-sided mid-substance Achilles tendinosis, which subsequently led to mismanagement, persistent pain and severe functional limitations. After performing a thorough evaluation, we diagnosed the patient with chronic left-sided sural neuropathy secondary to entrapment within the gastrocnemius fascia. The patient's physical symptoms abated completely with chiropractic care, while overall disability improved substantially after taking part in an interdisciplinary pain program. The objectives of this case report are to describe a challenging differential diagnosis of sural neuropathy, and present conservative

Diagnostic et traitement conservateur de la neuropathie surale : un rapport de cas

La compression des nerfs dans les membres inférieurs est rare et peut être difficile à diagnostiquer. Nous décrivons ici le cas d'un vétéran des Forces armées canadiennes souffrant d'une douleur postéro-latérale gauche au mollet. L'état du patient avait été diagnostiqué à tort comme une tendinite achilléenne moyenne du côté gauche, ce qui a entraîné une mauvaise prise en charge, une douleur persistante et de graves limitations fonctionnelles. Après une évaluation approfondie, nous avons diagnostiqué chez le patient une neuropathie surale chronique du côté gauche, secondaire à une compression du fascia gastrocnémien. Les symptômes physiques du patient ont complètement disparu grâce aux soins chiropratiques, tandis que l'incapacité globale s'est considérablement améliorée après avoir participé à un programme interdisciplinaire de lutte contre la douleur. Les objectifs de ce rapport de cas sont de décrire un diagnostic différentiel difficile de neuropathie surale et de présenter des options de gestion

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This work received no specific funding from any agency or institution in the public, commercial, or not-for-profit sectors. Two co-authors (Dr. Assimakopoulos and Dr. Mailis) are presently clinical staff at the facility at which the patient underwent treatment.
The involved patient provided consent for case publication.

whole-person management options according to the patient's needs and goals.

(JCCA. 2023;67(1):67-76)

KEY WORDS: neuropathic pain, interdisciplinary, rehabilitation, differential diagnosis, sural nerve

conservatrice de la personne entière en fonction des besoins et des objectifs du patient.

(JCCA. 2023;67(1):67-76)

MOTS CLÉS : douleur neuropathique, interdisciplinaire, réhabilitation, diagnostic différentiel, nerf sural

Introduction

The sural nerve originates in the popliteal fossa from branches of the tibial and fibular nerves, with constituent fibers derived primarily from the S1 nerve root level, and variable contribution from the L5 level.[1] The nerve travels between the two heads of the gastrocnemius muscle and becomes subcutaneous at the distal one-third of the lateral lower leg within the gastrocnemius fascia. The sural nerve travels inferiorly along the lateral aspect of the Achilles tendon, posterior to the lateral malleolus and along the lateral foot. The nerve provides cutaneous innervation to the lateral lower third of the leg and the dorsolateral aspect of the foot before terminating on the lateral aspect of the fifth toe. The lateral calcaneal branch of the sural nerve innervates the skin over the lateral one-fourth to one-third of the heel and the pre-Achilles fat pad.

Entrapment neuropathies are caused by compression or irritation of peripheral nerves in narrow anatomical spaces. The mechanistic etiology of nerve entrapment is multifactorial, with contributing factors including prolonged ischemia, neuroinflammation, axonal demyelination and fibrosis, and central sensitization.[2] For sural neuropathy specifically, nerve trauma from ankle fracture, repetitive or prolonged external ankle compression, or iatrogenic injury, have been most commonly reported in the literature.[3-6] Entrapment of the sural nerve due to thickening of the gastrocnemius fascia has been previously described in cadaveric studies.[7]

Patients with sural neuropathy often present with persistent pain, burning, aching, or numbness in the posterolateral leg, lateral ankle, or lateral foot, that has failed to respond to nonsurgical management.[3] Delayed diagnosis and/or management of persistent neuropathic pain can have a significant impact on individuals, contributing to anxiety, depression and sleep difficulties.[8] In military personnel and veterans, rates of persistent pain are two to three times higher than in the general population.[9] Here we describe a case of a 36-year-old male Canadian Armed Forces veteran with left-sided posterior-lateral calf pain secondary to sural neuropathy. The objectives of this case report are to describe the clinical process for the diagnosis of sural neuropathy, and describe the conservative whole-person management approach which resulted in complete recovery for this individual.

