TÜBİTAK

Turkish Journal of Medical Sciences

http://journals.tubitak.gov.tr/medical/

Research Article

Turk J Med Sci
(2016) 46: 620-625
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doi:10.3906/sag-1502-56

Effectiveness of P6 acupoint electrical stimulation in preventing postoperative nausea and vomiting following laparoscopic surgery

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Received: 10.02.2015 • **Accepted/Published Online:** 30.05.2015 • **Final Version:** 19.04.2016

Background/aim: The effects of pericardium 6 (P6) electrical stimulation in patients at risk of postoperative nausea and vomiting (PONV) following laparoscopic surgery were evaluated.

Materials and methods: Eighty patients for laparoscopic surgery with at least one of the determined risks (nonsmoker, female, previous PONV/motion sickness, or postoperative opioid use) were randomized into either an active or sham group. At the end of surgery, Reletex electrical acustimulation was placed at the P6 acupoint. The active group had grade 3 strength and the sham group had inactivated electrodes covered by silicone. It was worn for 24 h following surgery. PONV scores were recorded.

Results: The active group had significantly shorter durations of surgery and lower PONV incidence over 24 h (35.1% versus 64.9%, P = 0.024) and this was attributed to the lower incidence of nausea (31.4% versus 68.6%, P = 0.006). The overall incidence of vomiting was not significantly different between the groups, but it was higher in the sham group of patients with PONV risk score 3 (23.9%, P = 0.049).

Conclusion: In patients at high risk for PONV, P6 acupoint electrical stimulation lowers the PONV incidence by reducing the nausea component. However, this reduction in nausea is not related to increasing PONV risk scores.

Key words: P6, acupoint electrical stimulation, postoperative nausea and vomiting

1. Introduction

Postoperative nausea and vomiting (PONV) is a common complication following surgery and anesthesia (1,2). Before the 1960s, when older inhalational anesthetic agents such as ether and cyclopropane were widely used, the incidence of vomiting was as high as 60% (3). Improved anesthetic techniques, along with newer generations of antiemetics and shorter-acting anesthetic drugs, have reduced the overall incidence of PONV to approximately 30% (4). Nonetheless, PONV still occurs in as many as 70% of high-risk patients (5).

It is estimated that one episode of vomiting prolongs postanesthesia care unit stay by approximately 25 min (6). Even incidences of mild PONV can lead to an unanticipated hospital admission, greatly increased medical costs, and reduced patient satisfaction (7).

There are several centrally acting antiemetics currently available for the prophylaxis of nausea and vomiting. Unfortunately, antiemetics are not always successful. In addition, antiemetic pharmacological agents are associated with adverse side effects that vary from lethargy to extrapyramidal signs and symptoms (2). These concerns have led researchers to investigate alternative approaches, such as stimulation of an acupuncture point, which had anecdotally been reported to decrease nausea and vomiting contributed by a variety of conditions (8). The acupuncture point can be stimulated using various methods. Application of pressure onto the pericardium 6 (P6) area (acupoint pressure), needling of the P6 point (acupuncture), and transcutaneous electrical nerve stimulation (TENS) are some of the techniques described (8–10).

In this study, we compared the effectiveness of P6 acupoint electrical stimulation in preventing PONV following laparoscopic surgery.

2. Materials and methods

This prospective, randomized, controlled, and observer-blinded clinical trial was carried out after obtaining our institution's ethics committee approval and patients' informed consent. Patients above 18 years of age classified

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as physical status I or II according to the American Society of Anesthesiologists (ASA) with at least one additional PONV risk factor, as suggested by Apfel et al. (5,11,12), who were scheduled for laparoscopic surgery were recruited into the study. These risk factors were: nonsmoker, female, history of PONV/motion sickness, and postoperative opioid use. Patients who were pregnant, dependent on a cardiac pacemaker or implanted cardioverter/defibrillator, allergic to nickel/chrome, anticipated to have a difficult airway or require postoperative ventilator support, known to have peripheral neuropathy, or with a body mass index (BMI) of >35 kg/m^2 were excluded.

Following recruitment, patient risk factors for PONV, including laparoscopy surgery, were summed up with a risk score modified from Apfel et al. (5,11,12). Each risk factor was given a score of one point. Therefore, the minimum PONV risk score was 2.

