ORIGINAL RESEARCH

Backpacking-Induced Paresthesias

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Objective.—To evaluate the presence of numbness and paresthesias among long-distance backpackers on the Appalachian Trail.

Methods.—Backpackers who hiked a minimum of 7 days were interviewed while hiking. Following their hike, a written questionnaire was mailed to the participants that explored the incidence of injuries and illnesses among hikers. Paresthesias were defined as either numbness or “phantom, burning, or shooting pains.” A case-control analysis of risk factors for paresthesias was performed.

Results.—Paresthesias were reported by 34% (96 of 280) of the backpackers completing the study. They included ulnar paresthesias ($n = 4$), meralgia paresthetica ($n = 10$), tarsal tunnel syndrome ($n = 6$), digitalgia paresthetica ($n = 21$), and nonspecific paresthesias ($n = 61$). The most common symptom was numbness: 81% (78 of 96). Significant risk factors included a distance of >2000 miles (relative risk [RR] = 1.3; 95% CI, 1.1–1.6; $P = .01$) and the duration of hiking (RR = 2.0; 95% CI, 1.2–3.2; $P = .004$) for the longest quartile. Nonsignificant factors included backpack weight, initial body weight, percentage of weight loss, running shoe usage, and multivitamin usage. Ninety-eight percent of the paresthesias (94 of 96) had resolved by the time of follow-up (median = 30 days).

Conclusions.—Paresthesias were a surprisingly common complaint among long-distance backpackers. Although they were distressing during backpacking, these neuropathies were self-limited and resolved after completion of hiking.

Key words: backpacking, neuropathy, paresthesia, meralgia paresthetica, tarsal tunnel syndrome

Introduction

Paresthesias are neurologic disorders characterized by painful burning, tingling numbness, and decreased touch and pain sensation. There are no motor deficits. Backpackers are at risk for particular paresthesias in specific distributions due to the compression of backpack straps, waist belts, and boots. Prior case reports have described bilateral ulnar paresthesias associated with tight backpacking straps compressing the ulnar nerves as they leave the axillary fossae.^{1,2} To our knowledge, no study has previously systematically evaluated the frequency of this problem.

A backpack's waist belt may cause meralgia paresthetica. This is a neurologic disorder characterized by pain, burning, or tingling paresthesias and decreased touch and pain sensation on the anterolateral aspect of the thigh in the distribution of the lateral femoral cutaneous nerve.³ The lateral femoral cutaneous nerve is vulnera-

ble to an entrapment neuropathy where the nerve passes through the lateral end of the inguinal ligament. Such an occurrence is common in pregnant women and obese people, in whom the nerve is compressed by a pad of fat.^{4,5} In backpacking, this can occur via an external compression of the nerve against the anterior iliac spine as the backpack's waist belt is cinched.

The feet are at risk for entrapment neuropathies due to poorly fitting hiking boots as well as neuropraxias, in which direct injury to a nerve induced by repetitive trauma produces pain and/or numbness. When present in the toes, it is known as digitalgia paresthetica. Tarsal tunnel syndrome is an entrapment neuropathy of the posterior tibial nerve within the tunnel formed by the flexor retinaculum, posterior and distal to the medial malleolus of the ankle.^{6–9} This is a relatively uncommon problem of the foot and ankle, and yet it can occur by an intrinsic or extrinsic compression on the posterior tibial nerve. It typically presents as a burning pain, tingling, or numbness at the medial malleolus with radiation to the heel or sole in the distribution of the tibial nerve.^{6–9} The symptoms are often vague and have nocturnal exacerbations.¹⁰

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Table 1. Demographic characteristics of backpacking paresthesias

<i>Paresthesia</i>	<i>n</i>	<i>Body weight prehike (kg)</i>	<i>Weight loss (%)</i>	<i>Duration of hike (d)</i>	<i>Distance hiked (miles)</i>	<i>Backpack weight (kg)</i>
Digitalgia paresthetica	21	72.6	5.4	144	1800	17.9
Meralgia paresthetica	10	69.3	4.4	179*	2030**	19.4
Tarsal tunnel	6	69.7	1.9	204*	1900	20.6
Ulnar paresthesia	4	65.6	1.1	184	2160	16.6
Nonspecific†	61	76.7	7.4	148**	1730	19.5
All paresthesias	96‡	75.3	6.4	154*	1785*	19.1
Controls	176	75.6	7.5	131	1555	19.1

†Nonspecific paresthesias lacked sufficient detail to categorize them appropriately.

