Transcutaneous Electrical Nerve Stimulation for Pain Control After Spinal Fusion with Harrington Rods

A Clinical Report

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During the past two years, we have been using transcutaneous electrical nerve stimulation (TENS) for pain control after spinal fusion with Harrington rods. This report describes our postoperative pain management program and our evaluation of its effectiveness. We examined postoperative pain medication usage and found that patients using TENS received fewer doses of several commonly prescribed pain drugs than did patients not using TENS devices. Difficulties we encountered in evaluating our program are described along with recommendations for other researchers interested in assessing TENS in the management of postoperative pain.

Key Words: Electrical stimulation, Pain, Physical therapy.

Pain control is an important consideration in the postoperative management of surgical patients. One technique that has helped control pain in recent years is transcutaneous electrical nerve stimulation (TENS). Numerous reports in the literature attest to its clinical effectiveness in a wide variety of pain conditions, such as postherpetic neuralgia, cancer, spinal cord injury, orofacial pain, low back pain, Guillain-Barré syndrome, phantom limb pain, rheumatoid arthritis, arachnoiditis, muscle cramps, angina pectoris, reflex sympathetic dystrophy, osteoarthritis, and headache.1-20

Transcutaneous electrical nerve stimulation has also been reported to be of value in the management of postoperative pain.21-27

Based on these reports, we began using TENS to control postoperative pain in patients undergoing spinal fixation using Harrington rods. After using TENS for some months for these patients, we decided to review our experience with this modality and examine whether TENS, as we were using it, was effective in controlling postoperative pain. This report describes the results of our examination.

ASSESSMENT METHODS

Because our patients routinely received drugs for pain control and because reduction in the need for pain medications has been used previously as a measure of the effectiveness of alternative pain-control strategies, we decided to use pain medication intake as our measure.2-24-28

Hospital charts from a sample group of 20 adolescents and young adults of both sexes undergoing spinal fixation with Harrington rods were reviewed. One group consisted of 10 patients who used TENS to control postoperative pain supplemented by pain medications. The comparison group consisted of 10 age- and sex-matched patients who received pain medications only during the postoperative period for pain control (Tab. 1). The effectiveness of TENS in reducing postoperative pain was assessed by comparing medication intake in the fourth postoperative day in both groups. We chose this day because routinely used pain medications were still available to all patients on an as needed basis and in the TENS group, the units were still being used on a continuous, 24-hour basis. In addition, we might expect any cumulative effects of either drug therapy or continuous TENS use to be most clearly detected on the last full day of TENS usage.

Transcutaneous Electrical Nerve Stimulation Application Procedures

On the day before surgery, each patient in the TENS group was instructed in the use of the TENS unit* and given a demonstration. The demonstration included placement of the electrodes and an opportunity for each patient to increase and decrease the amplitude setting to become familiar with the sensation they would be feeling postopera-

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* Stim pulse model 6067, dual channel, Stimtech Inc, Minneapolis, MN 55428; now a product of Codman and Shurtleff Inc, Randolph, MA 02368.
The rate and pulse width settings were preset and maintained in the midrange position both for the demonstration and throughout the postoperative stimulation period. After the patient had become familiar with the sensation of TENS, the initial stimulation amplitude during the postoperative phase was determined. This was accomplished by slowly increasing the amplitude until the patient reported discomfort and then reducing the output slightly to a more comfortable level.

In the operating room, immediately after wound closure, two sterile rubber polymer electrodes (about 5 cm × 18 cm) were placed approximately 1.5 cm on either side of the skin incision. Two additional electrodes were placed along either side of the incision at the graft site over the iliac crest. As soon as the patients were returned to the surgical recovery room, they were awakened and TENS stimulation at the predetermined setting was begun. During the remainder of the postoperative period, the patients received continuous, 24-hour stimulation and were allowed to increase or decrease the amplitude of stimulation to achieve as much pain relief as possible. All batteries were replaced with fresh alkaline cells every 24 hours. The lead wires were also checked daily to ensure their attachment to both the TENS unit and the stimulating electrodes.

As previously instructed, each patient attempted to reduce pain by adjusting the output of the TENS unit. Rate and pulse width were not changed from the midrange settings established during the preoperative period. When necessary, supplemental pain control was achieved through medications administered by the nursing staff according to the patient's individual needs on an as needed basis. Other physical therapy procedures besides TENS were active ankle and foot exercises and isometric quadriceps femoris muscle sets.

