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Transcutaneous electrical stimulation for postoperative pain

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Summary

A prospective randomised trial was conducted to assess transcutaneous electrical stimulation in the management of postoperative pain and its effect on postoperative pulmonary function and respiratory complications. Consecutive patients undergoing abdominal surgery were allocated to receive transcutaneous electrical stimulation or 'sham' therapy. There was no significant difference in the amount of postoperative pain as measured by linear analogue pain scales or morphine requirements. Arterial oxygen and carbon dioxide tensions were similar in both groups. There was no difference in the incidence of postoperative chest infection. These results do not support the use of transcutaneous electrical stimulation following abdominal surgery.

Introduction

Conventional approaches to the management of postoperative pain remain inadequate *(1–4)*. Intermittent 'on-demand' administration of opiates results in fluctuating plasma levels and poor pain relief; increasing the frequency of administration and the amount of opiate may improve pain control but result in unwanted side effects. Intravenous opiate infusion may provide better analgesia *(5)* but with the risk of respiratory depression *(6)*.

The success of transcutaneous electrical stimulation in the management of chronic pain along with its absence of side effects, particularly respiratory depression, has led to recent interest in its use in the management of postoperative pain. Preliminary studies from North America have reported that transcutaneous electrical stimulation may reduce postoperative analgesic requirements *(7,8)*. There is, however, conflicting evidence on the effect of transcutaneous electrical stimulation on lung infection and pulmonary complications in the postoperative period *(7–9)*.

We report the results of a prospective randomised trial to assess the effect of transcutaneous electrical stimulation on postoperative pain, pulmonary function and pulmonary complications after abdominal surgery.

Methods

Consecutive patients undergoing elective abdominal surgery under the care of three consultant surgeons in a single unit were eligible for study. Patients with a psychiatric history and those receiving narcotics prior to surgery were excluded. Before operation respiratory status was established by means of clinical history, physical examination and chest radiography. A sample of arterial blood was withdrawn for blood gas analysis.

All patients received narcotic premedication. Following induction with thiopentone, intermittent positive pressure ventilation was instituted and anaesthesia maintained by a combination of inhalational agents supplemented with narcotic drugs as required.

In the recovery room immediately after surgery, electrodes were applied on either side of the incision. Patients were randomly allocated to receive either (a) transcutaneous electrical stimulation (TES) or (b) 'sham' stimulation for 3 days. All patients were aware that if pain persisted despite TES, intramuscular morphine 10 mg was available.

TES was provided using Electronic Pain Control/Dual device (Codman, Berks.) which uses a modified rectangular wave form with a fixed pulse width (170 microseconds) and pulse rate (80 cycles per second) and a maximum output of 15 milliamperes. In the group receiving 'sham' therapy, the batteries in the device were reversed.

Prior to surgery, the use of the TES device was explained to all patients who underwent a short demonstration and the level at which the current produced a tingling sensation without discomfort was recorded. Patients were told that they might or might not experience the tingling sensation in the postoperative period. After operation the current was initially set at the level determined preoperatively. Subsequently the TES device was checked twice daily in both groups.

Pain was assessed by linear analogue scales *(10)*. Assessments were carried out prior to the administration of the first injection of parenteral analgesia and thereafter twice daily for 3 days, patients being asked to record their average pain over the previous 12 hours. Morphine requirements were noted.

Arterial blood gas analysis was performed on the morning of the first four postoperative days. Using clinical and radiological criteria, patients were assessed daily for the development of pulmonary complications.

Pain scores were compared using the Mann–Whitney U test. Results of blood gas analysis between groups were analysed using an unpaired *t* test. Qualitative differences between groups was assessed using Chi square with Yates correction.

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TABLE I *Comparability of groups*

	'Sham'	*TES*
n	53	53
Mean age in years	57	51
Range	25–81	14–80
M : F	21 : 32	23 : 30
Mean weight in kg	62	64
Range	30–92	42–83
Smokers	31	23
Upper abdominal incision	49	48
Mean duration of anaesthesia in minutes	103	98
Range	45–225	60–180
Intraoperative narcotics	45	48
Mean interval to parenteral analgesia in minutes	184	228
Range	25–1200	20–1440

TABLE II *Linear analogue scales in mm (mean ± SEM)*

	Pre-treatment	*Day 1*		*Day 2*		*Day 3*	
		am	*pm*	*am*	*pm*	*am*	*pm*
'Sham' ($n = 53$)	56 ± 4	50 ± 4	40 ± 3	40 ± 3	37 ± 3	36 ± 3	28 ± 3
TES ($n = 53$)	59 ± 3	49 ± 4	43 ± 3	43 ± 3	33 ± 3	32 ± 3	25 ± 3

TABLE III *Arterial oxygen and carbon dioxide tensions in kPa (mean ± SEM)*

	Pre-operative	*Postoperative*			
		Day 1	*Day 2*	*Day 3*	*Day 4*
'Sham' ($n = 53$)					
(PaO_2)	11.6 ± 0.1	9.2 ± 0.3	9.3 ± 0.3	9.7 ± 0.3	10.0 ± 0.3
($PaCO_2$)	4.6 ± 0.1	4.7 ± 0.1	4.6 ± 0.1	4.4 ± 0.1	4.5 ± 0.1
TES ($n = 53$)					
(PaO_2)	11.8 ± 0.1	9.7 ± 0·3	9.7 ± 0.3	10.3 ± 0.3	10.5 ± 0.3
($PaCO_2$)	4·7 ± 0.1	4.7 ± 0.1	4.7 ± 0.1	4.6 ± 0.1	4.4 ± 0.1

Results

One hundred and six patients were included in the study. The groups were comparable in terms of age, sex and weight. There was no difference in the number of smokers or upper abdominal incisions between the groups. The duration of anaesthesia and the interval from the end of anaesthesia to the first dose of parenteral analgesia between the groups were comparable. The number of patients receiving intraoperative narcotics and the amount of narcotics used were similar in both groups (Table I).