Case presentation

A 36-year-old male Canadian Armed Forces veteran with chronic posterior-lateral calf pain was referred to The Pain and Wellness Centre (PWC) in Vaughan, Ontario for a pain medicine consultation in November 2020. The PWC is a community-based interdisciplinary pain clinic, offering pain medicine consultations, alongside a range of allied healthcare services, including chiropractic. Specifically, chiropractors at the PWC are responsible for obtaining a full history and performing a detailed neuromusculoskeletal evaluation alongside pain physicians. An interdisciplinary plan of management is subsequently proposed for a select number of patients who meet specific eligibility criteria.[10]

The patient's problem started with the gradual onset of episodic left lateral calf tightness in May 2010 while in active military service, which progressively resolved without intervention. However, the tightness gradually returned, typically presenting after performing activities such as jumping jacks, rucksack marching and running. The symptoms gradually resolved after physiotherapy, but returned after rucksack marching up a steep hill in January 2011. The patient continued to suffer frequent episodes of activity-related pain exacerbations, which impaired his ability to engage in normal duties. Diagnostic imaging, including a right ankle MRI and an ankle/foot ultrasound performed in 2013, were unremarkable. He underwent orthopedic, sports medicine and interventional consultations, which concluded he suffered from left-sided mid-substance Achilles tendinosis. He subsequently underwent several interventional pain treatments including left-sided Achilles peri-tendinous corticosteroid injections, prolotherapy and tendon scraping, which failed to provide analgesic effect. Ultimately, the patient was voluntarily released from the Canadian Military in 2016.

On evaluation at the PWC, the patient described intermittent searing and burning left lateral calf pain. He marked his posterior-lateral lower leg on a pain diagram (Figure 1). The pain was rated as 0/10 on the Numeric Pain Rating Scale (NPRS) on the date of presentation, with 0/10 being his lowest pain rating, and 9/10 being his highest pain rating. His pain was aggravated by end-range ankle dorsiflexion, running and marching, and relieved by rest. He scored 54/70 on the Pain Interference Scale of the Brief Pain Inventory, indicating a high degree of pain-related functional interference.[11] He additionally scored 22/27 on the Patient Health Questionnaire-9 questionnaire (PHQ-9) indicating severe depression[12], and 18/21 on the Generalized Anxiety Disorder-7 questionnaire (GAD-7) indicating severe anxiety[13].

We observed mild bilateral standing calcaneal inversion. The left Achilles tendon appeared unremarkable to visual inspection. Repeated left-sided standing heel-raising aggravated the left lateral lower leg pain. Repeated standing lumbar flexion and extension significantly improved the calf pain with heel raising. Deep tendon reflexes were graded 2+ in the upper and lower extremities. Plantar responses were flexor bilaterally. We noted pinprick hyperalgesia and dynamic mechanical brush allodynia in the left sural nerve distribution. Palpation of the left sural nerve lateral to the left Achilles tendon recreated his pain. Figure 2 outlines the area of sensory alteration (dotted line) and the point of palpation (arrow). Tinel's

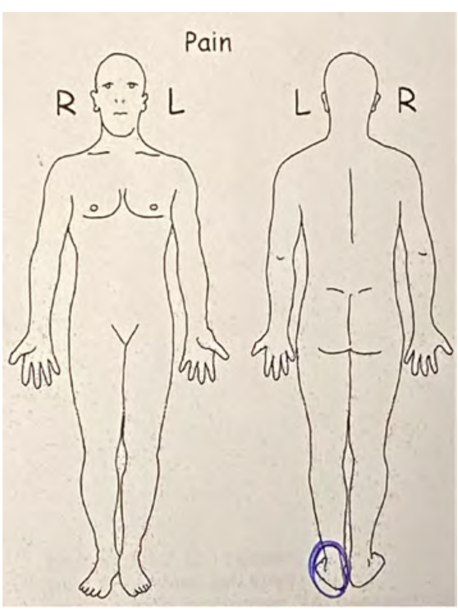

Figure 1
Patient-marked pain diagram at presentation.

