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Decreasing Post-Operative Nausea and Vomiting Through Stimulation of the Pericardium-6 Acupoint

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DECREASING POST-OPERATIVE NAUSEA AND VOMITING THROUGH STIMULATION OF THE PERICARDIUM-6 ACUPOINT

by

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PERMISSION

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ABSTRACT

Title: Decreasing Post-Operative Nausea and Vomiting Through Stimulation of the Pericardium-6 Acupoint

Background: Post-operative nausea and vomiting (PONV) is one of the most common side effects following anesthesia. Effects of PONV can cause significant patient distress, morbidity, and increase healthcare costs. Despite the use of newer pharmacological drugs, PONV still occurs in up to 25% of patients, warranting the use of additional means to control PONV that are simple, cost-effective, and non-invasive (Trueman, 2011).

Purpose: The purpose of this case report/independent study is to determine if the addition of P-6 acupoint stimulation reduces the incidence of post-operative nausea and vomiting in surgical patients.

Process: A comprehensive review of literature was completed using the PubMed, CINAHL, and Cochrane database from the Harley E. French Library of the Health Sciences website. The findings were reviewed and evaluated to determine relevancy to the research topic.

Results: P6 acupressure is effective as an alternative or adjuvant therapy for prevention of PONV in low to moderate risk patients. When used in conjunction, P6 acustimulation and modern antiemetic treatment may provide a synergistic effect that can greatly decrease the incidence of PONV.

Implications: P6 acupoint stimulation is a non-invasive and non-pharmacological technique examined to decreased PONV.

Keywords: P6 acupoint, Neiguan P-6, pericardium, acupressure, nausea and vomiting, transcutaneous electric nerve stimulator, and electro-acupuncture.

Management of Post-Operative Nausea and Vomiting Through Stimulation of the Pericardium-6 Acupoint

Post-operative nausea and vomiting (PONV) is one of the most frequent complaints following surgery. In addition to impairing the patient's comfort, it can lead to various complications, some of which are severe and life threating (Trueman, 2011). Various pharmaceutical agents are currently being used as the standard to treat PONV, but with limited success. The side effects and cost profiles of the current treatment modalities reinforce the belief that there is opportunity for improvement in managing PONV. The primary research question investigated in this independent study is: Does the addition of Pericardium-6 acupoint stimulation decrease the incidence of post-operative nausea and vomiting when used alone, or in combination with other traditional pharmacologic antiemetics?

Case Report

A 25-year old, 72 kg, 165 cm Caucasian female presented for a robotic assisted laparoscopic cholecystectomy. The patient denied any allergies. Her medical history included back pain, myofascial pain, sinusitis, anxiety, and occasional heartburn. The patient denied alcohol use, cigarettes, or street drugs. Her surgical history included prior cesarean section and laparoscopic hernia repair. Current medications included acetaminophen, hydrocodone-acetaminophen 10-325 (Norco), tizanidine, and cetirizine. The patient reported a history of post-operative nausea and vomiting with her two prior anesthetics that each lasted approximately 12 hours post procedure.

The patient was given an American Society of Anesthesiologists physical status level of 2. The patient received an assessed Mallampati score of 2, thyromental distance of 3 fingerbreadths, and displayed full neck range of motion. Preoperative vital signs were as follows:

blood pressure 116/71, heart rate 82, respiratory rate 14, pulse oximetry 98%, and temperature 98.6 degrees Fahrenheit. When the patient arrived to the preoperative holding area, a transdermal scopolamine patch was placed behind the patient's ear. Thirty minutes later the patient received midazolam 2 milligrams (mg) and ondansetron 4 mg intravenously (IV). The patient was transported to the operating room where she was assisted onto the operating room table. Standard monitors were applied and included a non-invasive blood pressure cuff on her left upper extremity, finger pulse oximeter, 5-lead electrocardiogram (EKG), and a bispectral index (BIS) monitor. Initial vital signs prior to induction were: blood pressure 112/70, heart rate 78, respiratory rate 12, and pulse oximetry 98%. The patient was pre-oxygenated via facemask at 10 liter per minute (LPM) for five minutes. After pre-oxygenation, the following medications were administered IV: lidocaine 50 mg, fentanyl 150 mcg, propofol 160 mg, and rocuronium 30 mg. A 7.0 mm, cuffed, endotracheal tube (ETT) was placed via direct laryngoscopy utilizing a Macintosh 3 blade and a grade 1 view was noted. Correct placement of the ETT was confirmed with the auscultation of bilateral breath sounds and the presence of an ETCO2 waveform.

The endotracheal tube was secured with tape and the patient was placed on the ventilator in a volume control mode with a respiratory rate of 12, tidal volume 550 milliliters (mL), and positive end expiratory pressure (PEEP) of 4. Fresh gas flows were decreased to oxygen 1 LPM and air 1 LPM. A total intravenous anesthesia technique was performed utilizing a propofol infusion starting at 175 mcg/kg/min. Decadron 5 mg IV was administered for additional nausea prophylaxis and cefazolin 1 gram IV was administered prior to incision for a preoperative antibiotic.

