

**Percutaneous Electrical Nerve Stimulation
(PENS): A Complementary Therapy for the
Management of Pain Secondary to Bony
Metastasis**

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Abstract:

Objective: To evaluate the use of a novel nonpharmacologic analgesic therapy known as percutaneous electrical nerve stimulation (PENS) in the management of opioid-resistant cancer pain.

Design: PENS therapy was administered to three cancer patients on three or more occasion using acupuncturelike needle probes that were stimulated for 30 minutes at frequencies of 4-100 Hz.

Results: Two of the three patients achieved good to excellent pain relief that lasted 24-72 hours after each treatment session.

Conclusion: PENS therapy is a useful supplement to opioid analgesics for the management of pain secondary to bony metastasis in terminal cancer patients.

The management of pain secondary to bony metastasis in terminal cancer patients typically involves administration of large doses of opioid analgesics.¹⁻³ Despite the proven pain-relieving properties of these compounds, many cancer patients continue to experience inadequate pain control because the rapid development of tolerance to the analgesic effects of opioids necessitates a continual escalation in their dosage requirements.^{4,5} In addition, the excessive sedation and gastrointestinal side effects (e.g., nausea, emesis, ileus) produced by opioid analgesics can be problematic in this patient population. Finally, more physically active cancer patients are becoming increasingly reluctant to take these medications if other alternatives are available.⁴

Recently, considerable interest has been generated in the use of nonpharmacologic "alternatives" to the opioid analgesics for pain management. Percutaneous electrical nerve stimulation (PENS) is a novel therapy for acute and chronic pain syndromes that involves the

insertion of acupuncture-like needle probes to stimulate peripheral nerve fibers in the dermatomal distribution corresponding to the patient's pain.⁶⁻⁸ The conceptual basis for PENS is related to both transcutaneous electrical nerve stimulation (TENS) and electroacupuncture. Although TENS has proved disappointing in the management of pain secondary to metastatic cancer,² the use of PENS has the advantage of allowing the practitioner to "bypass" the resistance of the cutaneous barrier and deliver the electrical stimulus in closer proximity to the nerve endings located in the soft tissue, muscle, and periosteum of the involved dermatomes. Electrical stimulation of the nerve endings located in the periosteum may be an important factor in achieving PENS-induced analgesia in this patient population.

In this preliminary report, we describe the use of PENS therapy for the short-term management of pain associated with metastatic cancer in three patients whose symptoms were inadequately controlled with conventional opioid and nonopioid analgesics. The PENS treatment variables (i.e., location of probes, 30-minute time interval, stimulation frequencies of 4-100 Hz, and polarity of the leads) were arbitrarily chosen based on previous clinical experience with this technique (WFC).

Case 1

A 76-year-old Hispanic man with prostate cancer metastatic to the spine region presented for PENS treatment because of worsening low back pain in spite of escalating doses of oral morphine (MS Contin 30 mg po 2-3 times per day). The pain was located in the paraspinous region at the L5-S1 dermatomal levels. The patient received PENS treatments with 32-gauge (0.20 × 30 mm) stainless steel needle probes (ITO, Tokyo, Japan) inserted into the periosteum (negative electrode) and soft tissue (positive electrode) as illustrated in [Fig. 1](#). The acupuncture-like needle probes were stimulated alternately at frequencies of 15 and 30 Hz for 30 minutes. Following the initial treatment, the patient reported a significant reduction in his pain [from 7 to 2 cm on a 10-cm visual analog scale (VAS), with 0 = none to 10 = worst pain imaginable] lasting for approximately 36 hours. On follow-up evaluation 3 days after the initial PENS treatment, the pain had returned to 5.5 cm on the VAS scale. The patient received a second treatment with the needle probes stimulated at a frequency of 100 Hz for 30 minutes, with the pain being immediately reduced to a "tolerable level" (VAS score of 2.5 cm) for 3-4 days. One week after the second treatment, the patient reported that the pain had subsequently increased to a VAS score of 4.5 cm, however, it was easily managed with his oral analgesic medication (i.e., hydrocodone/acetaminophen 1-2 po q 8-12 hours).

