Treatment of peripheral extremity pain with TENS: a report of three cases

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This paper reviews three cases in which radiculopathies of the cervical and lumbar spine were successfully managed by the use of transcutaneous electrical nerve stimulation (TENS) in addition to, or instead of, spinal manipulative therapy. Characteristics of TENS, indications for its use, and application procedures are discussed.

KEY WORDS: transcutaneous electrical nerve stimulation, TENS, chiropractic, manipulation.

Cet article passe en revue trois cas dans lesquels une radiculopathie de la colonne cervicale et lombaire a été traitée avec succès par l'emploi d'une stimulation nerveuse électrique transcutanée (TENS, de l'anglais "transcutaneous electrical nerve stimulation") en plus de, ou à la place d'un traitement par manipulation vertébrale. Les caractéristiques du TENS, ses indications, et les procédures d'application sont discutés.

MOTS CLÉS: stimulation nerveuse électrique transcutanée, TENS, manipulation, chiropratique.

Introduction

Transcutaneous electrical nerve stimulation (TENS) has been increasingly used for the relief of acute and chronic pain. The first reported use of electricity in medicine dates back to the Socratic era, when electrogenic torpedo fish were used as generators to provide electricity for pain relief.[1] In the early 1800's man-made devices began replacing these natural sources of electricity, and galvanic current was offered as a panacea for many afflictions, including pain.[2] The current concept of afferent stimulation techniques (often called neuromodulation) for controlling pain began in 1965 with the publication of Melzack and Wall's Spinal Gate Control Theory.[3] This theory postulates that activity in the large myelinated primary afferent proprioceptive fibres (A fibres), acting via inhibitory circuits in the laminae of the dorsal horn, inhibit the transmission of activity in the small unmyelinated primary afferent pain fibres (C fibres), thereby stopping pain messages from getting through the gate. TENS is designed to provide sensory, rather than motor stimulation, affecting sensory pathways. One basic assumption underlying its action is that large fibres can be selectively stimulated to set the gating mechanism in motion, thereby blocking small fibre activity.[4] There is also experimental evidence to suggest that the analgesic effect of TENS may be modulated by the endogenous opiate system through the release of endorphinergic substances.[5]

Stimulator characteristics

A large number of manufacturers now produce TENS devices and the electrical functions that are available vary greatly from manufacturer to manufacturer. The majority of effective stimulators use a variable square wave pulse with controllable voltage, pulse width, and frequency. Most devices deliver maximum currents in the 100 to 200 mA range. Pulse width can range from 40 to several hundred micro-seconds. Most units are capable of producing frequencies within 2 to 200 Hz pulse repetition rates.

Two basic TENS procedures are commonly used in clinical practice: 1) stimulation delivered at high frequency and low intensity (conventional mode) and 2) stimulation delivered at low frequency and high intensity (acupuncture mode).[5] A few models offer additional settings, such as the burst mode (a series of higher frequency pulses in bursts at a low rate), and the modulated mode (a progressive alteration of pulse rate and width).

Most units have two channels with separate current amplitude controls and are powered by rechargeable batteries or disposable transistor alkaline batteries. The most widely used electrodes are silicone rubber impregnated with carbon particles that require adhesive tape to attach them to the skin. Recently, disposable and re-usable electrodes which are self-adhesive are available, but they are expensive. Retail prices of TENS units generally range from $200 to $900 (1986 dollars), and there are significant differences with respect to stimulation quality. With the cheaper units, patients usually report that the stimulation does not feel as strong or comfortable as with the more sophisticated devices.

