

Postoperative Electroanalgesia

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Fifty-six patients who had undergone abdominal hysterectomy and 10 patients who had undergone cesarean section had fine steel wires placed subdermally in order to provide continuous electrostimulation for pain relief during a 5-day postoperative period. Compared to the same number of patients with identical surgical procedures and postoperative medication orders, but no electrostimulation, they required considerably less analgesic medication. A smaller group of 20 patients who had had abdominal hysterectomy and received mock electrostimulation required approximately the same average amount of medication for pain relief as the group without electrostimulation. Other beneficial effects noted in the patients with electroanalgesia included marked stimulation of the bowel and contraction of the postpartum uterus.

TRANSCUTANEOUS electrical stimulation for pain relief has been used frequently in recent years.¹⁻⁸ Vander Ark,⁷ for example, used this treatment for the management of postoperative pain in patients who had undergone abdominal or thoracic surgical procedures. He found significant pain relief in 77% of his electrostimulated patients, compared to a relief rate of 17% in control patients who had received "mock" stimulation.

Transcutaneous electrostimulation appears to have beneficial effects that go beyond the alleviation of pain. Hymes⁹ recently reported a 1% incidence of ileus in a group of patients who had received electrostimulation following abdominal surgery, as opposed to a 16% incidence in a control group.

Although transcutaneous electrical stimulation is useful and relatively easy to apply, skin burns frequently result from the electrodes. Subdermal electrostimulation reduces this danger of skin burns. In addition, subdermal stimulation delivers current more efficiently, and thus should require less overall current to achieve a comparable effect. Therefore, this study was undertaken to determine the effects of subdermal electrical stimulation on postoperative pain relief and recovery.

MATERIALS AND METHODS

Two principal groups, each consisting of 56 patients who had undergone abdominal hysterectomy and 10 patients who had undergone cesarean section, participated in this study. Patients in the treatment group were able to obtain continuous electrostimulation, 24 hours a day, for a period of 5 to 10 days that commenced immediately after surgery. Patients in the control group received Percodan or Demerol for pain relief.

Initially, this study was designed to include a third group, consisting of an equal number of patients who received mock stimulation following surgery. However, the mock stimulation was discontinued after it had been tried on 20 patients, since 18 of these patients required continuous postoperative medication for pain. These same patients stated after 5 days that they thought they had not received any current. Nevertheless, the procedures for and results of this group of 20 patients will be reported here, because the response to mock stimulation, even if it is recognized as such, can be helpful in evaluating and partitioning out the effects of increased attention.

The patients in this study were volunteers who signed an informed consent prior to participation. They were all operated on by the author during 1975 and 1976; the hysterectomies were elective. Candidate patients for the treatment and mock treatment groups had preoperative electrocardiograms, and those having abnormal ECGs or pacemakers were excluded. The 86 patients who were included were assured that they also could have Percodan or Demerol for pain relief on request, and they had the option to discontinue electrical stimulation at any time. Demerol was administered by injection, Percodan orally. No routine laxative or enema orders were given for patients in the stimulation groups, so that the stimulatory effect of electric current on the bowel could be evaluated.

Electrostimulation Device

The stimulator was equipped with 3 control knobs: one controlling the pulse amplitude from 0-50 mamp, the second controlling the pulse frequency from 10-100 pulses/second (Hertz), and the third controlling the pulse duration from 100-400 μ sec. The patients were taught how to adjust all 3 knobs to obtain an electric current

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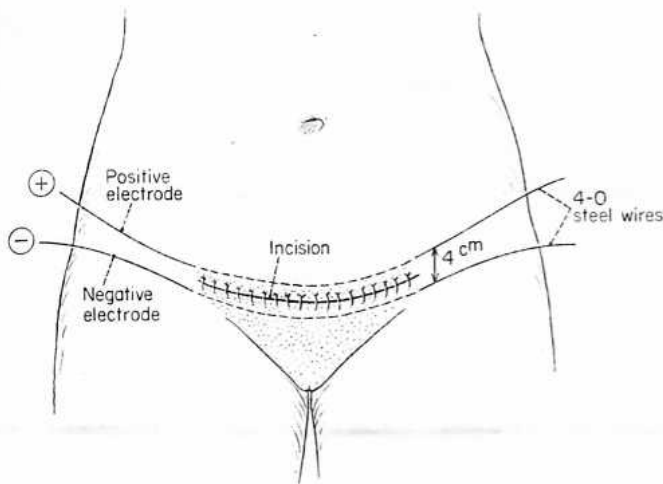


Fig 1. Placement of steel wires with a Pfannenstiel incision.

combination that made them feel most comfortable. The mock stimulator had a faulty connecting wire that made no electrical contact. Both genuine and mock stimulators had a red light that flashed in accordance with the frequency of the desired electric current.