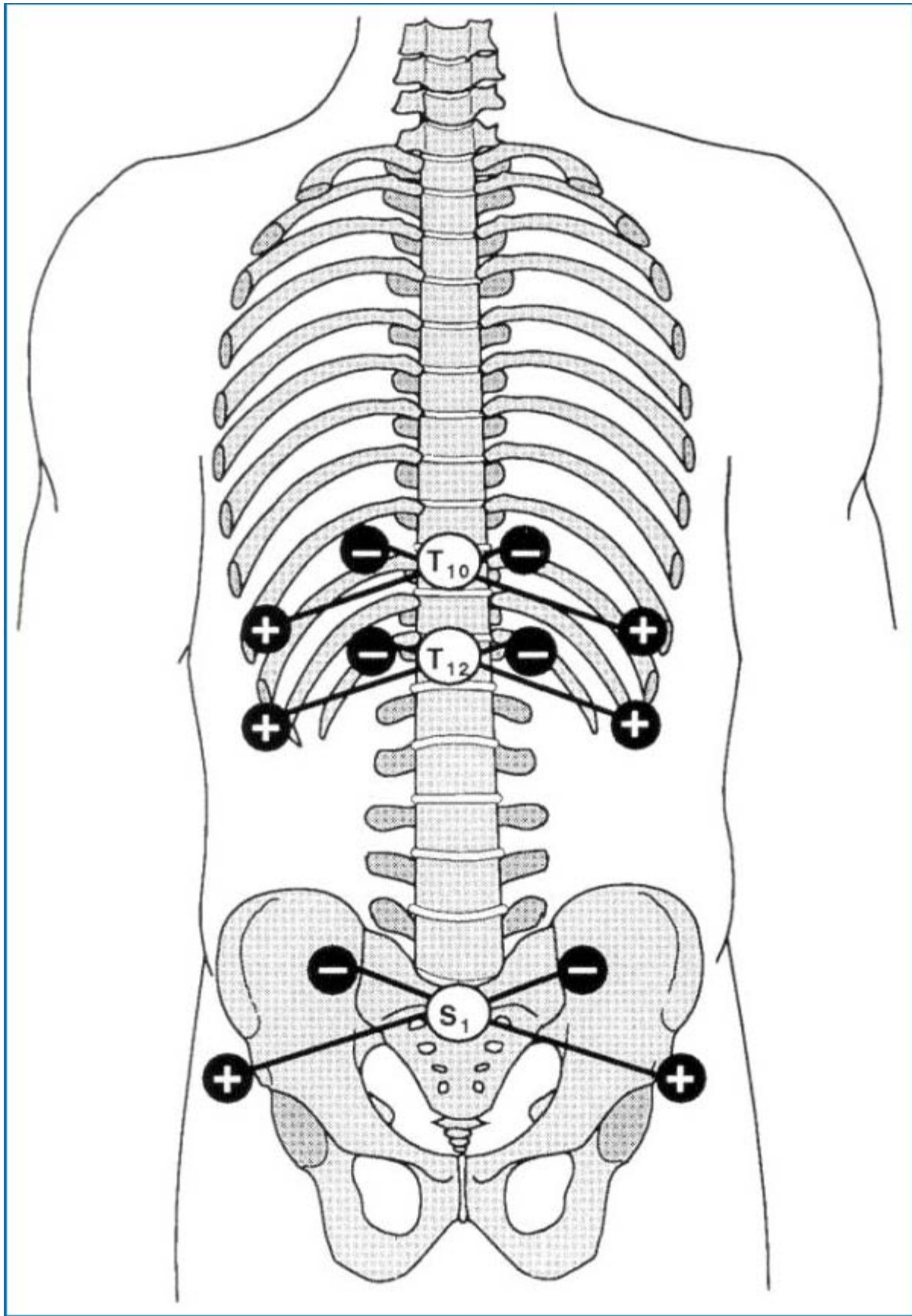


FIG. 1. The PENS montage consisted of six bipolar leads, with the negative (-) electrodes connected to needles placed into the periosteum at T₁₀, T₁₂, S₁ on both sides of the spine and the positive (+) electrodes placed laterally in the soft tissue (at a depth of 2-4 cm) in the same dermatomes.