Case reports

The following three cases all involve radiculopathies due to spondylotic changes of various degrees. A radiculopathy results from irritation of the nerve root in the lateral recess just medial to the intervertebral foramen. Cervical spondylosis is most frequently seen at C5-6 followed by C6-7. Degenerative intervertebral disc disease and associated changes in the joints of Luschka and the apophyseal joints show predilection for these same levels. Frequently the three sites are affected concomitantly, each contributing to neural compression. A study correlating radiographic changes of degeneration in the cervical spine with clinical signs and symptoms, found that exuberant osteophytosis need not be associated with significant clinical manifestations.[6] Degenerative changes in the lumbar spine predominate in the lower lumbar region, particularly between the

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fourth lumbar and first sacral segments. It has been shown that there is a poor correlation between narrowing of the disc spaces, osteophyte formation and low-back pain. Only with marked disc space narrowing and traction spurs, an increased incidence of low-back pain is noted.[7,8,9] It is, therefore, important to exercise considerable caution before assuming that mild or moderate degenerative changes, as observed on radiographic examination, are of clinical significance.

Case 1: E.P. is a 58-year-old male who was involved in a minor motor vehicle accident five weeks prior to presentation. Approximately one week after the accident he developed right-sided neck pain and stiffness with sharp pain radiating to his right shoulder and posterolateral aspect of his right arm.

On examination, the range of motion of his cervical spine was moderately restricted for extension, right rotation and right lateral bending. Foraminal compression tests reproduced his right neck, shoulder and arm pain. There was tenderness over the C4-6 posterior joints on the right, with significant joint dysfunction at these levels. Cranial nerve examination was normal. Muscle strength, reflexes and sensations were normal in the upper extremities and the plantar responses were downgoing. Provocational tests for vertebrobasilar insufficiency failed to elicit any symptoms.

Radiographic examination of his cervical spine showed advanced degenerative disc disease at C5-6 with prominent posterior osteophytes. The intervertebral foramena at that level demonstrated narrowing on the oblique views. Less marked degenerative disc disease was seen at C4-5 (Figure 1).

A diagnosis of mild lower cervical radiculopathy and posterior joint dysfunction was made.

The patient was treated daily for two weeks with gentle neck mobilization, manipulation, and TENS applied to the right lower neck, shoulder fibres of right trapezius muscle, right lateral shoulder and posterolateral aspect of right arm. Each treatment session lasted twenty minutes during which the stimulator was set on modulation mode. At the end of the treatment regimen, and at follow-up two weeks later, the patient reported to be very much improved, and range of motion of his cervical spine was full and pain-free in all directions.

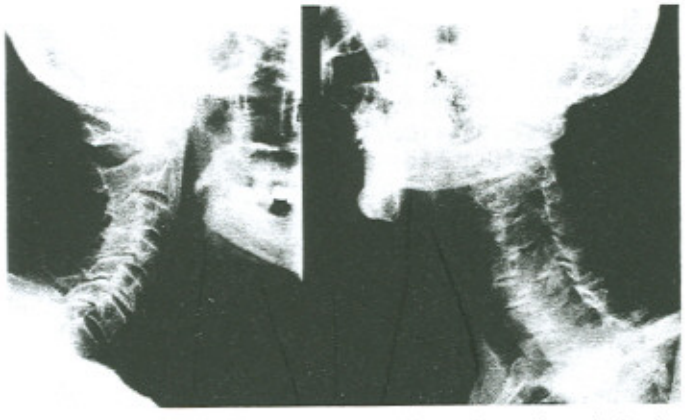

Figure 1 Case 1. Neutral lateral and oblique views of cervical spine showing advanced degenerative disc disease at C5-6 with narrowing of the intervertebral foramena.

Case 2: L.N. is a 43-year-old female who presented with a one-year history of right-sided neck and arm pain to about the elbow. There was no history of trauma.

Examination of the cervical spine showed slight restriction of right rotation. There was marked tenderness over the posterior joints at C2-3 as well as C5-7 on the right with significant joint dysfunction at these levels. Cranial nerve examination and neurological examination of her upper extremities was normal. Holding her neck in extension with rotation caused her to become dizzy.

Radiographic examination of her cervical spine demonstrated advance disc space narrowing and prominent osteophyte formation at C5-6 and to a lesser extent at C6-7, with a slight kyphosis centered at those levels (Figure 2).

