

POSTOPERATIVE ANALGESIA BY PERCUTANEOUS ELECTRICAL STIMULATION IN GYNECOLOGY AND OBSTETRICS

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Percutaneous electrical stimulation (PES) for relief of acute postoperative pain was applied in 10 patients after cesarean section and in 20 women who had undergone various gynecological operations. Thirty other women, subjected to identical surgical interventions, served as controls. In the latter group, the electrodes were attached to a nonfunctioning apparatus. In all patients, including the controls, the two electrodes were introduced intradermally, one on each side of the incision. Implantation was carried out at the end of the surgical procedure while the patient was still anesthetized, and stimulation was commenced immediately. The electrical stimulation was applied continuously for 1 to 3 postoperative days. The generation of pulses was perceived by the patients as a tingling sensation. Complete pain relief was obtained in 40% of the patients treated with PES, whilst in 27% the pain was markedly diminished. Postoperative analgesic medication in this group was reduced by 50–80% as compared to the analgesic requirements in the control group. Other beneficial effects observed in the treated patients included early ambulation, early peristalsis, postpartum uterine contractions and absence of respiratory complications.

electrical stimulation; postoperative pain; analgesia

INTRODUCTION

Transcutaneous electrical stimulation (TES) for the relief of pain is a relatively new technique based on the gate theory of pain perception which was introduced by Melzack and Wall (1965, 1970, 1974). Wall and Sweet (1967) were the first to demonstrate in the human that stimulating primary afferent neurons could ameliorate pain. Since then, electrical stimulation (ES) of painful areas has been advocated as a form of therapy in various pain syndromes (Sweet, 1968; Sweet and Wepsic, 1968; Long, 1973, 1974; Picaza et al., 1975). While the concept has been recognized for some years (Burton and Maurer, 1974), its therapeutic application has only recently become

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practical with the availability of suitably designed electrical stimulators.

The first commercial transcutaneous stimulators were produced (Shealy, 1972, Burton and Maurer, 1974) and initially employed in an attempt to find a screening method to select patients for implantable devices for relief of pain. During these trials, it soon became apparent that the method in itself had a significant effect upon pain, postoperative pain proving the most amenable to this method (Hymes et al., 1974; Van der Ark and McGrath, 1975; Cooperman et al., 1977; Ledergerber and Facs, 1978; Magora et al., 1978; Pike, 1978; Baker et al., 1980; Ticho et al., 1980).

In patients who had undergone thoracic (Hymes et al., 1974, Magora et al., 1978), abdominal (Van der Ark and McGrath, 1975; Cooperman et al., 1977), orthopedic (Pike, 1978), gynecologic (Ledergerber and Facs, 1978) and ophthalmologic (Ticho et al., 1980) operations, the application of transcutaneous or percutaneous electrical stimulation (PES) proved successful in ameliorating postoperative pain.

The electrical treatment may be applied either through externally placed electrodes, i.e., TES, or by way of subcutaneously implanted wire electrodes, i.e., PES.

This article presents a controlled study of the effects of percutaneous electrical stimulation in patients who had been subjected to cesarean section and in women who underwent various gynecologic operations.

MATERIALS AND METHODS

Sixty women between 21 and 50 yr of age who underwent obstetric or gynecologic operations form the basis of this report. Thirty of these patients served as a control group. The surgical procedures consisted of cesarean section in 20 patients, total abdominal hysterectomy in 20, conservative myomectomy in 12 and unilateral adnexectomy in 8 patients (Table I).

All patients received oral premedication with 10 mg diazepam 1–2 h before surgery. General anesthesia was induced i.v. with thiopentone, 3–4 mg/kg, and maintained with N₂O-oxygen and halothane 0.5–1.0%. Pancuronium, 0.1 mg/kg, was administered to facilitate endotracheal intubation and provide relaxation during the operative procedure. Surgical intervention was performed via a transverse incision in 41 patients and through a longitudinal incision in 19 patients.

The control group comprised patients comparable with those in the PES-treated group regarding type of surgery, mode of anesthesia and surgical incision, and the patients were randomly allocated to either of these groups. Implantation of the electrodes and setting to the 'on' position of the apparatus were identical for both groups, with the difference that in the control group no current was delivered as the generator lacked batteries. Analgesic drugs (papaveretum-HCl containing approximately 50% morphine-HCl or paracetamol) were administered as required in both groups.