Case 2

A 51-year-old black man with rectal carcinoma metastatic to the sacral region [status/post (S/P), an anteroposterior resection 1 year earlier] presented because of a recent worsening of the dull, aching pain in the lower back, requiring treatment with an oral opioid and nonopioid combination (i.e., hydrocodone/acetaminophen 3-4 po per day) and a nonsteroidal anti-inflammatory drug (NSAID) (i.e., ibuprofen 400-800 mg po BID). As a practicing dentist, the analgesic medication interfered with his ability to continue his professional activities. The patient was referred by his colorectal surgeon for PENS therapy. The 32-gauge acupuncture-like needle probes were placed in the lumbosacral region as illustrated in Fig. 2. The negative leads were connected to needles placed percutaneously into the periosteum, and the positive leads were connected to probes placed in the soft tissue at a depth of 2-4 cm. The probes were initially stimulated at a frequency of 6 Hz for 30 minutes. The patient reported a reduction in his VAS pain score from 9 to 2 cm (on the 10-cm scale) immediately after the treatment. The patient reported that the management of his pain required only three doses of the NSAID (i.e., ibuprofen 2,400 mg po) over the subsequent 48-hour period. He underwent a second PENS treatment 3 days later when his pain again increased to an intolerable level (i.e., a VAS score of 8 cm). The second treatment involved a similar needle montage; however, the frequency of stimulation was increased to an alternating 15-Hz and 30-Hz pattern. At 30 minutes after the treatment, he reported that his pain had decreased to 1 cm on the VAS and remained below his baseline level for 24 hours. One week later, a third treatment was administered using the same needle montage; however, the frequency of stimulation was increased to 100 Hz. The VAS pain score was decreased from 6 to 1.5 cm immediately after the PENS treatment, and his pain level remained decreased for almost 72 hours. After receiving three additional PENS treatments at weekly intervals, he was referred to a neurosurgeon who implanted a spinal cord (dorsal column) stimulating device that allowed him to maintain his pain at a tolerable level (3-5 cm on the VAS) with only occasional use of an oral NSAID or NSAID/opioid combination.