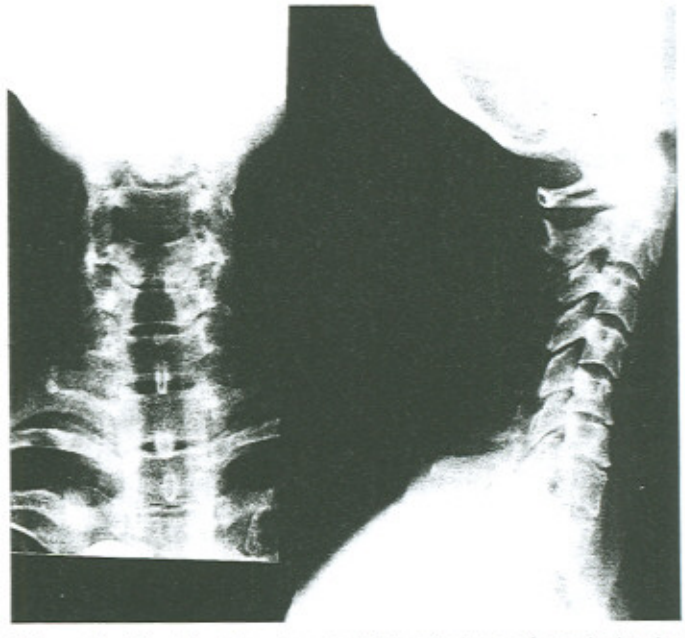

Figure 2 Case 2. AP and neutral lateral views of cervical spine showing advanced disc space narrowing and osteophyte formation at C5-6 and at C6-7.

A diagnosis of mild lower cervical nerve root irritation and joint dysfunction was made. A possible vertebrobasilar insufficiency syndrome had to be considered, since neck extension combined with rotation made her dizzy. Therefore, it was elected not to manipulate her neck, but rather use very light mobilization, avoiding extension, and TENS to treat her. The electrodes were applied to the suboccipital region and to the shoulder fibres of the trapezius muscle bilaterally. The stimula-

tor was set at a pulse width of 50 microseconds and a frequency of 85 Hz for five minutes and at the modulated mode for an additional ten minutes. After eight consecutive treatments the patient was pain-free and without any radiations into her right upper extremity. She was still asymptomatic when reviewed one month and a half later.

Case 3: W.K. is a 80-year-old male who presented with bilateral buttock and right lower extremity pain of several years duration. His thigh and leg pain was within the L5 nerve root distribution and more severe than the buttock pain. After walking the distance of one block Mr. W.K. had to stop because of severe leg pain, and had to rest for a few minutes before he could continue walking. Sleep was undisturbed.

Examination revealed moderate restriction of lumbar spine extension and flexion with aggravation of the right lower extremity pain on extension. There was marked tenderness over the L4-5 and L5-S1 posterior joints bilaterally. Muscle power, reflexes, and sensation were normal in the lower extremities; the plantar responses were downgoing.

Radiographic examination of his lumbar spine demonstrated generalized degenerative disc disease with advanced disc space narrowing and osteophyte formation at L4-5 and L5-S1. The facet joints at these lower levels also showed marked degeneration (Figure 3).

The diagnosis in this case was intermittent neurogenic claudication. Treatment initially consisted of two weeks of gentle mobilization and manipulation of the lower lumbar and lumbosacral facet joints. After this period Mr. W.K. noticed some improvement with respect to being able to walk further, but still complained of right lower extremity pain. A subsequent week of treatment with TENS was initiated. The electrodes were applied as follows: paraspinally at the L4-5 level, over the sciatic notch, over the popliteal fossa and over the lateral calf. The TENS unit was set at 50 microseconds and 85 Hz for five minutes, followed by the modulated setting for another ten minutes. This decreased his leg pain considerably and led to further improvement of walking distance. Unfortunately the patient was lost to follow-up due to death of an unrelated cause.