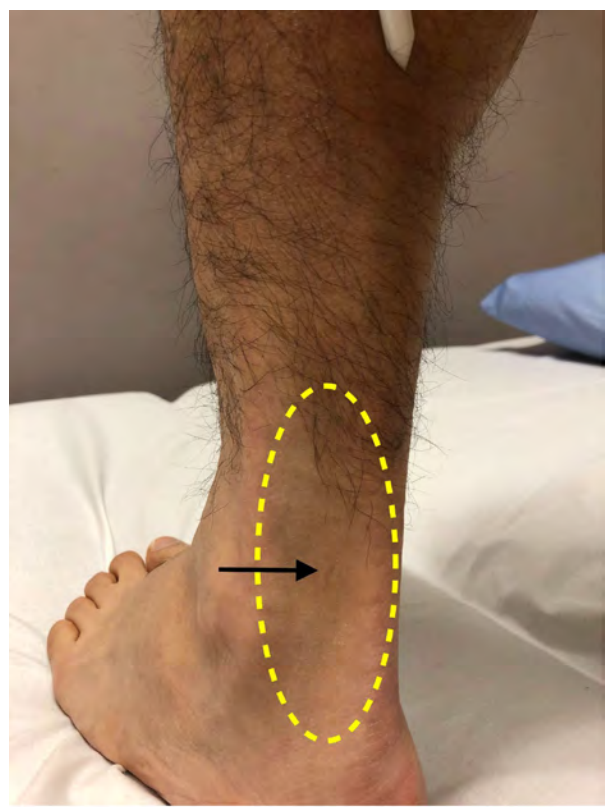

Figure 2.
Area of hyperalgesia and allodynia is encircled in yellow. Point of palpation and Tinel's test reproducing the symptoms is marked by the black arrow.

Figure 3.
Sural nerve sliding mobilization. Patient lies supine and moves from a position of knee flexion, and ankle inversion/dorsiflexion (a) to a position of knee extension, and ankle eversion/plantarflexion (b).

test[14] over the sural nerve, left sural nerve tension test[15] and Slump test[16] reproduced his symptoms.

From the biomedical point of view, the patient was diagnosed with chronic left-sided sural neuropathy secondary to entrapment within the gastrocnemius fascia, and from the psychological point of view with Major Depressive Disorder and Generalized Anxiety Disorder rendered by the pain physician, based on our evaluation and the patient's scores on baseline questionnaires. The patient was admitted to the PWC's government-funded Interdisciplinary Pain Program (IDP) that operates on a shared decision-making model and offers 80-90 hours of one-to-one treatment across multiple disciplines on the basis of "whole person approach", at no cost to the patient[10]. All patients complete baseline (pre-program) psychometric questionnaires, which were repeated at three months, six months and one year post-program.

Of note, our case report only discusses in detail the chiropractic portion of the patient's care. Additionally, the patient also received psychological treatment and mindfulness training aimed at managing depression, anxiety, and pain coping, naturopathy treatment to address digestive issues, and massage therapy.

In regard to chiropractic treatments, IDP patients attend a total of 24 chiropractic visits, each 60-minutes in duration, consisting of variable combinations of manual therapy, physical rehabilitation, strength and conditioning, and general counseling. The program was modified to accommodate the patient who was coming to PWC weekly from a distance greater than 100 km. Therefore, the chiropractic visits were divided into 11 in-person and 13 by phone. Our patient's long-term program goals were to reduce pain and to run three times weekly for 30 to 45 minutes at a 6/10 rating of perceived exertion (0 indicates complete rest, and 10 indicates maximal exertion).