The patients were randomly allocated to either an active group (acustimulation group) or a sham group (sham acustimulation group) by using a random sequence of computer-generated numbers. The investigators responsible for data collection were blinded to the treatments administered to the study patients.

TENS was provided by the commercially available Reletex device. It is an FDA-approved piece of equipment commonly used as an adjunct to antiemetics in PONV prophylaxis and treatment. The portable, watch-like device is lightweight (34 g), battery-powered (two 3 V lithium coin cells), and capable of delivering current at 5 mA to 40 mA gradable in 5 strengths. This transdermal neuromodulation device generates specific pulses in waveform, frequency, and intensity for stimulation of the median nerve. The device's surface, which has direct contact with the skin, has two flat metal electrodes through which electrical stimulation is applied transcutaneously.

At the end of surgery, the Reletex device was applied over the acupoint area known as P6 on the dominant upper extremity of the active group. The P6 is the sixth point on the pericardial meridian, located on the anterior surface of the forearm, 2–3 cm proximal to the distal wrist crease between the tendons of the flexor carpi radialis and the palmaris longus (13). The device was set at grade 3 strength. In the sham group, the inactivated Reletex device was applied to the P6 acupoint. It was inactivated by placing a silicone cover over the electrodes, which was invisible to both patients and investigators. The devices were worn for 24 h after surgery.

In the operating theater, an intravenous (IV) cannula was inserted in the nondominant hand to avoid interfering with the acustimulation device. IV dexamethasone 4.0 mg was given prior to induction of anesthesia. General anesthesia was induced with IV propofol 1.5–2.5 mg/kg, IV fentanyl 1 μg/kg, and IV rocuronium 0.6–1.0 mg/kg. Anesthesia was maintained by sevoflurane at a MAC of 0.8–1.2 in an oxygen:air mixture titrated to FiO_2 of 0.4–0.6. All patients received IV morphine 0.05–0.1 mg/kg after induction of anesthesia and prior to surgical incision. Carbon dioxide (CO_2) gas was used to create surgical pneumoperitoneum at intraabdominal pressure maintained at less than 15 cm H_2O. It was fully evacuated at the end of the operation. Following decompression of pneumoperitoneum, infiltration with 0.5% levobupivacaine in a 10 mL solution to the surgical wounds was given. IV parecoxib 40 mg was given 30 min before extubation and was repeated at 8 h after extubation. Residual neuromuscular blockade was antagonized with IV neostigmine and IV atropine. Tablet paracetamol (1 g) at 6-h intervals was prescribed once patients could tolerate oral administrations in the postoperative period. There was no further opioid administration in the ward.

Patients were evaluated for occurrence and severity of nausea and vomiting, and for pain, in the recovery room (0 h) and at 2, 6, 12, and 24 h postoperatively. PONV assessment was done using a 3-point scale (0 = no nausea and vomiting, 1 = mild to moderate nausea, and 2 = severe nausea and vomiting needing treatment). Rescue therapy with 1 mg granisetron was administered to patients who experienced severe nausea and vomiting. Pain was assessed with a visual analog scale (VAS), whereby 0 = no pain and 10 = most painful. Recruited patients were briefed on the process of VAS measurement. Patients who required postoperative opioids as a rescue analgesia were excluded from the study.

Sample size was calculated based on Frey et al., whereby a total of 80 patients were required in order to have 80% power with a significance level of 0.05% to detect a difference in the incidence of PONV at 33% between groups after considering a 20% drop-out rate (14). All the data were analyzed using SPSS 21.0. Parametric variables were compared using Student's t-test. Categorical variables were compared using the chi-square test. $P < 0.05$ was considered statistically significant.

3. Results

Eighty-five patients were recruited into the study. Forty-two patients were randomly allocated into the active acustimulation group and 43 patients into the sham acustimulation group. Four patients were excluded due to the conversion of laparoscopic to open surgery and one patient was given an opioid postoperatively for pain treatment. Of the 80 patients who completed the study, 40 patients were in the active group and 40 patients were in the sham group. Patient demographic characteristics and factors likely to influence PONV were not significantly different between the active and sham groups. Duration of surgery was found to be significantly shorter in the active group (Table).

Table. Demographic data, duration of surgery, and PONV risk factors. The values are expressed as mean ± SD and number (%) where appropriate.