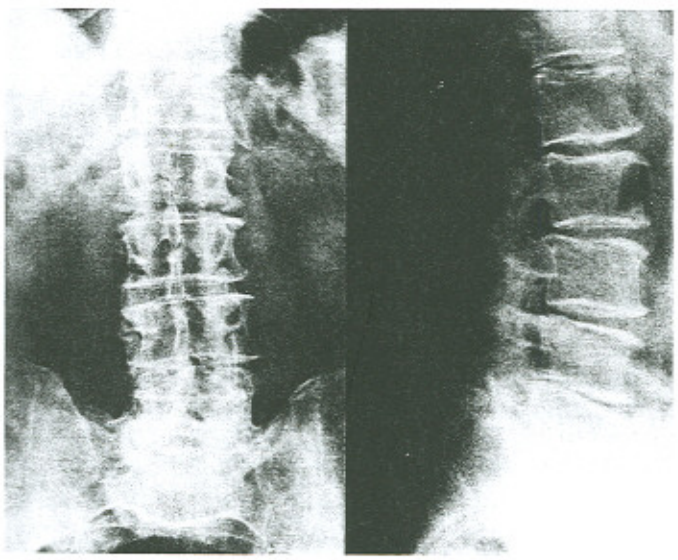

Figure 3 Case 3. AP and neutral lateral views of the lumbar spine demonstrating advanced disc space narrowing, osteophyte formation and facet joint degeneration at L4-5 and L5.

Discussion

Essentially TENS may be used to treat any localized pain of somatic or neurogenic origin provided paraesthesia can be obtained in the area of the pain. Its most extensive application is for chronic pain of non-malignant origin, but there is growing interest in its use in cancer pain, acute post-traumatic and post-operative pain, and labor pain.[10] TENS is particularly suited for the treatment of pain of neurogenic origin, including peripheral nerve injury, radiculopathies, compression syndromes, causalgia, post-herpetic neuralgia, and intercostal neuritis.[4,11,12,13] Other conditions that can be treated by TENS include chronic low-back pain and certain arthritic states.[14,15,16,17] Types of pain that are not suitable for TENS are those that are widespread, poorly localized, psychogenic, and central pain states.[11]

Thorsteinsson et al[18] studied the placebo effect of TENS in 93 chronic pain patients in a double-blind cross-over trial using a genuine stimulator and a placebo machine. Placebo analgesic effects occurred in 32 percent of trials, as compared with 48 percent for actual stimulation. They concluded that the placebo effect of TENS is similar to the placebo effect that is noted in other double blind studies in which medications are used. Taylor et al[16] demonstrated significantly better pain reduction with TENS than with a placebo machine in ten patients with osteoarthritis.

The aim of TENS is to obtain a "deep tingling" or paresthesia that feels comfortable to the patient without producing muscle contraction or dysthesia. Choices of electrode sites and methods of placement are numerous and should be based on anatomical and physiological principles. Electrodes are most frequently placed within or around the area of pain, and stimulation of the nerve within the appropriate dermatome is found to be most effective.[19] The proximal electrode (anode) is usually placed over the nerve root close to the vertebral column. A site for the distal electrode (cathode) may then be selected within the dermatome over one of the following[4]: along the course of a major nerve trunk, a trigger point, an area where the peripheral nerve lies most superficially – often coinciding with a motor point, or an acupuncture point designated for the same pain pattern. Other methods for electrode placement include, two painful sites within the same dermatome, or bilateral paravertebral placement for spinal pain.

The vast majority of patients prefer frequencies between 40 and 70 Hz with pulse widths of 10–50 microseconds.[11] Leo et al[20] recently compared the effects of four treatment variables on

the pain reduction produced by TENS. Although pain was reduced significantly, they found that pulse width, frequency, amplitude, and therapist attributed little to treatment effect, and that subthreshold stimulation proved more effective than stimulation to tolerance.

The time for TENS to produce analgesia may range from immediate to several hours, the average time being about 20 minutes.[4,11] One problem reported with the use of TENS to treat chronic pain is that of attrition, meaning that the efficacy of TENS tends to fall off with time.[12]

TENS must not be used in patients with pacemakers or other implanted electrical devices. It should not be used during pregnancy, or on patients with heart problems when the heart is between the electrodes. Stimulators may also interfere with baroreceptor function when used near the carotid sinus.[10] Skin irritation or thermal burns may occur, and patients with partial sensory loss in the stimulated area are particularly susceptible. Allergic reactions may be initiated by the electrode gel or adhesive tape.