Passive therapy, in the form of cupping over the suspected sural nerve entrapment site in the lateral gastrosoleus region, was utilized in five of the 11 in-person treatments as a form of pain modulation. In-person visits were otherwise focused on active care to improve running tolerance, and to gradually expose the patient to running. Phone visits were dedicated to goal setting for the week, education and problem solving.

Five minutes of cupping was performed during the first visit after assessment, diagnosis, and completion of informed consent. The rest of the session focused on performance of active treatments including repeated standing lumbar spine extension end-range loading (two sets of 10 repetitions), and dynamic left-sided sural nerve sliding mobilizations (two sets of 10 repetitions; see Figure 3). He was instructed to perform up to 10 repetitions of supine sural nerve sliders three times daily, and 10 repetitions of standing lumbar extensions every hour. The patient was additionally introduced to the *Activity Traffic Light* handout, which served as an education tool to differentiate hurt versus harm, and to provide personalized guidance on how to respond to increased pain as a result of exercise performance (Table 2).[17,18]

At the next visit (phone), reported pain levels during walking had decreased. A shared decision-making process

Table 2.
Activity traffic light (adapted from O'Connor A, Lotus TJ. Chapter 12: Therapeutic Exercise. In: Truumees E & Prather A, editors. Orthopedic Knowledge Update Spine 6. American Academy of Orthopedic Surgeons; 2021 p. 155-171.)

*Harm Check: Walking his dogs for 20-minutes daily

*A harm check is defined as a range of motion, strength, or functional activity that is consistently performed on a daily basis that the patient has confidence in performing. The patient is educated that a 50% reduction in their harm check alongside other indicators (below) is an indication that they may have suffered a new tissue injury, and a check-up from their therapy team is warranted.

Traffic Light Colour	During and Post-Activity Pain	Harm Check	Meaning/Action
Red	Severe pain aggravation that does not allow continued activity that persists for > 4-days to several weeks	50% reduction in harm check (eg. < 10-minutes dog walking duration after 4-days.	Potential new injury or aggravation of current injury. Contact therapy team. Stop prescribed activity.
Yellow	Moderate-to-severe pain during and after an activity, which returns to baseline pain intensity within 12-48-hours	No loss of ability to walk dog for 20-minutes the day following activity performance	Indication that no new injury has taken place (ie. Hurt does not equal harm). Advised to continue or mildly reduce activity, and to pace.
Green	Mild-to-moderate pain during activity that returns to baseline within a 30-minute to 24-hour period.	No loss of ability to walk dog for 20-minutes the following activity performance	Indication that no new injury has taken place (ie. Hurt does not equal harm). Advised to continue or increase activity.

was employed to create a meaningful home exercise program, in keeping with the patient's stated long-term goal to improve running tolerance. The goal for that week was to run for five minutes on a treadmill at a self-perceived intensity of 30%. The running duration and intensity were gradually increased thereafter on a weekly basis, using a shared decision-making model. By visit eight (phone) the patient reported complete resolution of symptoms at rest and during activity.

On visit 15 (in-person), the patient reported an exacerbation of postero-lateral calf pain rated 5/10 after performing 30 minutes of treadmill running at five miles per hour. Modification of the sural neuromobilization to a "tensioning" exercise reduced this pain to 2.5/10, within the session. The patient was instructed to discontinue supine sural nerve sliding neuromobilizations, and transition to supine sural nerve tensioning exercises three times daily, with the intent of habituating the patient to simultaneous proximal and distal tensioning of the sural nerve while running. Figures 3 and 4 indicate the differences between sliding and tensioning maneuvers.