On approximately the 5th postoperative day, the dressings were changed and the TENS units were removed. All patients were placed in plastic body braces to restrict trunk mobility and were started on ambulation activities in the brace. Discharge from the hospital was targeted for the 10th to the 13th postoperative day.

**Comparison Results**

A variety of drugs were administered during a 24-hour period on the fourth postoperative day. Each time a medication was administered, it was counted as one dose of that medication. Doses of each medication are presented in the Figure.

The most striking difference between the TENS patients and the non-TENS group was seen in meperidine hydrochloride usage. Twenty-three doses of meperidine hydrochloride were received by the non-TENS group, but none of the TENS patients received this drug. The non-TENS patients also received more doses of morphine sulfate, diazepam, and propoxyphene napsylate than did the patients using TENS for pain control. Only acetaminophen with codeine, hydroxyzine hydrochloride, and oxycodone hydrochloride were administered more often to TENS patients on the fourth postoperative day. On an individual basis, 7 out of 10 patients in the non-TENS group required either meperidine hydrochloride or morphine sulfate, whereas only 3 out of 10 individuals in the TENS group received this drug. The non-TENS patients also received more doses of morphine sulfate, diazepam, and propoxyphene napsylate than did the patients using TENS for pain control. Only acetaminophen with codeine, hydroxyzine hydrochloride, and oxycodone hydrochloride were administered more often to TENS patients on the fourth postoperative day. Conversely, 6 of 10 TENS patients received only acetaminophen with codeine for pain, but only one patient in the non-TENS group could be adequately managed with this drug as the sole medication for pain relief. No problems were encountered with the TENS units, and none of the patients developed skin rashes or reactions to the electrode gel.
**DISCUSSION**

In assessing our postoperative pain management program, we considered pain medication usage as an indicator of the effectiveness of TENS-induced hypalgesia. Our reasons for selecting this method were based on the observations of others that patients using TENS for pain control requested fewer pain medications than patients not using TENS devices.24-27 These findings suggest that reduction in the use of pain drugs is an appropriate way to measure TENS-produced pain relief.

In our series of patients, we noted that, collectively, TENS patients received no meperidine hydrochloride or propoxyphene napsylate and fewer doses of morphine sulfate and diazepam than non-TENS patients. These results in young patients are consistent with those reported for older patient groups.24-27 An interesting similarity exists between our observations and those of Schuster and Infante who found that adult patients using TENS to control postoperative pain after back surgery required fewer pain medications than a control group of back surgery patients who did not use TENS postoperatively.25

An alternative method to evaluate TENS effectiveness involves measuring the length of hospital stay.22,29 We examined this variable in our two sample groups and found that in the TENS group, the average length of stay was 10 days (range 8-12 days), but patients in the non-TENS group were in the hospital an average of 12.8 days (range 8-16 days). Similar results were reported by Harvie who used TENS for pain control after surgical procedures on the knee.22 We believe, however, that these data may be less reliable and that length of stay may be inappropriate for determining TENS effectiveness because pain may be only one of several factors considered in determining the time of discharge.

We found little reliable information concerning the stimulation characteristics appropriate to achieve effective pain control for our type of patients. Although most TENS units permit the independent adjustment of amplitude, rate, and pulse width, it is not clear which characteristic or combination of characteristics will bring about adequate pain relief. In our hospital, rate and pulse width are fixed at midrange levels, and the patients are allowed to adjust the amplitude of stimulation to levels just below those that cause discomfort. No attempt was made to record amplitude settings or changes in amplitude that might have occurred over time. Each patient was seen daily, however, and reminded of the desired stimulation effect. In looking back, we wonder to what extent individual patients adjusted the amplitude settings and also what might be the possible relationship between amplitude and the level of pain relief. We believe that an examination of specific output characteristics, including changes that occur during the treatment, might provide helpful information for maximizing the therapeutic effects of TENS. Information based on careful observation might significantly alter the way in which TENS is used in postoperative pain control programs.