‡Three hikers had >1 paresthesia.

* $P < .01$; ** $P < .05$.

Although paresthesias are typically benign in nature, the onset of a paresthesia may cause considerable distress, prompting a visit to a health care provider for further evaluation.

Methods

Data for this study were obtained via a prospective observational surveillance study. Participants were initially recruited from May 15 to August 1, 1997. The sample was obtained by interviewing backpackers sequentially as they were met while hiking >1000 miles of the Appalachian Trail stretching from New Hampshire to North Carolina. A follow-up written questionnaire was mailed to the participants in October 1997. The 25 most common medical problems of the initial recruitment phase were assessed. The inquiry of a medical problem focused on whether it occurred, the number of occurrences, treatments performed, and whether medical attention was sought. Paresthesias were defined as either “numbness” or “phantom, burning, or shooting pains.” Paresthesias were classified on the basis of written descriptions if sufficient detail was provided. The inquiry addressed backpackers’ “chronic past medical problems.” Demographic information was assessed such as age, gender, starting and finishing locations, pre- and post-body weight, footwear, and backpack weight. Institutional review board approval was obtained for this study. Continuous variables were compared with the unpaired, 2-tailed t test. Categorical variables were compared with the χ^2 test. Case-control comparisons are presented as relative risks (RRs) with 95% CIs. No adjustments were made. Controls were hikers not reporting numbness or paresthesias.

Results

In a prospective surveillance study of 334 Appalachian Trail backpackers who hiked at least 7 days (mean = 140 days) in 1997, 280 (84%) completed the study. They represented a total of 106 person-years of wilderness exposure. Ninety-six hikers (34%) complained of either numbness ($n = 62$) or paresthesias ($n = 78$). Numbness in the feet ($n = 38$) was reported most often. Foot numbness followed 2 primary patterns—digitalgia paresthetica ($n = 21$) and tarsal tunnel syndrome ($n = 6$). Of the various paresthesias, symmetric upper extremity ulnar paresthesias occurred in 4 (1.4%) hikers, and 10 (3.6%) hikers reported lateral thigh paresthesias consistent with meralgia paresthetica. Sixty-one hikers did not provide enough data to fully characterize their paresthesia.

Factors influencing the incidence of paresthesias were examined (Table 1). Hikers experiencing paresthesias were younger by nearly 8 years (average = 30 ± 11 years, $P < .001$). In comparing quartiles (Table 2), those

Table 2. Duration of hiking quartile comparison

<i>Quartile</i>	<i>Duration (mo)</i>	<i>Paresthesias Y/N</i>	<i>Relative risk</i>	<i>95% CI</i>	<i>P value</i>
1	<3	17/53	1	...	...
2	3.1–5.1	19/51	1.12	0.64 1.97	.69
3	5.1–6	28/41	1.67	1.01 2.76	.04
4	>6	34/37	1.97	1.22 3.19	.004

Figure 1. Meralgia paresthetica: innervation of the lateral femoral cutaneous nerve distribution.

with the longest duration experienced more paresthesias (RR = 2.0; 95% CI, 1.2–3.2; $P = .004$). Paresthesias occurred more frequently in those backpacking >2000 miles (RR = 1.3; 95% CI, 1.1–1.6; $P = .01$). Women were more likely than men to experience paresthesias (RR = 1.43; 95% CI, 1.05–1.97; $P = .03$), with a 46% (33 of 71) occurrence in women compared to a 31% (65 of 209) occurrence in men. The routine use of multivitamins was not protective among those with routine use, with 33% (44 of 134) of the routine users experiencing paresthesias vs 38% (54 of 143) of those who did not (RR = 0.9; 95% CI, 0.6–1.2; $P = .4$). The use of running shoes ($n = 19$) was not a significant factor in acquiring paresthesias, with 38% (7 of 19) having paresthesias ($P = .6$), although this was underpowered because of the small sample size. The median follow-up was 30 days, at which time 2% (2 of 96) still complained

of persistent paresthesia symptoms of digitalgia paresthetica.

Discussion

Paresthesias were commonly experienced by approximately one third of the long-distance backpackers in our study. The largest significant contributors to the development of paresthesias were duration and distance of backpacking.

