TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION AND POSTOPERATIVE USE OF NARCOTIC ANALGESICS

Gregory Strayhorn, MD, MPH
Iowa City, Iowa

Transcutaneous electrical nerve stimulation (TENS) has been reported to reduce the use of narcotic analgesic medication for pain relief in the postoperative period. This study compares the use of narcotic analgesics and the occurrence of postoperative complications in 205 patients who underwent gastric bypass surgery for control of obesity. Seventy-four patients used TENS for postoperative pain relief. The control group comprised 131 patients who did not use TENS. There were no statistically significant differences in the use of narcotic analgesic medication and the occurrence of postoperative complications between the experimental group and the control group.

Previous studies report a 30 to 50 percent reduction in narcotic analgesic use when transcutaneous electrical nerve stimulation (TENS) is used postoperatively.[1-3] Since narcotic analgesics can cause certain postoperative complications,[4] singularly or in conjunction with incisional pain, a reduction in their use may decrease these complications. However, researchers give conflicting results as to the reduction of postoperative complications when TENS is used for pain control.[1,2,5,6]

Factors associated with the perception of pain and the response to pain relief modalities include cultural and religious background, socioeconomic status, sex, age, underlying disease, body build (height, weight), preoperative use of narcotic medications, length and type of surgical procedure, and psychological makeup.[7-10] Age, sex, and length and type of surgical procedure have been shown to play insignificant roles in pain relief with TENS.[6,7] Preoperative use of narcotic medications and type of underlying disease are associated with a patient's perception of postoperative pain relief when TENS is used,[7] but cultural and religious background has not been included in any of these studies as potential confounders of the perception of postoperative pain relief with TENS.

The current study was designed to compare the postoperative use of narcotic analgesics and TENS and the degree of postoperative complications in two groups of gastric bypass patients. The study tested the following hypotheses: (1) when potential confounders are controlled statistically, the surgical group that used TENS used fewer postoperative narcotic analgesics than the group

From the Department of Family Practice, University of Iowa Hospitals and Clinics, Iowa City, Iowa. Requests for reprints should be addressed to Dr. Gregory Strayhorn, Robert Wood Johnson Clinical Scholar, Clinical Scholars Program, Medical School Wing B Box 5, University of North Carolina 207H, Chapel Hill, NC 27514.

that did not use TENS and (2) the TENS group had fewer postoperative complications.

METHODS

Charts were reviewed for 205 consecutive patients who underwent gastric bypass surgery for control of obesity at Mercy Hospital, Iowa City, between June 1973 and September 1980. The Roux-en-Y gastrojejunostomy was performed on each patient by the same surgeon, who is a private practitioner of general surgery. He selected the patients for the surgical procedure based on weight, height, and the absence of medical illness that might contraindicate the operation. TENS was used for analgesia in addition to narcotic analgesics beginning in January 1979 to determine whether there would be a reduction in the use of postoperative narcotic analgesics and in the occurrence of postoperative complications. There were no predetermined criteria used to decide who used TENS during the period. Seventy-four consecutive patients used TENS postoperatively between January 1979 and September 1980. The control group numbered 131 patients who did not have access to TENS prior to 1979. The following information was obtained from the chart review: (1) demographic data, (2) preoperative history of prior illness and surgery, (3) preoperative medications, including routine medications taken before hospitalization, as well as preoperative medications received as an inpatient, (4) intraoperative complications and procedures, (5) length of operation in minutes, (6) postoperative use of narcotic analgesics, (7) postoperative use of narcotic potentiators, (8) postoperative use of nonnarcotic analgesics, (9) other postoperative medications, (10) postoperative use of sleeping pills, (11) postoperative complications, (12) length of hospitalization, and (13) postoperative use of TENS.