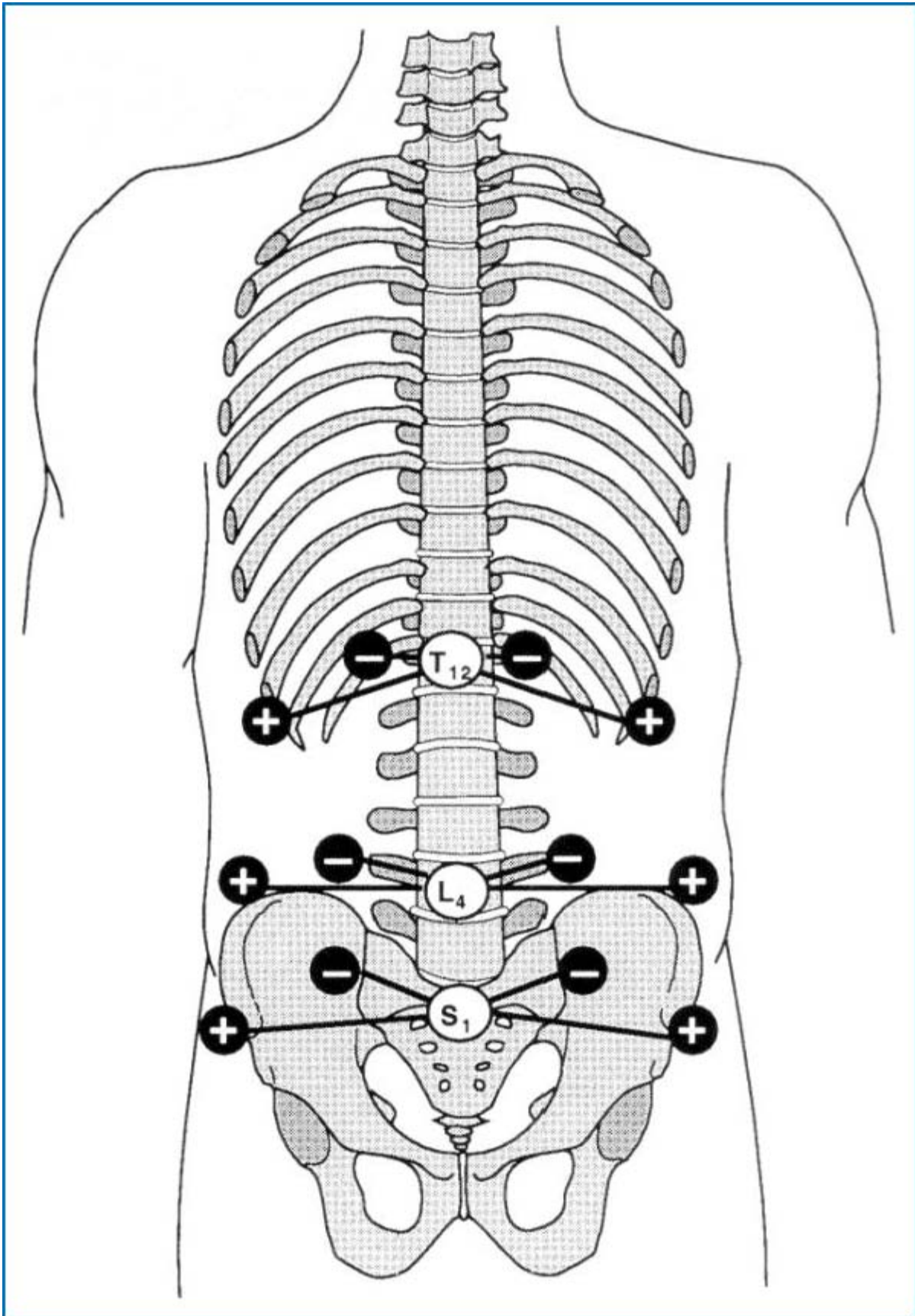


FIG. 2. The PENS montage consisted of six bipolar leads, with the negative (-) electrodes connected to needles placed into the periosteum at T₁₂, L₄, S₁ on both sides of the spine and the positive (+) electrodes connected to needles placed laterally at a depth of 2-4 cm in the soft tissue at the same dermatome levels.

Case 3

A 78-year-old retired white man with gallbladder cancer (S/P, an open cholecystectomy 4 months earlier) presented with uncontrolled pain in the right upper quadrant region radiating through to his back (at a T6-8 level). The patient had been treated 1 month earlier with a local anesthetic celiac plexus block without any significant pain relief. Although his bone scan was negative for metastatic disease, there was evidence of local tumor extension involving the hilum of the liver on computerized axial tomography scan. The patient was referred by his oncologic surgeon for a trial with PENS therapy. Three consecutive PENS treatments were performed for 30 minutes each using a combination of periosteal and soft-tissue stimulation in the paraspinous region at the T4, T10, T12 dermatomal levels (Fig. 3), with stimulation frequencies of 4 Hz, 15/30 Hz and 100 Hz, respectively. Unfortunately, these treatments failed to provide any significant relief of his pain symptoms. The PENS therapy was discontinued, and the patient was started on an oral morphine-containing solution. He died 2 months after undergoing a palliative biliary tract decompression procedure.