Age (years)	Sham group (n = 40)	Active group (n = 40)
	46.5 ± 14.3	41.5 ± 13.8
Sex (male : female)	7 : 33	12 : 28
BMI (kg/m^2)	22.8 ± 2.8	23.3 ± 2.9
Duration of surgery (min)	112.8 ± 52.2*	76.8 ± 44.9*
Nonsmokers (%)	(85.0)	(80.0)
History of PONV/motion sickness (%)	(12.5)	(17.5)
Total risk score (n)		
2	10	17
3	28	18
4	2	5

*Significant at $P < 0.05$.

Overall incidence of PONV was 46.3%. The active group had significantly lower PONV incidence over 24 h than the sham group (35.1% versus 64.9%, P = 0.024). This was mainly due to the significantly lower incidence of nausea over 24 h in the active group (31.4% versus 68.6%, P = 0.006). However, the incidence of vomiting over 24 h was not significantly different between groups (Figures 1 and 2).

Patients with a PONV risk score of 2 and above were not statistically different in their incidence of nausea between the two groups. However, the incidence of vomiting was significantly higher (23.9% versus 4.3%, P = 0.049) in the sham group with a PONV risk score of 3 (Figures 3 and 4).

Nine patients (22.5%) in the active group required granisetron rescue therapy, compared to 15 patients (37.5%) in the sham group. However, this was not statistically significant (P = 0.222).

The pain scores between the sham and active groups were not significantly different in the first 24 postoperative h. There were no adverse effects noted in this study, such as allergic reaction to the Reletex device, rashes, or skin scalding.

4. Discussion

Known patient risk factors that contribute towards PONV include young, female adults with previous PONV or

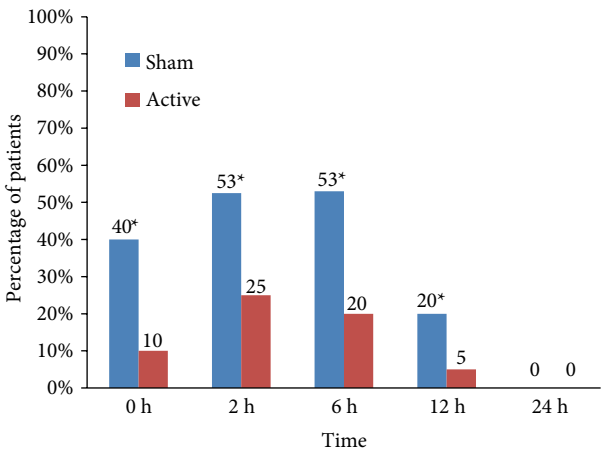

Figure 1. Incidence of postoperative nausea in sham and active groups at 0–24 h. *Significant at $P < 0.05$.

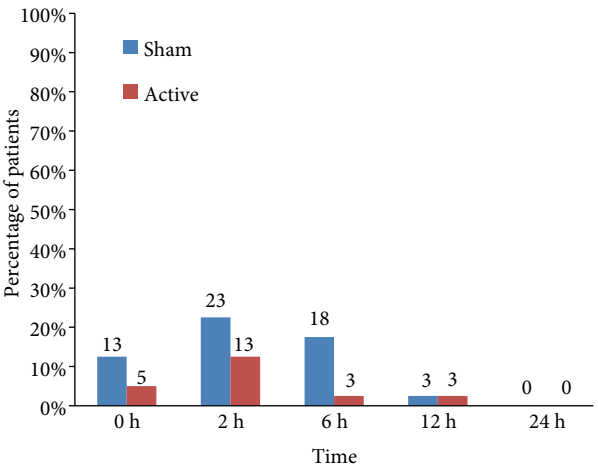

Figure 2. Incidence of postoperative vomiting in sham and active groups at 0–24 h.