The preoperative surgical and medical history of each patient was classified according to the major organ system involved. All preoperative and intraoperative medications were classified according to the major drug groups. The preoperative surgical, medical, and drug-use history was recorded as "yes" or "no" depending upon the presence or absence of the history in each classification category. The total dose of postoperative nonnarcotic analgesics was calculated for each patient. The total frequency of use of narcotic potentiators and other postoperative drugs was calculated for each patient and used as potential confounders of narcotic analgesic use. The surgeon routinely used a narcotic potentiator drug, usually hydroxyzine, along with narcotic medications.

The TENS device used by the patients was the Neuromod model 3701,* which was pocket sized and battery powered. It had three adjustable knobs that controlled the pulse amplitude (0 to 50 mA ± 15 percent (500 Ω load), adjustable), pulse rate (12 to 100 pulse/sec ± 20 percent, adjustable), and pulse width (50 to 400 μsec ± 20 percent, adjustable). These parameters determined the amount of stimulation needed to give adequate analgesia to the individual patient. The Neuromod was double channeled and supplied two electrodes per channel to each side of the incision.

The electrodes were taped to the skin along the surgical incision after it was closed in the operating room. The controls were adjusted to the individual patient's threshold of discomfort in the recovery room by the nursing staff. The patient was transferred to the intensive care unit for a 24-hour period or until the patient was medically stable. The ICU nurse followed the surgeon's written orders, which had not changed between 1973 and 1980, to administer postoperative narcotic analgesics. The nurse administered narcotic analgesics for pain relief if the patient's pain was not controlled by the TENS device at approximately four-hour intervals. The nurse and the patient adjusted the TENS device after the patient was transferred to the surgical ward. The TENS device was left on continuously and periodically readjusted to the patient's threshold of discomfort.

Statistical Analysis

The total dose of meperidine (Demerol) (TOTDEM) used during the patient's postoperative period was calculated, and a total meperidine dose equivalent was calculated for each nonmeperidine narcotic drug. Conversion factors for determining the equivalent dose of various narcotic analgesics were based on a review of clinical trials of Vandam (Table 1).[11] The mean TOTDEM dose was calculated to compare the overall use of narcotic analgesics in the control and experimental groups.

*Medtronic, Inc, Minneapolis, Minnesota

TABLE 1. CONVERSION OF POSTOPERATIVE NARCOTIC ANALGESICS TO EQUIVALENT MEPERIDINE DOSE

Drug	Conversion Factor × mg Dose
Meperidine	1.0
Morphine	7.5
Codeine	1.6
Oxycodone	7.5
Propoxyphene	3.2
Alphaprodine	1.87
Levorphanol tartrate	37.5

Student's *t* test was used to determine if there was a statistically significant difference in the TOTDEM between the two groups. A 95 percent confidence interval was computed to detect the true difference between the control and experimental means. The author chose a mean difference of 25 percent in total narcotic analgesic use between the two groups that would represent a clinically significant reduction.

Analysis of covariance was used to calculate the adjusted mean difference of the TOTDEM while controlling for those factors that might affect the perception of pain, and thus the use of postoperative narcotic analgesics. Stepwise linear regression analysis was used to determine which independent variables in the study significantly predicted the use of narcotic analgesics.

Student's *t* test, chi square, and Wilcoxon two-sample test were used to determine if there were significant differences between the experimental and control groups for the potential confounding variables and the complications, when appropriate. The Statistical Analysis System* was used for the above analysis.

RESULTS

The experimental group had a significantly higher frequency of history of cardiovascular disease than the control group (P = .04). The control group received more preoperative autonomic nervous system-type drugs and intraoperative narcotic analgesic drugs than the experimental group (P = .03 and P = .02, respectively). The experimental and control groups did not otherwise differ significantly. There were no recorded differences in the postoperative management of the control and experimental groups by the nursing staff and the surgeon (Tables 2 through 6).

The mean TOTDEM for the experimental group was 1,086.4 mg and 1,205.6 mg for the control group, P = .198 (Table 5). The 95 percent confidence interval for detecting the true difference between the control group and the experimental group mean was (−62,300.45).

The power of this study to detect a statistically significant difference in the means of the control and experimental groups as small as the calculated difference (119.19 mg) was 0.25. The power was increased to 0.90 when a 25 percent reduction was calculated.