While we were conducting this evaluation, several other issues came to our attention that deserve mention and that might be profitably addressed in future investigations of TENS effectiveness. We selected the fourth day after surgery

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**TABLE 2**

| Drugs Administered to Individual Patients on the Fourth Postoperative Day | PATIENT GROUPS |
|---|---|---|---|---|---|
| | TENS | Non-TENS |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Meperidine hydrochloride (Demerol®) | X | | | | | | | | | | | | | | | | | | | | |
| Morphine sulfate | | | X | | | | X | | | | | | X | | | | | | | | | | |
| Diazepam (Valium®) | | | | | | | | | | X | | | | | | | | | | | | |
| Oxycodeone hydrochloride (Percofan®) | | | | | | | | X | | | | | | | | | | | | | | |
| Pentobarbital sodium (Nembutal®) | | | | | | | | | | | | | | | | | | | | | | |
| Hydroxyzine hydrochloride (Vistaril®) | | | | | | | | | X | | | | | | | | | | | | |
| Promethazine hydrochloride (Phenergan®) | | | | | | | | | | | | | | | | | | | | | | |
| Propoxyphene napsylate (Darvocet-N®) | | | | | | | | | | | X | | X | | | | | | | | |
| Acetaminophen/codeine (Tylenol® #3) | | | X | X | X | X | X | X | X | X | | | | | | | | | | | |

*a* Winthrop Laboratories, 90 Park Ave, New York, NY 10016.  
*b* Roche Laboratories, Div of Hoffmann-La Roche, Inc, Nutley, NJ 07110.  
*c* Du Pont Pharmaceuticals, El du Pont de Nemours & Co, Inc, Wilmington, DE 19898.  
*d* Abbott Laboratories-Abbott Pharmaceuticals, Inc, Pharmaceuticals Product Div, N Chicago, IL 60604.  
*e* PfiPharmecs Div, Pfizer, Inc, 235 E 42nd St, New York, NY 10017.  
*f* Wyeth Laboratories, Div of American Home Products Corp, PO Box 8299, Philadelphia, PA 19101.  
*g* Eli Lilly and Co, 307 E McCarty St, Indianapolis, IN 46285.  
for our analysis for several reasons. On this day, all patients were still using the units on a continuous, 24-hour basis. In addition, this day represented the last full day of usage before the dressings were changed, and the TENS units were removed. Furthermore, any cumulative effects of TENS usage might be most easily observed on the last day. We recognize that assessing medication intake on one day may provide us with only limited data. The pain-suppressive effects of TENS might have been evident earlier in the postoperative course, and the addition of these data might make the argument for the use of TENS in postoperative pain control even more persuasive. We would encourage others interested in using this type of evaluation to consider collecting data throughout the postoperative period.

A final consideration relates to the administration of individual pain medications. In our hospital, orders for drugs for pain control are written so that they may be used on an as needed basis. Although the doses are specified, decisions concerning when to administer a particular drug are usually made by the nursing staff. This arrangement seems to work well in our hospital and is based on the skill and judgment of our nurses and on the confidence and rapport that has been developed between our nurses and doctors. In considering pain medication intake as a measure of TENS effectiveness, this arrangement represents a variable that may have influenced our observations. We have no way of knowing how this arrangement might have affected our results. In future investigations of TENS effectiveness, eliminating or, at least, limiting this variable would be desirable. Perhaps, future studies might be designed cooperatively with the medical and nursing staff for a very limited number of pain medications and close monitoring of their administration. We believe that controlled studies are needed to establish the validity of TENS. Assisted by the results of these investigations, physical therapists can develop confidence in their decisions concerning the use of TENS for pain control. Our observations, however, lead us to believe that TENS is effective in the management of postoperative pain.

CONCLUSIONS

Our evaluation of TENS with pain medication intake as a measure of successful pain control suggests that this modality is effective in reducing postoperative pain. We believe our treatment program involving conventional TENS characteristics is successful but recognize that other forms of stimulation deserve careful study and consideration and that some of these may prove more effective than those we presently use. In our examination, we looked at pain medication intake on the fourth postoperative day. We have pointed out weaknesses in this limited approach and suggest improvements that we believe would be helpful to other therapists assessing the effectiveness of their TENS programs for pain control. Critical examination of current treatment modalities and procedures is essential to the growth and development of the physical therapy profession, and we encourage others in both clinical and academic settings to become as actively involved in this process as possible.

REFERENCES