MERALGIA PARESTHETICA

Meralgia paresthetica is a paresthesia of the lateral femoral cutaneous nerve on the anterolateral aspect of the thigh (Figure 1). In backpacking, this nerve is vulnerable to an entrapment neuropathy via compression of the nerve against the anterior iliac spine as the waist belt is cinched. The most common factors noted in its pattern of presentation were that it was reported after 2 to 3 weeks of hiking and mild weight loss.

Other circumstances in which this paresthesia has been reported include transfemoral angiography,¹¹ metastatic cancer in the iliac crest,¹² inguinal hernia repair,¹³ iliac crest bone-graft harvesting,¹⁴ seat belt injury,^{15,16} weight changes,¹⁷ tight trousers or belts,¹⁸ pocket watch usage,¹⁹ pregnancy,^{5,9} and gymnastics of the uneven parallel bars.²⁰ Standing, walking, or adduction of the thigh may exacerbate the pain.²¹ Historically, >90% of those with meralgia paresthetica have weighed >80 kg with a 2.8:1 male-to-female predominance.²² However, in our study, weight, weight change, and male gender were not risk factors.

The diagnosis is made mainly on clinical grounds. Numbness, painful burning, and itching in the lateral aspect of the thigh are the main complaints. Examination reveals dysesthesia or hypoesthesia to touch and pinprick. There are no motor deficits.

The initial treatment of meralgia paresthetica is conservative and includes explanation and reassurance concerning the benign nature of the otherwise baffling symptoms.²³ Patients may benefit from looser clothing and increased padding of their backpack waist belt. Non-steroidal anti-inflammatory drugs as well as topical capsaicin have also been successful.²⁴ For severe cases, local hydrocortisone injections or local anesthetic injections into the lateral end of the inguinal ligament can provide temporary relief.²⁵ However, in our study, all of the cases of meralgia paresthetica were self-limited during backpacking and resolved spontaneously upon completion of hiking.

Figure 2. Foot paresthesias: tarsal tunnel and anterior tarsal tunnel paresthesia distributions.

DIGITALGIA PARESTHETICA

Digitalgia paresthetica is the isolated numbness of the toes. This is a neuropraxia, pain, and/or paresthesia induced by direct repetitive trauma to a nerve. A common example is the ulnar neuropraxia of the “funny bone.” Digitalgia paresthetica has been observed in new army recruits as they adjust to marching with heavy packs.²⁶ One previous study showed no difference between hiking boots and running shoes.²⁶ Indeed, in our study there was no difference either, although our study was underpowered to detect a difference because of the small sample size of those who used running shoes ($n = 19$). Further study to examine the effect of increased padding or cushioning in the forefoot may be warranted. The 2 backpackers with persistent digitalgia paresthetica at the time of follow-up suggest that this ailment has the potential of showing a longer recovery process because of the continued repetitive trauma while walking, even after backpacking cessation.

TARSAL TUNNEL SYNDROME

Tarsal tunnel syndrome is an entrapment neuropathy caused by an intrinsic or extrinsic compression on the posterior tibial nerve within the tunnel formed by the flexor retinaculum, posterior and distal to the medial malleolus of the ankle.⁶⁻⁹ This is a relatively uncommon problem of the foot and ankle. It typically presents as paresthesia, dysesthesia, or hypoesthesia at the medial malleolus with radiation to the heel or sole in the distribution of the tibial nerve (Figure 2). The symptoms often are vague but usually consist of burning pain and

paresthesias in the toes and soles of the feet with nocturnal exacerbations.¹⁰

The diagnosis is made clinically by the presence of dysesthesia in the distribution of the medial and lateral plantar nerves.²⁷ A positive Tinel’s sign, paresthesias with compression of the nerve at the tarsal tunnel, may be present as well as tenderness of the nerve along its course through the flexor retinaculum (Valleix phenomenon).²⁷ Weakness of dorsiflexion may be present in severe cases. Increasing the tension of the tibial nerve via foot eversion and/or dorsiflexion may exacerbate symptoms.²⁸

Many causes of tarsal tunnel syndrome have been described, including a ganglion cyst, lipoma, tumor, talocalcaneal coalition, occult calcaneal fracture, diabetes mellitus, edema, abnormal foot biomechanics, rheumatoid arthritis, synovial hypertrophy, pressure on the accessory muscles, varicose vein, and bleeding after trauma.²⁹⁻³¹ More recently, this syndrome has also been described as an overuse injury in recreational and athletic endeavors. In runners, overpronation and excessive training tend to be the most common etiological factors.^{32,33} As well, ski boots have been reported to precipitate this disorder.³⁴ Both ski and hiking boots are similar in being a potential source of significant external pressure on the malleolus.