Placement and Removal of Wires

The correct placement of the 4-0 Ethicon steel wires is demonstrated in Figure 1. The wires were placed sub-

dermally with a straight needle. Since fat is a poor conductor, care was taken to avoid implanting the needle in it. As shown in Figure 2, the wires were positioned on either side of the incision, in both Pfannenstiel and midline incisions. The wires at each end of the incision were separated by at least 4 cm with nonallergic Dermical tape; in Pfannenstiel incisions, the negative wires were located caudally for greater effectiveness. To avoid burns, the alligator clips, which conduct current to the wires, were insulated from the skin with tape. The possibility of burns also necessitated the exclusive use of nylon sutures for skin closure.

Current was increased prior to removal of the sutures; this procedure made the process painless. The current was then turned off for removal of the steel wires, because removal of live electric wires causes pain.

RESULTS

General Response to Electroanalgesia

The patients receiving electrostimulation reported an initial tickling sensation from the electric current. However, the current had an anesthetizing effect and, after a few minutes, their perception of stimulation was lost.

As a general observation, patients were able to cough and breath deeply without significant pain while receiv-

Fig 2. Patient with electric stimulation of a midline incision.



TABLE 1. ELECTRIC STIMULATION PARAMETERS USED BY VARIOUS INVESTIGATORS AND PREFERRED BY PATIENTS IN THIS STUDY

Current (mamp)	Pulse width (μs)	Frequency (Hz)	Pain type	Investigator, year
Variable	100-200	30-120	Percutaneous peripheral nerve stimulation	Sweet & Wepsic, 1969 ⁵
20-35	250-400	50-150	Acute postoperative	Hymes et al, 1974 ⁹
Variable	50-500	15-180	Postherpetic	Nathan & Wall, 1974 ¹¹
15-40	200 (fixed)	25-60	Chronic pain	Picaza et al, 1975 ¹²
20-35	250-400	100-150	Acute postoperative	Vander Ark, 1975 ⁷
20-30 (26%)	50-100 (74%)	14-60 (74%)	Chronic pain	Linzer, 1976 ¹⁰
50-60 (31%)				
20-35	100-300	40-60	Acute postoperative	Ledergerber, 1977
Preferred current stimulation				

ing electrostimulation. A number of these patients were also able to ambulate without pain shortly after surgery. Sixteen of the patients who received electrostimulation had undergone previous pelvic surgeries. They stated unanimously that they had less pain than with their previous surgeries. The degree of analgesia in patients with electrostimulation was found to be greater in mid-line incisions than in Pfannenstiel incisions.

The 10 cesarean section patients in the electrostimulation group had practically no postoperative blood loss; they reacted as though they had been given a constant Pitocin drip for 5 days. Patients in the electrostimulation group appeared to have improved wound healing.

Preferred Electrostimulation Parameters

Fifty percent of the patients who received electrostimulation preferred a pulse amplitude of 25-35 mamp, along with a pulse frequency of 40-60 Hz and a pulse duration of 100-300 μsec. In Table 1, this result is contrasted with the stimulus parameters used by various investigators in other electrostimulation studies.^{5,7,9,12} Twenty percent of the patients in this study required pulse amplitudes between 36 and 50 mamp; smaller amounts of current did not appear to relieve their pain. Another 25% of the patients in the electrostimulation group preferred a pulse frequency of 100 Hz.

Analgesic Requirements

Table 2 summarizes the average analgesic requirements of patients during the first 5 postoperative days as

a function of group and surgical procedure. It can be seen that the 56 patients in the electrostimulation group who had undergone abdominal hysterectomies required an average of 126 mg of Demerol and 5 Percodan tablets, while those in the control group required 706 mg of Demerol and 12 Percodan tablets. Similarly, the 10 patients in the electrostimulation group who had undergone cesarean section needed an average of 120 mg of Demerol and 5 Percodan tablets, compared to 520 mg of Demerol and 15 Percodan tablets for the control group. The 20 abdominal hysterectomy patients in the mock electrostimulation group required an average of 680 mg of Demerol and 10 Percodan tablets.

Bowel Patterns

Patients on electrostimulation usually had bowel sounds within 6 to 8 hours postoperatively. As shown in Table 2, only 10 of the abdominal hysterectomy patients in this group needed enemas; 46 had spontaneous bowel movements. In contrast, 16 of the 20 hysterectomy patients in the mock stimulation group required enemas. Further, only 3 of the cesarean section patients with electroanalgesia needed enemas.