The patient was discharged from the PWC IDP on February 19, 2021. At this time, he reported complete resolution of left calf pain, and was able to run two to three times weekly for 20 minutes, including hill training. Re-examination demonstrated complete resolution of sensory alteration. Left-sided sural nerve tension and Slump testing produced a perception of tension in the left posterior thigh, but were otherwise negative. At six and 12-month follow-up, he reported continuation of pain-free running (Table 4). Additionally, there was substantial improvement across emotional and mental health domains, based on our model of care. Furthermore, he rated himself as "very much improved" on the Patient Global Impression of Change Scale. Table 1 presents baseline and follow-up psychometric questionnaire scores.

Figure 4.
Sural nerve tensioning mobilization. Patient lies supine and moves from a position of knee flexion, ankle plantarflexion and foot eversion (a) to a position of knee extension, ankle dorsiflexion and ankle inversion (b).

Discussion

Neuropathic pain as a clinical descriptor is defined by the International Association for the Study of Pain (IASP) as "pain caused by a lesion or disease of the somatosensory nervous system".[19] The IASP Neuropathic Pain Grading Criteria[19] stipulates that a description of symptoms within a neuroanatomically plausible distribution alongside clinically demonstrable sensory signs is indicative of "probable neuropathic pain." A Delphi study by Smart *et al*.[18] identified that a cluster of symptoms and signs including "pain referred in a dermatomal or cutaneous distribution", "pain/symptom provocation with mechanical/movement tests that move/load/compress neural tissue", and "history of nerve injury, pathology or mechanical compromise" has high levels of classification accuracy. Our clinical evaluation satisfied all of the above-mentioned criteria.[19,20]

Our evaluation also found that leg symptoms were reduced after performance of repeated end-range lumbar flexion and extension. Performance of this procedure is rooted in principles from the Mechanical Diagnosis and Therapy (MDT) system for classification and rehabilitation of spinal and extremity pain, and aids in the identification of Extremity Pain of Spinal Source (EXPOSS).[21] The proportion of patients with ankle or foot symptoms suspected to have a spinal source is estimated to be as high as 29.2%.[21] A plausible mechanism for this phenomenon has not been elucidated, and requires further study. However, based on our physical examination findings, lumbar end-range extension was proposed as a 'directional preference' that the patient could repeatedly perform to provide self-generated symptomatic relief.

The suspicion of a peripheral neuropathic pain mechanism also guided the incorporation of neural mobilization as an intervention. Neural mobilization purports to restore nervous system homeostasis through movement of neural structures within their interface.[22] The effectiveness of neural mobilization for management of exercise-related lateral ankle and foot pain in an athletic population has been previously reported.[23] The improvement of pain and baseline symptoms within the first session supported the prescription of self-guided neural mobilization for continued self-treatment. Previous literature has suggested that within-session improvements in an episode of care can positively influence patient prognosis and the success of a program of care.[24-26]

To further provide early short-term symptom modulation, brief sessions of cupping were provided in the first few in-person visits. Cupping, as used in this plan of management, may beneficially modify perceptions of pain and increase pressure pain threshold for short periods of time.[27,28] It is proposed that cupping accomplishes this by modifying viscosity and flexibility of fascia.[29] However, evidence in this area is of low quality and further research may help elucidate the mechanisms by which cupping and other forms of manual therapy provide pain modulation in some patient populations. Regardless, the