There was no significant difference in the severity of pain as measured by the linear analogue scales prior to the administration of the first dose of parenteral analgesia (Table II). Pain scores over the three days of the study showed that both groups experienced similar degrees of pain. The mean morphine requirements were 50 mg (range 10–190 mg) in the 'sham' group compared with 59 mg (range 10–140 mg) in the TES group (NS). There was no significant difference in either arterial oxygen or carbon dioxide tensions between the two groups prior to surgery and for the first four postoperative days (Table III). Sixteen patients in the 'sham' group and 12 patients in the TES group developed chest infection. All patients tolerated the TES device well.

Discussion

The introduction of the 'gate control' hypothesis *(11)* provided a rational basis for the use of transcutaneous electrical stimulation in the management of pain. It was thought that pain was largely transmitted by small unmyelinated 'C' fibres which could be inhibited by activity of myelinated 'A' fibres. Stimulation of these larger 'A' fibres could close the spinal gating mechanism in the substantia gelatinosa and thus prevent painful peripheral stimuli from gaining access to higher cortical centres. The release of endorphins and activation of inhibitory reflex areas in the brain stem have been proposed as alternative mechanisms for the effect of transcutaneous stimulation *(12)*.

In a retrospective study *(9)*, transcutaneous electrical stimulation provided pain relief and reduced the incidence of pulmonary complications following abdominal and thoracic surgery. Subsequently randomised studies demonstrated that transcutaneous stimulation reduced narcotic requirements *(7,8,13)* but failed to reduce the frequency of pulmonary complications after abdominal surgery *(7,13)*. In contrast, in a small non-randomised study, Ali and his colleagues *(8)* found that transcutaneous stimulation was associated with improvement in postoperative pulmonary function including arterial oxygen tension and a reduction in the incidence of respiratory complications.

In our study we compared transcutaneous electrical stimulation with 'sham' therapy in patients undergoing abdominal surgery. To assess the value of transcutaneous stimulation in the context of conventional anaesthetic practice, the technique of anaesthesia was not standardised. We found that transcutaneous stimulation did not provide better analgesia; the interval from surgery to the first administration of morphine, linear analogue pain scales and total morphine requirements were comparable in both groups. Interestingly the morphine requirements in this study were less than those in our previous studies comparing the efficacy of morphine with sublingual buprenorphine *(14)* suggesting the presence of the TES equipment may have had a placebo effect. There were no significant differences in arterial oxygen tensions between the stimulated and 'sham' group throughout the period of study; the incidence of postoperative pulmonary complications was similar in both groups.

Our findings are at variance with previous reports despite using apparatus with similar characteristics *(7–9,12)*. These studies were retrospective *(9)*, non-randomised *(8)* and conclusions were based on small samples *(7,8,15)*. In addition, a reduction in narcotic requirements was equated with good pain relief *(7,8,12)* and no direct measurement of pain was undertaken. The study by Ali and his colleagues *(8)* noting an improvement in pulmonary function excluded obese patients, smokers and those with respiratory disease. These groups comprise over 50% of patients in our study and may explain the failure of transcutaneous electrical stimulation to influence pulmonary gas exchange of the incidence of respiratory complications.

In this study the use of transcutaneous electrical stimulation did not provide better pain relief than conventional analgesia, did not modify the degree of pulmonary dysfunction or influence the incidence or pulmonary complications following abdominal surgery.

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Notes on books

Sport and Medicine by P N Sperryn. 271 pages, illustrated. Butterworth, Kent. £14.95.

This clearly written and illustrated book can be understood not only by medical practitioners but by paramedical physiotherapists and by trainers. The short chapters discuss in turn various aspects of health, injury and sport. Simple easily understood advice is given on each of the topics.

Proceedings of the European Dialysis and Transplant Association—European Renal Association. Volume 20. Edited by A M Davidson, P J Guillou. 777 pages, illustrated. London. £39.

The twentieth congress was held in London in 1983. The material is split up into 20 sections including dialysis, transplantation, stones, hypertension, general nephrology, diabetes and bone disease.

A Colour Atlas of Surgery for Varicose Veins by C V Ruckley. 64 pages, illustrated. Wolfe Medical, London. £12.00.

This makes an excellent means of demonstrating the definition of varicose veins and the various operative procedures on them. It will be very valuable for trainee surgeons.

Atlas of Skin Repair by Janos Zoltan. 303 pages, illustrated. Karger, Basel. SFr 160.

This is a translation from the German edition and covers in detail skin repair in various sites on the body. It describes local and migration flaps, tubed pedicle flaps, free grafts, microvascular anastomosis and then deals individually with various sites in the body. The book is richly illustrated and the drawings are supplemented with line drawings where necessary.