The adjusted mean dose of the TOTDEM was 2,192 mg and 2,273.1 mg for the TENS and control groups, respectively. The difference of 81.1 mg was not statistically significant (P = .4) (Table 5).

When stepwise linear regression analysis was used and the entry level of variables to enter the model was set at 0.05, the following variables predicted the TOTDEM at the 0.05 level of significance or less: age, weight, surgery of the reproductive system, routine use of narcotic analgesics, routine use of minor tranquilizers or sedative hypnotics, length of surgical procedure, and administration of narcotic potentiators (Table 6).

The mean length of use of the Neuromod by the experimental group was six days. The control group had a mean duration of hospitalization of 8.1 days compared with 7.6 days for the experimental group (P = .005). There were no significant differences between the two groups for postoperative complications.

DISCUSSION

The present study did not show a statistically significant difference in the TOTDEM used by the control and experimental groups. The power of the study to detect the mean difference found in this study was small. However, data from previous studies suggest that a difference of at least 30 percent in postoperative narcotic use should be seen

*SAS Institute Inc, Raleigh, North Carolina

TABLE 2. COMPARISON OF EXPERIMENTAL AND CONTROL GROUP

	Experimental (n = 74)	Control (n = 131)	P
Age (yr)	36.35	34.77	.23*
Sex			
Male	10	20	.73**
Female	64	111	
Weight (kg)	123.7	122.24	.73*
Height (cm)	163.48	164.33	.49*
Marital Status			
Single	12	16	
Married	55	103	.71†
Separate/divorced	5	11	
Widowed	2	1	

*Student's *t* test
**Chi square
†Wilcoxon 2-sample test (normal approximation)

TABLE 3. FREQUENCY DISTRIBUTION OF OCCUPATION*

	Experimental n = 74 (%)	Control n = 131 (%)
Professional/technical	9 (12)	13 (10)
Management/proprietor	7 (9)	8 (6)
Clerical/sales	10 (14)	19 (15)
Craftsman/foreman/skilled	0	4 (3)
Operative/semiskilled	6 (8)	16 (12)
Service workers/farm managers	8 (11)	19 (15)
Laborers (except farm and mine)	6 (8)	15 (11)
Housewife	28 (38)	37 (28)

*Wilcoxon 2-sample test (normal approximation) $z = 0.42$, P = .67. Categories taken from job classifications according to "Standardized Scores for Specific Occupations," *Public Health Rep* 1970; 85(9) 819-824

TABLE 4. FREQUENCY DISTRIBUTION OF RELIGIONS*

	Experimental n = 74 (%)	Control n = 131 (%)
Catholic	16 (22)	27 (21)
Baptist	7 (9)	14 (11)
Methodist	18 (24)	26 (20)
Lutheran	2 (3)	18 (14)
Presbyterian	0	2 (2)
Christian	4 (5)	2 (2)
Protestant (no reference)	10 (14)	27 (21)
Jehovah's Witness	0	1 (1)
Episcopalian	0	1 (1)
None	17 (23)	10 (8)
Other	0	3 (2)

*Wilcoxon 2-sample test (normal approximation) $z = 0.64$, P = .52

TABLE 5. COMPARISON OF POSTOPERATIVE NARCOTIC USE BETWEEN GROUPS

	Experimental (n = 74)	Control (n = 131)	Difference	P
Mean TOTDEM (mg)	1,086.41	1,205.6	119.19	.198*
Adjusted mean TOTDEM (mg)	2,192.0	2,273.1	81.1	.4**

*Student's *t* test used to test difference in means
**Analysis of covariance used to calculate adjusted means