A different but similar condition known as the anterior tarsal tunnel syndrome is a rarely reported entrapment neuropathy of the deep fibular (peroneal) nerve under the extensor retinaculum at the ankle. Within the tunnel, there are the 4 tendons of the foot’s extensor muscles, the anterior tibial artery, a vein, and the deep fibular

(peroneal) nerve. A tendinitis of the extensor tendons or poorly fitting shoes exerting significant pressure on the anterior dorsum of the foot may cause a compressive entrapment neuropathy characterized by weakness of dorsiflexion and/or paresthesia between the first and second digits (Figure 2).

Tarsal tunnel syndrome is a recognized clinical entity, and therapy depends on correct recognition of the underlying cause. In backpacking-induced cases, foot biomechanics and footwear should be investigated. Changing footwear to decrease eversion and to increase padding to relieve extrinsic pressure on the medial malleolus or dorsum of the foot may be warranted.

STUDY WEAKNESSES

The largest weakness of this study is its written survey format with its inability to examine patients at the time of their paresthesias. Only half of those with paresthesias provided sufficient written data to accurately assign their paresthesia. Recall bias is present with any written survey, although an attempt to minimize underreporting was performed by directed questioning regarding paresthesias. Without prior published prevalence or incidence data, power calculations were post hoc, not a priori as ideal. Thus, some areas were underpowered to detect statistical significance because of the small sample sizes. Specifically regarding tennis shoe use, to detect a difference in paresthesias of 50% with 90% power ($\alpha = .05$), each sample would require 147 people.

Self-reported weight and recall of one's weight up to 1 year have been validated as reliable by previous literature.^{35–37}

Conclusions

Paresthesias, especially numbness, are common occurrences in long-distance backpackers, with one third of all backpackers experiencing them. Typically, these are self-limited during backpacking. In some cases, a prolonged duration of paresthesia may occur even after cessation of hiking. This may cause enough concern to prompt a visit to a health care professional. Primary care providers should be aware of the potential for entrapment paresthesias such as meralgia paresthetica, tarsal tunnel syndrome, and ulnar paresthesias. As well, the potential exists for a neuropraxia involving the feet with digitalgia paresthetica, resulting in isolated toe numbness. The benign and self-limited nature of these disorders should be reassuring.

Acknowledgments

I would like to thank W. W. Forgey, MD, for financial support of the study as well as Ben Rosner, MD, PhD, and Michael Hartley Jr, MD, for critical review of the manuscript.

References

- Goodson JD. Brachial plexus injury from tight backpack straps. *N Engl J Med*. 1981;305:524–525.
- Johnson RJ. Anatomy of backpack-strap injury. *N Engl J Med*. 1981;305:1594.
- Schiller F. Sigmund Freud's meralgia paresthetica. *Neurology*. 1985;35:557–558.
- Ivins GK. Meralgia paresthetica, the elusive diagnosis: clinical experience with 14 adult patients. *Ann Surg*. 2000;232:281–286.
- Deal CL, Canosa JJ. Meralgia paresthetica and large abdomens. *Ann Med*. 1982;96:787.
- Edwards WG, Lincoln CR, Bassett FH III, Goldner JL. The tarsal tunnel syndrome. Diagnosis and treatment. *JAMA*. 1969;207:716–720.
- Keck C. The tarsal-tunnel syndrome. *J Bone Joint Surg*. 1962;44:180–182.
- Lam S. A tarsal-tunnel syndrome. *Lancet*. 1962;2:1354–1355.
- Akyuz G, Us O, Turan B, Kayhan O, Canbulat N, Yilmaz IT. Anterior tarsal tunnel syndrome. *Electromyogr Clin Neurophysiol*. 2000;40:123–128.
- DeLisa JA, Saeed MA. The tarsal tunnel syndrome. *Muscle Nerve*. 1983;6:664–670.
- Antunes PE, Antunes MJ. Meralgia paraesthetica after aortic valve surgery. *J Heart Valve Dis*. 1997;6:589.
- Thorian G, Bhattacharji S. Malignant secondary deposit in the iliac crest masquerading as meralgia paraesthetica. *Arch Phys Med Rehabil*. 1997;78:1010–1011.
- Dibenedetto LM, Lei Q, Gilroy AM, et al. Variations in the inferior pelvic pathway of the lateral femoral cutaneous nerve: implications for laparoscopic hernia repair. *Clin Anat*. 1996;9:232–236.
- Weikel AM, Habal M. Meralgia paraesthetica: a complication of iliac bone procurement. *Plast Reconstr Surg*. 1977;60:572–574.
- Nahabedian MY, Dellon AL. Meralgia paraesthetica: etiology, diagnosis, and outcome of surgical decompression. *Ann Plast Surg*. 1995;35:590–594.
- Beresford HR. Meralgia paresthetica after seat-belt trauma. *J Trauma-Inj Infect Crit Care*. 1971;11:629–630.
- Baldini M, Raimondi PL, Princi L. Meralgia paraesthetica following weight loss. Case report. *Neurosurg Rev*. 1982;5:45–47.
- Boyce JR. Meralgia paresthetica and tight trousers [letter]. *JAMA*. 1984;251:1533.
- Mack GJ. Watchpocket meralgia paresthetica. *Ind Med Surg*. 1968;37:778–779.
- MacGregor J, Moncur JA. Meralgia paraesthetica—a