Informed signed consent was obtained from all participants in the study.

Physical examination, total blood count, serum electrolyte tests and

TABLE I
THE SURGICAL PROCEDURES AND MEAN ANALGESIC AND LAXATIVE REQUIREMENTS IN 30 PATIENTS TREATED WITH PERCUTANEOUS ELECTRICAL STIMULATION AND IN 30 CONTROL PATIENTS DURING THE IMMEDIATE 3-DAY POST-OPERATIVE PERIOD

Surgical procedure	Electrical stimulation				Control			
	No. of patients	Papaveretum-HCl (mg, mean/patient)	Paracetamol HCl (mg, mean/patient)	Laxatives (no. of patients)	No. of patients	Papaveretum-HCl (mg, mean/patient)	Paracetamol HCl (mg, mean/patient)	Laxatives (no. of patients)
Cesarean section	10	15 ^a (66.6) ^b	600 ^a (50.0)	3	10	45	1 200	7
Abdominal hysterectomy	10	13 ^a (69.0)	450 ^a (66.0)	1	10	42	1 350	5
Conservative myomectomy	6	10 ^a (71.4)	450 ^a (62.5)	2	6	35	1 200	4
Unilateral adnexectomy	4	10 ^a (80.0)	300 ^a (66.5)	0	4	50	900	2

^a Statistically significant ($P < 0.01$) according to the Mann-Whitney test.

^b The numbers in parentheses designate the percentage of reduction in the use of analgesic drugs as compared to control patients.

electrocardiograms were part of the preoperative procedures. All patients were A.S.A. score I. Patients with abnormal ECG's were excluded from the study. In order to evaluate the effect of PES alone on bowel movement and uterine contractions, laxatives and oxytocin were withheld in both groups unless absolute indications, such as uterine bleeding, postcesarean section or postoperative constipation for more than 3 days, made administration of these drugs imperative.

The effect of PES was assessed every 6 h as regards the subjective pain experience of the patient and her need for analgesic drugs. The results were defined as 'very good' when the patient was free of pain and did not require analgesic medication, 'good' when pain was moderate and a sedative or mild analgesic drug sufficed, and as 'bad' when pain persisted in spite of the application of PES, and potent analgesic medication had to be administered. Bowel peristalsis, postcesarean blood loss and Hb were also examined.

PES was commenced immediately upon completion of surgery in all patients, and continuously applied.

Equipment

The implanted wire electrodes are connected to a portable battery-operated nerve stimulator (Neurogar, Agar Electronics, Ginosar, Israel) (Fig. 1). The apparatus has a frequency of 80 Hz and a pulse duration of 0.4 msec; it generates direct asymmetric square pulses, which are perceived by the patient as a tingling sensation. An additional feature is the preset 'modulation current output' which increases the duration of the pulse wave from 0.4 msec to 0.6 msec over a total period of 0.2 msec, after which it automatically reverts to 0.4 msec pulse duration, to restart the whole cycle. This results in a step-up of current intensity by approximately 25%. The modulation current is experienced as a pulsating type of coarse vibration deep in the skin and subcutaneous tissue.

PES was administered by two steel wire electrodes (Ethicon Steel Wire, 4-0), inserted intradermally by means of a straight needle at a distance of 2 cm along the length at each side of the incision. The current is transmitted along the entire length of the metal wire electrodes directly stimulating the nerve endings. The connections and wires leading to the generator were insulated from the skin with tape. Intensity of the current and the switch to 'modulation current' was adjusted by the patient herself. The stimulation was applied continuously around the clock for 1 to 3 days after the operation. Standing orders were given for patients to receive papaveretum-HCl or paracetamol at the discretion of the nurse. Neither the nursing nor medical staff were aware of which group any individual patient belonged at the time she entered the study.

RESULTS

Of the 30 patients treated with PES in this study, results were 'very good' in 12 (40%), 'good' in 8 (27%) and 'bad' in 10 (33%) of the women.