TABLE 6. STEPWISE REGRESSION: VARIABLE ENTRY LEVEL 0.05 FOR PREDICTION OF TOTDEM

Variable	B Value	*f*	*df*	P
Age	3,815.71	4.18	1,196	.04
Weight	−10.08	12.08	1,196	.0006
Surgery of reproductive system*	205.11	5.31	1,196	.02
Routine use of analgesics*	−639.88	11.60	1,196	.0008
Routine use of minor tranquilizers/sedative hypnotics*	−609.69	6.73	1,196	.01
Length of operation (min)	4.26	8.46	1,196	.004
Narcotic potentiator (mg)	53.82	8.89	1,196	.0032
Overall model		7.71	7,196	.0001

*Coded 1-yes, 2-no; therefore, a negative B value would represent a higher "yes" response

when TENS is used.[1-3] The power of this study to find a 25 percent difference in the mean TOTDEM use was 0.90. A 95 percent confidence interval included zero and did not include the value for a 25 percent difference in the mean TOTDEM, which supports the conclusion that this study was powerful enough to detect a clinically significant difference between the means. The mean difference in the TOTDEM was decreased when analysis of covariance was used to control for factors that might affect perception of postoperative pain, and supports the lack of a significant difference in the mean TOTDEM between the control group and the experimental group.

The prediction of the TOTDEM by age and weight suggest that older and lighter patients used more postoperative narcotics. This is not supported by previous studies.[2,3,7] Prior surgery of the reproductive tract predicted a lower TOTDEM dose and indicates a sex difference in the postoperative use of narcotic analgesics, since only women had this history. VanderArk[6] found that older women in his control group experienced less postoperative pain relief; however, he found no age or sex difference in his experimental group for pain relief by TENS or narcotic analgesics.

A positive prediction of the TOTDEM dose by a preoperative history of narcotic analgesics use

supports the findings of previous studies.[2,3,5] This study found that the routine use of preoperative minor tranquilizers or sedative hypnotics predicted the use of postoperative narcotic analgesic use. This was not reported by other studies. Postoperative narcotic potentiators (hydroxyzine) positively predicted the TOTDEM, which is consistent with the FDA classification of narcotic potentiators as "lacking of effectiveness for use in the management of postoperative . . . pain."[12] However, Bellville[13] found that 50 to 75 mg of hydroxyzine was comparable to 5 mg of morphine when treating postoperative pain. Higher doses did not increase the analgesic effect and caused considerable discomfort at the injection site.

The control and experimental groups did not differ significantly in occurrence of postoperative complications. Hymes[5] and Sadipo[2] found fewer postperative problems in the TENS group. Rosenberg[1] and VanderArk[6] did not find significant differences in objective measures of pulmonary function and in the development of an ileus between their control and experimental group. No studies showed a significant difference in the length of hospital stay between the TENS and control groups. This study did find a significant difference in the mean length of stay. However, this difference represented only 0.5 days.

The preoperative use of autonomic nervous system drugs and the intraoperative use of narcotic analgesic drugs were greater in the control group. The TENS group had a greater frequency of cardiovascular disease history. These factors could bias the results; however, none of these variables predicted the TOTDEM in stepwise linear regression. The control group had their surgical experience earlier than the TENS group. Improved surgical techniques and technology might have affected the results in favor of lowering the TOTDEM in the TENS group. Length of operative procedure did predict the TOTDEM, but there was no difference in the operative time between the groups. The lack of difference in postoperative complications and length of operative procedure suggests that the surgical skills and technique should not have influenced the results significantly.

It would appear that the question of whether TENS actually reduces postoperative pain significantly remains an open one. Certain methodological problems in all the studies to date, this study included, may have led to questionable results. Past studies may not have been comprehensive enough in defining similar control and experimental groups and study settings.[1-3,5] This study was retrospective and used a historical control design. Past medical and surgical history and preoperative, intraoperative, and postoperative medications were categorized as to their presence or absence and were not used as individual variables for each diagnosis and medication.

A prospective study that will control for as many potentially confounding variables as possible should be designed. The effect of TENS could then be assessed more accurately. There should be attempts to define those groups of patients who have characteristics that will maximize the effectiveness of TENS in controlling pain. Such guidelines would help physicians in selecting patients for this method of control.

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