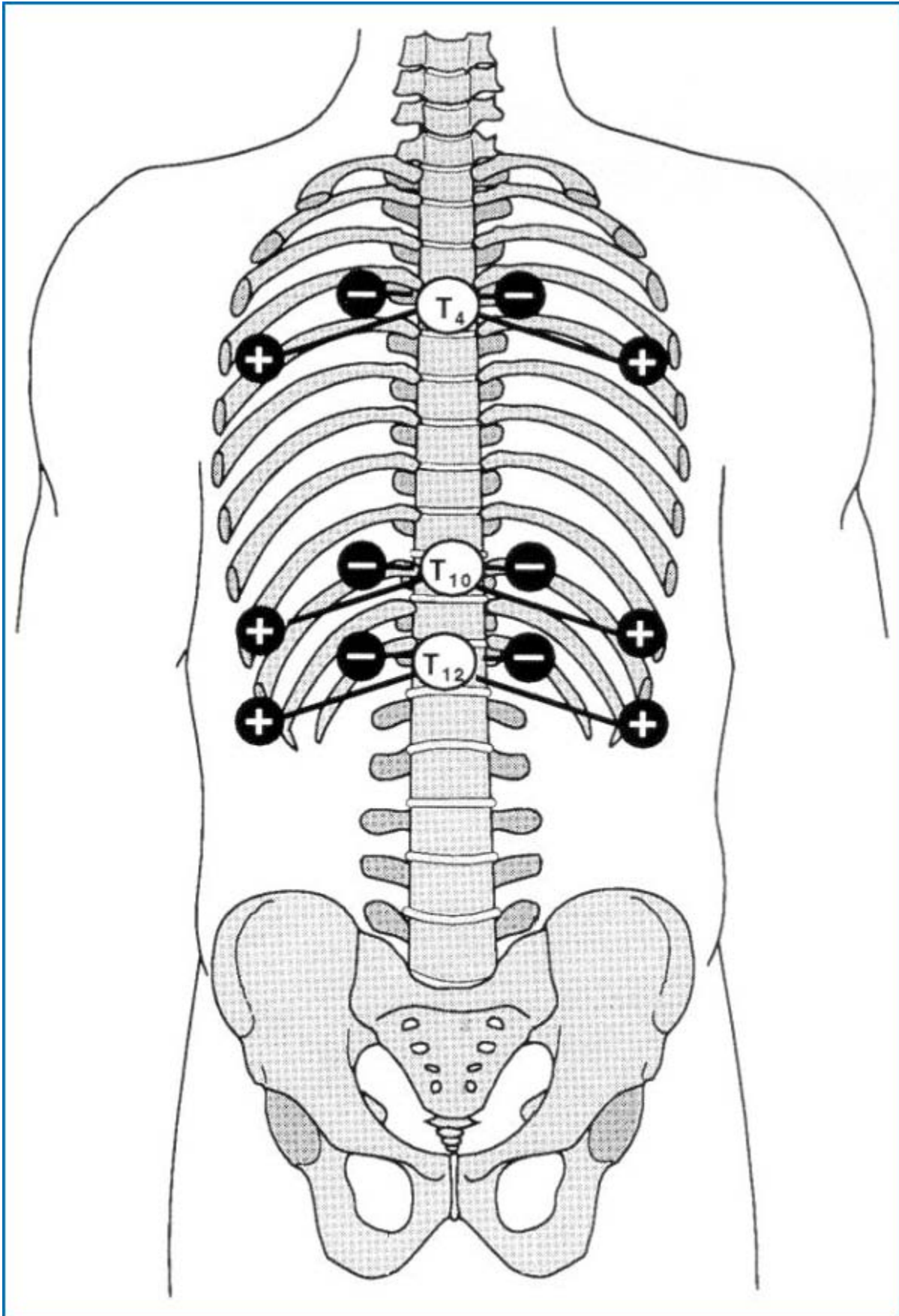


FIG. 3. The PENS montage consisted of six bipolar leads, with the negative (-) electrodes connected to needles placed into the periosteum at T4, T10, T12 on both sides of the spine and the positive (+) electrodes connected to needles placed laterally at a depth of 2-4 cm in the soft tissue at the same dermatome levels.

DISCUSSION

Despite published guidelines for pain management, many patients with metastatic cancer have considerable pain for which they receive inadequate analgesia.^{2,4} The treatment of cancer pain with large dosages of opioid and nonopioid analgesics is an unsatisfactory option for many terminally ill patients because of the well-known side effects associated with these pharmacologic compounds. In addition, the development of tolerance and physical dependence are also predictable consequences of long-term opioid administration. Other pharmacologic alternatives to the commonly used opioid and nonopioid analgesics (e.g., strontium-89 and bisphosphonates) have been reported to be effective in relieving pain associated with metastatic disease;^{9,10} however, they also produce side effects. Therefore, some practitioners have begun to examine the use of nonpharmacologic analgesic therapies in an effort to minimize the risks of side effects and adverse drug interactions in this patient population.

Acupuncture, electroacupuncture, dorsal column stimulation, and TENS have all been used with limited success in the management of cancer-related pain syndromes.² The type of electrical nerve stimulation used in these three cancer patients combines the advantages of both electroacupuncture and TENS therapies. Although it has been suggested that these electroanalgesia therapies stimulate the release of analgesic-like substances within the central nervous system,¹¹ a more likely explanation for the opioid-sparing action of PENS is the direct effect of the electrical stimulus on neural modulation.¹² Although this nonpharmacologic technique may decrease the need for analgesic drugs, it should not be viewed as substitute (or alternative), but rather as a supplement (or complement) to conventional pharmacotherapy. In this preliminary evaluation, PENS provided short-term analgesic-sparing effect in two cancer patients with bony metastases.

In the patients with bony metastasis secondary to prostate and rectal carcinoma (cases 1 and 2, respectively), PENS therapy also produced significant acute pain relief. Longer-lasting improvement in their pain symptoms was achieved by varying the frequency of stimulation through a range from 6 to 100 Hz at subsequent treatment sessions. However, in the absence of bony metastases (case 3), PENS therapy was largely ineffective in providing any clinically significant pain relief. These anecdotal reports can be criticized because of the small number of patients evaluated, the arbitrarily chosen treatment parameters, and the potential investigator bias and methodologic contamination resulting from the lack of "blinding." However, the number of referral cases is very limited because of the common practice of administering large dosages of opioid analgesics to these terminally ill cancer patients.

In conclusion, PENS therapy appears to offer an alternative to escalating doses of opioid and nonopioid analgesics for the management of cancer pain secondary to bony metastasis. In the future, larger scale, prospectively randomized, sham-controlled studies are needed to evaluate the role of PENS as a complementary therapy to analgesic medications in the management of cancer-related pain.

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Key Words: Cancer pain, bony metastasis; Electroanalgesia; Percutaneous electrical nerve stimulation (PENS)