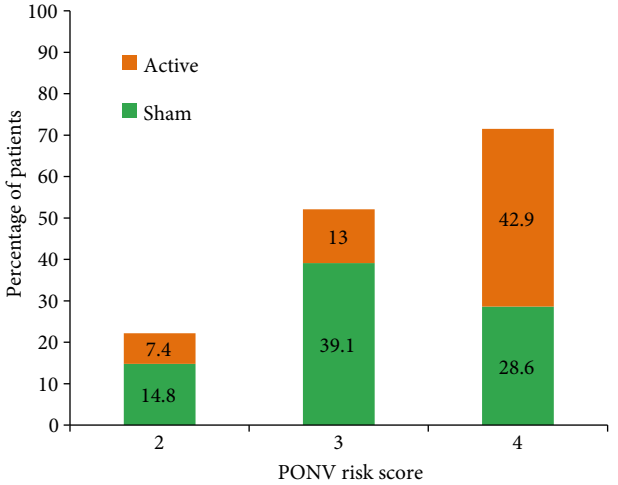

Figure 3. Incidence of postoperative nausea in subgroups of PONV risk score.

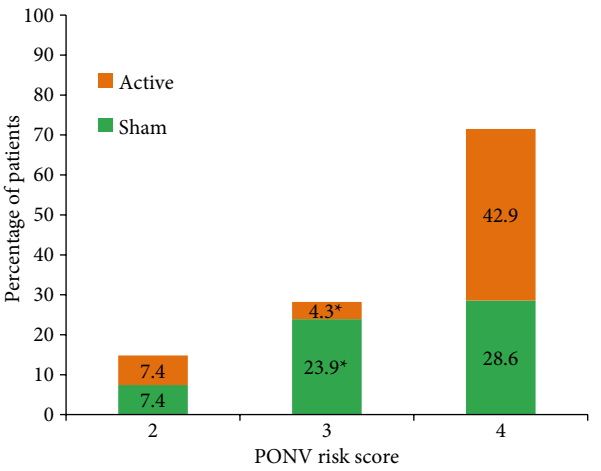

Figure 4. Incidence of postoperative vomiting in subgroups of PONV risk score. *Significant at $P < 0.05$.

motion sickness who are nonsmokers. The anesthetic plan, which utilizes opioids, nitrous oxide, and inhalational agents, also plays an important role in determining the incidence of PONV (15). However, of the many surgery types initially associated with PONV, only cholecystectomy, laparoscopic procedures, and gynecological surgery are probably independent predictors of PONV (16). PONV remains an important anesthetic issue, as it may result in a range of morbidities, including reduced patient satisfaction, delayed hospital discharge, unexpected hospital admission, fluid and electrolyte disturbances, wound dehiscence, bleeding, pulmonary aspiration, and esophageal rupture (15).

Using the Reletex acustimulation device, we demonstrated that TENS application at the P6 acupoint significantly reduced the incidence of postoperative nausea. This therapeutic effect was observed regardless of the PONV risk score in patients after laparoscopic surgery. Sixty-five percent of the patients in the sham group had significantly higher incidence of PONV, compared to 35.1% in the active group. These results are similar to previously published results regarding acupoint pressure stimulation (8,14,17–21). We analyzed the incidence of nausea and vomiting separately in order to assess the efficacy of P6 acupoint stimulation. Patients in the active group had significantly reduced nausea episodes for up to 12 h in the postoperative period. We did not find significant differences between groups in the incidence of vomiting. Similarly, a sham-controlled prophylaxis study by Zarate et al. using the Relief-Band acustimulation device demonstrated only an antinausea, rather than antivomiting, effect following laparoscopic cholecystectomy (22). According to Doubravska et al., the incidences of postoperative nausea and vomiting were 13.4% and 8.6%, respectively (23). In view of the lower incidence of vomiting compared to nausea, a study with a larger sample size will be better able to detect the effectiveness of nonpharmacological intervention, such as the P6 acupoint stimulation, at preventing postoperative vomiting.

Our results suggested that P6 acupoint electrical stimulation is more effective when applied to patients at high risk for PONV. High risk is usually defined as having three or more risk factors for PONV, as suggested by Apfel et al. (5,11,12). Patients at moderate risk for PONV (with only two risk factors present) are less likely to show favorable response to treatment, as the incidence of PONV itself is lower (14). Patients in our active group with a PONV risk score of 3 had a significantly lower incidence of vomiting, but not nausea. The efficacy of P6 acustimulation at reducing the incidence of vomiting is more likely as the number of risk factors for PONV increases. Our study was unable to demonstrate similar findings when the PONV risk score was at least 4. The low number of patients with very high PONV risk scores may have resulted in insufficient power to detect an effect.