Conclusion

The above three cases represent clinical entities commonly encountered in a chiropractic office which were successfully managed by TENS and manipulation or mobilization. Their common denominator consisted of mild radicular irritation without any hard neurological signs. If used judiciously and intelligently, TENS constitutes a low-risk, non-invasive, relatively inexpensive, and easily applied technique to relieve pain or supplement other therapeutic modalities.

References

1 Long, D M. Electrical stimulation for the control of pain. Arch Sug 1977; 112: 884–888.
2 Lampe GN. Introduction to the use of transcutaneous electrical nerve stimulation devices. Physical Therapy 1978; 58: 1450–1454.
3 Melzak R, Wall PD. Pain mechanisms: a new theory. Science 1965; 150: 971–979.
4 Herman E. The use of transcutaneous nerve stimulation in the management of chronic pain. Physiotheraphy Canada 1977; 29: 65–71.
5 Belanger AY. Physiological evidence for an endogenous opiate – related pain-modulating system and its relevance to TENS: a review. Physiotherapy Canada 1985; 37: 163–167.
6 Friedenberg ZB, Miller WT. Degenerative disc disease of the cervical spine. J Bone Jt Surg 1963; 45A: 1171.
7 Targerson WR, Dotter WE. Comparative roentgenographic study of the asymptomatic and symptomatic lumbar spine. J Bone Jt Surg 1976; 58A: 850–853.
8 Witt I, Vestergaard A, Rosenklint A. A comparative analysis of x-ray findings of the lumbar spine in patients with and without lumbar pain. Spine 1984; 9: 298–300.
9 Frymoyer JW, Newberg A, Pope MH, et al. Spine radiographs in patients with low back pain. J Bone Jt Surg 1984; 66A: 1048–1055.
10 Abram SE. Transcutaneous electrical nerve stimulation, in: Neural Stimulation. Edited by Myklebust JB et al. Boca Raton, Florida: CRC Press Inc., 1985: 1–10.
11 Woolf CJ. Transcutaneous and implanted nerve stimulation, in: Textbook of pain. Edited by Wall PD, Melzack R. Edinburgh: Churchill Livingstone, 1984: 679–690.
12 Loeser JD, Black RG, Christman A. Relief of pain by transcutaneous stimulation. J Neurosurg 1975; 42: 308–314.
13 Long DM. Electrical stimulation for relief of pain from chronic nerve injury. J Neurosurg 1973; 39: 718–722.
14 Melzack R, Vetere P, Finch L. Transcutaneous electrical nerve stimulation for low back pain. Physical Therapy 1983; 63: 489–493.
15 Fried T, Johnson R, McCracken W. Transcutaneous electrical nerve stimulation: its role in the control of chronic pain. Arch Phys Med Rehabil 1984; 65: 228–231.
16 Taylor P, Hallett M, Flaherty L. Treatment of osteoarthritis of the knee with transcutaneous electrical nerve stimulation. Pain 1981; 11; 233–240.
17 Mannheimer C, Carlsson CA The analgesic effect of transcutaneous electrical nerve stimulation (TNS) in patients with rheumatoid arthritis. A comparative study of different pulse patterns. Pain 1979; 6: 329–334.
18 Thorsteinsson G, Stonningtom HH, Stillwell GK, Elveback LR. The placebo effect of transcutaneous electrical stimulation. Pain 1978; 5: 31–41.
19 Mannheimer JS. Electode placements for transcutaneous electrical nerve stimulation. Physical Therapy 1978; 58: 1455–1462.
20 Leo KC, Dostal WF, Bossen DG et al. Effect of transcutaneous electrical nerve stimulation characteristics on clinical pain. Physical Therapy 1986; 2: 200–205.