DISCUSSION

The reduction of Demerol and Percodan requirements by 82% and 58%, respectively, for hysterectomy patients in the electrostimulation group, and by 77 and 67% for cesarean section patients in the same group, suggests that continuous electrostimulation through subdermal steel wires is effective in reducing certain

TABLE 2. AVERAGE ANALGESIC REQUIREMENTS AND NUMBER OF PATIENTS IN SELECTED GROUPS NEEDING ENEMAS DURING A 5-DAY POSTOPERATIVE PERIOD

Surgical procedure, number of patients	Electroanalgesia	Demerol (mg)	Percodan (Tablets)	Number of patients needing enemas
Abdominal hysterectomy, 56	With	126	5	10
Abdominal hysterectomy,* 56	Without	706	12	
Abdominal hysterectomy, 20	With mock	680	10	16
Cesarean section, 10	With	120	5	3
Cesarean section,* 10	Without	520	15	

* Control patients received enemas as part of their regular postoperative routine.

types of postoperative pain. In particular, this stimulation appears to relieve incisional pain; the internal pain due to pelvic surgery seems much less amenable to electroanalgesia. However, in this author's opinion, transcutaneous electrodes placed over the patient's back (with the negative electrode over the first 3 sacral nerves, and the positive electrode over the 12th thoracic vertebral body) would afford considerable relief for internal surgical pain.

The greater degree of analgesia in midline as opposed to Pfannenstiel incisions was expected from previous research;¹³ it probably results from nerve endings being more symmetrically blocked by the electric current. It should be noted that since only 4 of the patients who participated in this study had midline incisions, this effect of incision type did not contribute significantly to the group differences in analgesic requirements. The larger amount of Demerol used by hysterectomy, as opposed to cesarean section, patients within both the treatment and control groups probably results entirely from the postoperative procedure: all hysterectomy patients were receiving intravenous feedings for the first 48 hours, compared to 24 hours for the cesarean section patients. Thus, patients who had undergone cesarean section were able to receive oral medication 24 hours earlier.

That the patients who received mock electrostimulation needed an average of only 3.7% less Demerol and 16.7% less Percodan than comparable controls indicates that the significantly smaller amounts of analgesics required by the electrostimulation group were not due simply to increased attention. Unfortunately, however, the results reported here cannot be considered as part of a blind study on the analgesic effects of electrostimulation since, as noted previously, most of the patients realized that they were not receiving current. This problem may in part result from the methodology of telling the patients to find their "own current combination" for maximum pain relief. On the other hand, it is almost impossible to fool any patient about the feeling of electric current, because we have all felt it at one time or another during our lifetime.

While placebo and hypnotic effects cannot be ruled out, it is important to appreciate the remarkable effect of electrostimulation on the bowel. A full 80% of the patients receiving mock stimulation required enemas, compared to only 18% of comparable patients receiving genuine electrostimulation. Since the gastrointestinal system is under considerably less voluntary control than are responses to pain, this result suggests that at least some of the beneficial responses to electrostimulation do not result from placebo or hypnotic effects.

The author is additionally convinced about the effec-

tiveness of electrostimulation because if a patient didn't feel any relief, there was invariably a mechanical explanation, for example, a dead battery, a disconnected alligator clip, a short-circuiting wire, etc.

The Pitocin-like contracting action of electrostimulation on the postpartum uterus was expected from the results of previous research on electric induction of labor.¹⁴⁻¹⁷ This contraction undoubtedly results from stimulation of the ileoinguinal and ileohypogastric nerves. The qualitatively better wound healing was also anticipated from earlier studies that showed improved bone healing in both animals and humans as a result of applying electric current.^{18,19}

Table 1 shows that the results obtained in this study with respect to electrostimulation parameters compare favorably with those obtained by other investigators.^{5,7,9-12} The lower preferred frequencies and pulse widths reported for postoperative pain here probably reflect the use of subdermal rather than transcutaneous stimulation.

Thus, the present study gives at least a good anecdotal picture of electrostimulation's effect on the postoperative course of surgical patients. The picture is one of a patient who feels better, requires less medication for pain, has earlier bowel activity, and can ambulate sooner with less pain.

Since postoperative electrostimulation is non-addictive, does not induce sluggishness, is potentially applicable to almost all patients except those with cardiac abnormalities or surgical procedures near the heart, and might provide lifesaving analgesia for patients with allergies, it certainly merits further investigation both as an analgesic and as a source of other beneficial effects.

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