The optimal timing to implement P6 acupoint stimulation is still debatable when attempting to prevent the occurrence of PONV (24). Frey et al. demonstrated no differences between pre- and postoperative acupoint stimulation in the incidence of PONV (14). The same authors proceeded to mention that patients in the sham group had higher incidences of PONV, necessitating a longer duration of therapy until the 24-h postoperative period was over (14). On the other hand, White et al. showed the best effect on PONV prevention was obtained when acustimulation was administered until 72 h after surgery (21). Kotani et al. reported that preoperative application of an intradermal acupuncture needle, left

in situ for 4 postoperative days, reduced nausea and vomiting significantly after abdominal surgery (25). The PONV incidence over 24 h in our sham group was high at 64.9%. Thus, our active group patients benefited most from the Reletex device applied over a 24 h period. Along with timing, the postoperative P6 acupoint stimulation duration is equally important when considering PONV prevention strategy.

Following our institutional ethics committee with regards to the increased anticipated risk of developing PONV in laparoscopic surgeries, we precluded the omission of antiemetic prophylaxis from this study. IV dexamethasone 4 mg was selected as the routine antiemetic prophylaxis. It has been found to be a cost-effective prophylactic antiemetic, with a number needed to treat of 4.7 for PONV (26–28). Despite this antiemetic prophylaxis, the overall incidence of PONV in our sham group was reported at 64.9%. However, recent studies have documented the benefits of routine antiemetic prophylaxis for surgeries with recognized significant risk of developing PONV (7,29,30). Prophylaxis with either dual or more antiemetic drug regimens are justified in patients with more risk factors for PONV (30,31). Nonetheless, the possibility of adverse drug interactions may increase as a function of the number of drugs administered (32).

Our results showed significantly reduced incidence of nausea in the active group. This may have been confounded by the sham group having a significantly longer duration of surgery (76.8 min versus 112.8 min). According to Doubvraska et al., laparoscopic surgery was postulated as a risk factor of PONV as a result of carbon dioxide insufflation into the intestines, increased abdominal pressure, and vagus nerve irritation (23). Longer duration of surgical pneumoperitoneum is associated with increased exposure to these proemetic conditions.

Kaya et al. demonstrated similar efficacy in PONV prophylaxis when comparing droperidol with pressure effects to 6% dextran injections at the P6 acupoint (33). Despite inactivation of the device in our sham group, there is unavoidable continuous pressure on the P6 area and this can create an undesirable acupressure effect. However, minimization of the pressure effect was possible due to the device's unique build. The Reletex device is incorporated with a flattened posterior surface with stimulating electrodes protruding only 1 mm from its surface. These findings were supported by patients in the sham group using similar wrist bands in acupressure studies (9,10).

Identical acustimulation units were utilized throughout this study. Sham group patients received inactivated units, which were intended to produce a dummy effect at the P6 acupoint. Regardless of grouping, all patients were briefed similarly about the Reletex device, which produces a tingling sensation that they may perceive. However, we acknowledged that blinding can be further improved with application of the Reletex device at nonacupoint sites, which simulates a placebo effect. Nonetheless, these sites are also associated with transmission of electrical impulses to the P6 area (22).

Apfel et al. described a well-validated simplified PONV risk score (5,11,12). Our study, on the other hand, used a nonvalidated risk score, since we added laparoscopic surgery as a factor. This was based on the work of Apfel et al. and Gan et al. (16,34). Both studies concluded that of all the surgery types, only cholecystectomy, gynecologic, and laparoscopic surgeries are probably risk factors that independently increase the risk for PONV (16,34).

In conclusion, P6 acupoint electrical stimulation is a useful nonpharmacological adjunct to antiemetic drugs for preventing postoperative nausea for up to 12 h in adults. However this reduction in nausea is not related to increased PONV risk scores. Future studies should be designed to evaluate the relative cost-effectiveness of acustimulation and prophylactic antiemetic therapies when they are administered separately or in combination in preventing both postoperative nausea as well as vomiting (17).

Acknowledgments

The authors would like to thank Dato' Dr Jahizah Hassan, Head of the Department of Anaesthesia and Intensive Care, Penang General Hospital, Pulau Pinang, Malaysia, who assisted in allocating funds for the Reletex devices.

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