- sports lesion in girl gymnasts. *Br J Sports Med.* 1977;11:16–19.
21. Reid V, Cros D. Proximal sensory neuropathies of the leg. *Neurol Clin.* 1999;17:655–667.
 22. Ecker AD, Woltman HW. Meralgia paresthetica: a report of one hundred and fifty cases. *JAMA.* 1938;110:1650.
 23. Williams PH, Trzil KP. Management of meralgia paraesthetica. *J Neurosurg.* 1991;74:76–80.
 24. Puig L, Alegro M, De Moragas JM. Treatment of meralgia paraesthetica. *Dermatology.* 1995;191:73–74.
 25. Dilger JA. Lower extremity nerve blocks. *Anesthesiol Clin North Am.* 2000;18:319–340.
 26. Stein M, Shlamkovitch N, Finestone A, Milgrom C. Marcher's digitalgia paresthetica among recruits. *Foot Ankle.* 1989;9:312–313.
 27. Cimino WR. Tarsal tunnel syndrome: review of the literature. *Foot Ankle.* 1990;11:47–52.
 28. Daniels TR, Lau JT, Hearn TC. The effects of foot position and load on tibial nerve tension. *Foot Ankle Int.* 1998;9:73–78.
 29. Distefano V, Sack JT, Whitaker R, Nixon JE. Tarsal tunnel syndrome. Review of the literature and two case reports. *Clin Orthop.* 1972;88:76–79.
 30. Mann RA. Tarsal tunnel syndrome. *Orthop Clin North Am.* 1974;5:109–115.
 31. Takakura Y, Kitada C, Sugimoto K, Tanaka Y, Tamai S. Tarsal tunnel syndrome. Causes and results of operative treatment. *J Bone Joint Surg.* 1991;73:125–128.
 32. Jackson DL, Haglund BL. Tarsal tunnel syndrome in runners. *Sports Med.* 1992;13:146–149.
 33. Jackson DL, Haglund BL. Tarsal tunnel syndrome in athletes. Case reports and literature review. *Am J Sports Med.* 1991;19:61–65.
 34. Yamamoto S, Tominaga Y, Yura S, Tada H. Tarsal tunnel syndrome with double causes (ganglion, tarsal coalition) evoked by ski boots. Case report. *J Sports Med Phys Fitness.* 1995;35:143–145.
 35. Olivarius NF, Andreassen AH, Loken J. Accuracy of 1-, 5- and 10-year body weight recall given in a standard questionnaire. *Int J Obes.* 1997;21:67–71.
 36. Niedhammer I, Bugel I, Bonenfant S, Goldberg M, Leclerc A. Validity of self-reported weight and height in the French GAZEL cohort. *Int J Obes.* 2000;24:1111–1118.
 37. Klipstein-Grobusch K, Kroke A, Boeing H. Reproducibility of self-reported past body weight. *Eur J Clin Nutr.* 1998;52:525–528.