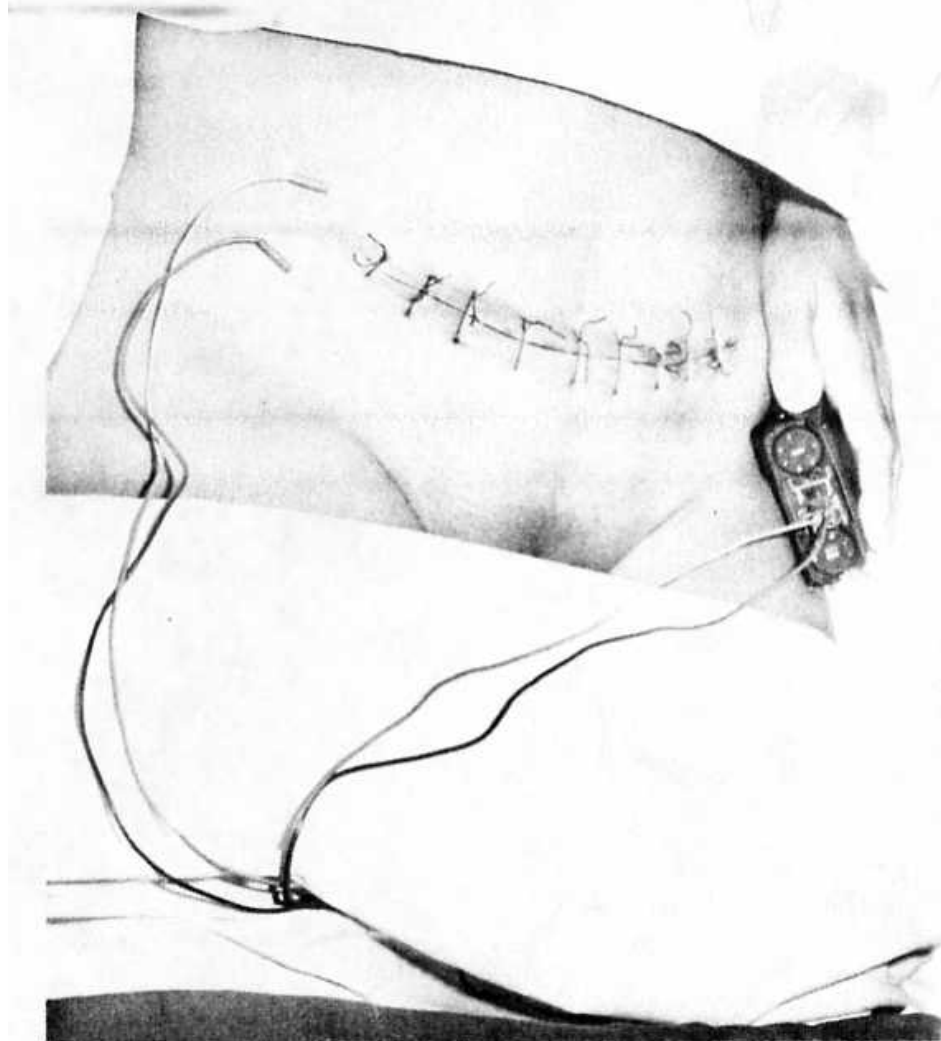


Fig. 1. A portable nerve stimulator connected to the implanted wire electrodes in a patient with a transversal abdominal incision.

General response to PES

PES elicited an initial tingling sensation, which disappeared after a few minutes due to the analgesic effect of the current. In general, those patients who experienced complete or partial pain relief were able to cough and breathe deeply without undue discomfort. Some began to ambulate shortly after surgery without pain while carrying the stimulator. Ambulation and body movement did not displace the electrodes or cause alteration in the electrical conductivity, since they were well secured by the percutaneous implantation. The analgesic effect of PES was found to be stronger in patients with longitudinal than in those with transverse incisions; 8 of the 12 patients with 'very good' results belonged to the former category.

Analgesic requirement

Table I summarizes the mean analgesic medication required by the patients in the PES treated group and in the control subjects during the first 3 post-operative days. In the treated group, the patients with cesarean section required an average of 15 mg papaveretum-HCl and 600 mg paracetamol per patient as compared to 45 mg papaveretum-HCl and 1200 mg paracetamol in the control patients, a reduction in the former of 66.6 and 50%, respectively, which is statistically significant ($P < 0.01$, according to the Mann-Whitney U-test). A similarly reduced need for analgesic drugs was observed in the PES-treated patients following gynecologic operations. In these patients, the use of papaveretum-HCl was reduced by 69–80% and that of paracetamol by 62.5–66.5%, as compared to the control group ($P < 0.01$) (Table I).

Bowel pattern

In the patients receiving PES, peristalsis usually appeared 6–10 h post-operatively, and laxatives were administered in only 6 (20%) women, whereas in the control group this treatment was provided in 18 instances (60%).