Table 1.
Outcome measures at baseline and follow-up

Outcome measure	Baseline	3 months	6 months	12 months	Questionnaire description
Brief Pain Inventory (BPI): Pain interference score	54/70	14/70	11/70	10/70	A 70-point scale reflecting how much pain interferes with physical function, emotional function and sleep[11]. There is no minimal clinically important difference (MCID) for chronic non-cancer pain.
BPI: pain severity score	20/40	3/40	9/40	10/40	The sum of pain ratings between 0-10, for pains at the worst, least, average and current[11]. The MCID is 2.2, corresponding to 34.2% reduction in baseline score[33]
Center for Epidemiological Studies Depression (CES-D)	46/60	38/60	22/60	23/60	A 20-item measure that asks individuals to rate how often over the past week they experienced symptoms associated with depression, such as restless sleep, poor appetite, and feeling lonely. Scores ≥ 16 are indicative for a high risk of depression, with higher scores indicating greater depressive symptoms.
Generalized Anxiety Disorder-7 (GAD-7)	18/21	15/21	11/21	13/21	A seven-item instrument that is used to measure or assess the severity of generalized anxiety disorder. The MCID is four points. A score greater than 15 is indicative of severe anxiety, with 10-14 considered moderate anxiety.
Pain Self-Efficacy Questionnaire	20/60	45/60	40/60	49/60	A 10-item questionnaire developed to assess the confidence people with ongoing pain have in performing activities while in pain. Lower scores are indicative of lower perception of self-efficacy regarding a range of functions. A higher score indicates greater self-efficacy. The MCID is 9 points[34]
Patient Global Impression of Change (PGIC) Scale	N/A	N/A	N/A	Very much improved	A seven-point scale measuring a patient's beliefs about efficacy of treatment. Patients rate their change as "very much improved," "much improved," "minimally improved," "no change," "minimally worse," "much worse," or "very much worse." "Much improved" or "very much improved" are considered clinically important[35]
Self-reported running	No running	Daily running 20 minutes	Daily running 15-20 minutes	3x weekly running 15-20 minutes	

Table 3.
Self-reported progression of running ability

Visit number	Date	Running progression
3	November 27, 2020	5 mins, 3.5 mph, grade 2
5	December 4, 2020	7.5 mins, 3.5 mph, grade 2
7	December 11, 2020	10 mins, 4 mph, grade 2
10	January 6, 2021	6-7 minutes daily
11	January 8, 2021	10 mins daily 15 mins, 4 mph
13	January 15, 2021	20 mins, 4 mph, grade 2%
15	January 22, 2021	30 mins, 5 mph (resulted in pain occurrence)
17	January 29, 2021	30 mins, 5 mph, grade 1
19	February 9, 2021	20 mins, 6 mph
22	March 12, 2021	30 mins 3xweekly
24	April 23, 2021	20 mins including hills
6 months		15-20 mins daily
12 months		15-20 mins every 2-3 days

goal of using manual therapy in this case was to positively modulate pain, and to encourage within session performance of rehabilitation and exposure to running, and not as a mainstay of treatment.

The key element in the chiropractic management of this patient's pain was behavioural activation through goal-setting and progressive rehabilitation, rooted in motivational models of pain self-management.[30] Ongoing support, appraisal, and feedback in action planning and goal negotiation are important components of the rehabilitation process[31], and can be well-addressed as part of chiropractic care. The patient's pre-program questionnaires indicated high levels of depression, anxiety, and functional interference, and low pain self-efficacy. The exercise plan, alongside use of the *Activity Traffic Light*[15,16], and continued education provided the patient with tools to immediately reduce symptoms on his own, and thus allowed him to progressively reach his goals.

Strengths and limitations

The strength of our case report relies on our ability to provide proper diagnosis and chiropractic care within the context of a "whole person" management, at no cost to the patient. Our model of care is unique and results in high levels of success and positive long-term outcomes.[10,32] A limitation of our case report, is the lack of generalizability to other settings and practices, exactly because of the uniqueness of our care model, including our Ontario Ministry of Health funding.

Summary

A 36-year-old Canadian Armed Forces veteran presented with chronic left lateral calf pain, with significant pain-related disability and loss of quality of life. After appropriate assessment and diagnosis, chiropractic care within the context of an interdisciplinary pain management program resulted in significant improvements of pain and physical/ emotional disability, with complete resolution of physical symptoms. This case provides an example of an isolated lower limb neuropathy with a non-traumatic origin, and describes the use of rehabilitative symptom modulation and goal-based, holistic behavioral interventions by a chiropractor as part of an interdisciplinary team.

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