Uterine contraction and blood loss

The mean hemoglobin concentration on the third postcesarean section day was similar in both groups (11 g%), although less oxytocin was needed in the PES-treated group: only 3 women were given oxytocin as compared to 8 in the control group.

Complications

The application of PES was not associated with complications such as skin burns or bleeding tendency. The electrodes were removed easily upon completion of treatment.

Respiratory complications

No respiratory problems occurred in the PES-treated group whereas in the control group 5 women required physiotherapeutic respiratory assistance due to the inability to cough adequately.

DISCUSSION

Inhibitory control of neural input from noxious stimuli by presynaptic mechanisms is the basis of the gate control hypothesis. Thus, nonnoxious stimuli can interfere with the transmission of pain within the central nervous system. Stimulation of the large myelinated nerve fibers that do not conduct

pain may block the transmission of pain prior to perception. Wall and Sweet (1967) stimulated large myelinated fibers of peripheral nerves and demonstrated a decreased response to pin pricks in the stimulated area. Electrical stimulation was soon thereafter devised for control of pain in man (Sweet, 1968; Sweet and Wepsic, 1968; Shealy, 1972; Long, 1973, 1974; Picaza et al., 1975). A number of studies substantiate the effectiveness of TES in the treatment of chronic pain conditions (Burton and Maurer, 1974; Long, 1974; Shealy and Maurer, 1974; Winter et al., 1974; Loester et al., 1975). The efficacy of the ES technique in the treatment of acute pain, especially postoperative pain, has often been described (Shealy, 1972; Hymes et al., 1974; Van der Ark and McGrath, 1975; Cooperman et al., 1977; Ledergerber and Facs, 1978; Magora et al., 1978; Pike, 1978; Baker et al., 1980; Ticho et al., 1980). However the lack of controls in most of these studies prevents evaluation of a possible psychological effect of the stimulator.

In the present study, the efficacy of PES in alleviating lower abdominal postoperative pain was tested. PES brought about total pain relief in 40% and ameliorated postoperative pain in 27% in a group of 30 patients. A further beneficial effect was a markedly decreased requirement for analgesic medication (Table I).

Longitudinal incision proved to be more amenable to the PES treatment than transverse incisions, an effect which is probably due to the fact that in the former, the nerve endings are more symmetrically blocked by PES (Ledergerber, 1975, Ledergerber and Facs, 1978).

The factors influencing perception of pain are numerous and highly individual and include physical as well as psychological aspects Shealy, 1972; Melzack, 1973. Perception of pain is modified by previous experiences and the ability to understand the cause of pain (Beecher, 1959). Long (1974) emphasizes the importance of the location of the electrodes with regard to success or failure of ES for pain relief, and argues against a major placebo effect of the technique. The occasional inadvertent interruption of the stimulation due to mechanical failure in some of our patients resulted in pain which was suppressed once the current was reestablished. This suggests that the pain relief of this method is due to its physiological mode of action rather than to its placebo effects.

The beneficial effects of PES on the bowel and uterus was noteworthy, as it greatly reduced the administration of laxatives and obviated the need for oxytocin after cesarean section. Perhaps the beneficial effect of PES on the bowel is partly due to the reduced intake of opiates as compared to the controls. The pitocin-like contracting effect of PES on the postpartum uteri was comparable to the findings reported by Ledergerber on the electric induction of labor (Ledergerber, 1973, 1974). It has been proposed that stimulation of the ilioinguinal and iliohypogastric nerves elicits the contracting effect of ES (Ledergerber and Facs, 1978).

Subdermal implantation of electrodes is a simple and absolutely painless procedure, since it is performed at the end of the operation while the patient is still anesthetized. Subcutaneous implantation of electrodes

prevents problems associated with externally placed electrodes (TES), such as skin burns and unpleasant sensations that may occur during movement of the electrodes or changes in skin resistance. In PES, the electrodes remain stable and by-pass skin resistance, the generated stimulation is uniform, the necessary current intensity is less than with transcutaneous stimulation, and the patient is not limited in her movements.

CONCLUSION

The use of PES in gynecologic and obstetric postoperative patients resulted in postoperative pain relief and reduced the need for narcotics and analgesic medication. The treatment is not addictive and presents no undesirable side effects. In allergic patients it may be the treatment of choice for the alleviation of pain.

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