Due to the ease of application and administration, P6 acustimulation was applied following induction using a traditional nerve stimulator in accordance with preoperative

education. Two surface electrodes were placed on the P6 acupressure point on the patient's right arm. The proximal positive electrode was placed between the tendons of the palmaris longus and the flexor carpi radialis 1 cm proximal to the P6 acupressure point. The distal negative electrode was placed 2 cm distal to the P6 acupoint. Each electrode was connected to the nerve stimulator and tetanic stimulation at 50 Hz for 5 seconds was delivered every 10 minutes following induction, for the duration of the procedure. The patient was repositioned with her arms abducted less than 90 degrees and placed in a slight Trendelenburg position. Incision was made and abdominal insufflation was initiated and maintained between 15 – 20 mmHg.

The ventilation mode was changed to a pressure control ventilation setting due to increased peak airway pressures (PAP) with a rate of 12, inspiratory pressure of 25 cm H20, and PEEP of 4. PAP reduced with delivery of adequate tidal volumes and end tidal carbon dioxide (EtCO2) levels maintained between 30 – 35 mmHg. One dose of ephedrine 5mg was administered IV for a non-invasive blood pressure reading of 90/49, with a mean atrial pressure (MAP) of 62, with a subsequent blood pressure reading of 105/67 (MAP 79). One additional dose of fentanyl 50 mcg was administered during the case for an increased heart rate of 88. The patient was also administered an additional dose of rocuronium 10 mg due to surgeon request for increased paralysis. The patient's vital signs remained stable throughout the case with a MAP > 65, heart rate 68-88, pulse oximetry > 97 %, and BIS of 39-50.

Near conclusion of the surgical procedure, glycopyrrolate 0.4 mg and neostigmine 2 mg were administered IV for reversal of neuromuscular paralysis. Subsequent twitches revealed 4 equally strong twitches, with 5 seconds of sustained tetany without fade. Ondansetron 4 mg IV was also re-dosed prior to emergence for additional nausea prophylaxis. A soft gauze bite block was placed in the patient's mouth. Spontaneous respirations were noted and the propofol infusion

was discontinued. Ketorolac 30 mg was given for additional pain control post operatively. The total surgical time was 117 minutes. Extubation criteria was achieved as evidence by stable hemodynamics, a regular respiratory rate of 10 breaths per minute, consistent tidal volumes of > 350 mL, appropriate response to command, and adequate head lift strength. The patient's airway was suctioned and extubated without complication. Oxygen via nasal cannula was applied at 4 LPM, and the patient was assisted in transfer to a transport bed.

Upon arrival to the Post Anesthesia Care Unit (PACU), the patient was awake, alert, and responding appropriately. She denied any pain or nausea. The post anesthesia evaluation was completed on post-operative day 1. The patient complained of only minor nausea when initially eating for the first time the evening of surgery. The patient denied any further episodes of nausea, vomiting, or dry heaving/retching throughout her hospital stay. She was discharged home post-operative day 1 without any further incidence.

Review of Literature

Risk Factors

A diverse range of chemical, mechanical, and psychological emetic stimuli influences the perioperative etiology of PONV. Primary risk factors associated with PONV can be patient specific, related to the anesthetic chosen, or surgery related (Nagelhout & Plaus, 2012; Trueman, 2011; Cheong, Zhang, Huang, & Zhang, 2013). Patient related risk factors include: female gender, age less than 50 years old, non-smoker, history of PONV, anxiety, and a history of motion sickness. The use of volatile anesthetics, nitrous oxide, and opioids are all anesthetic related risk factors. The specific type of surgery, such as laparoscopic, strabismus, craniotomy, breast, plastic, gynecologic, orthopedic, and any surgery lasting over one hour also increases the risk of PONV. Lastly, the experience of the surgeon is often overlooked as a risk factor.

Inexperienced surgeons increase the incidence of PONV due to longer surgical times and unnecessary handling of tissues (Nunley, Wakim, & Guinne, 2008).

Due to the cost and potential side effects of commonly used pharmacological agents, identification of high-risk PONV patients should be an important part of the preoperative evaluation. Trueman (2011) states, "female gender, non-smoking status, and a history of PONV or motion sickness remain the strongest predictors of PONV" (p. 39). Knowing and identifying the patient-specific risk factors can help manage nausea and vomiting from a prophylactic approach, rather than a therapeutic approach.

Etiology of Post Operative Nausea and Vomiting

Nausea and vomiting are caused by stimulation of neurologic mechanisms found in the gastrointestinal tract and brain, with the central nervous system (CNS) serving as the control central for regulation (Nunley et al., 2008; Trueman, 2011). The CNS integrates information received from the peripheral sensors and cerebral cortex, activating the autonomic nervous system (ANS). These efferent pathways travel within cranial nerves V, VII, IX, X, and XII to the upper and lower gastrointestinal tract, diaphragm, and abdominal muscles to produce vomiting (Becker, 2010).

The two principal anatomic sites involved in CNS control of nausea and vomiting are the vomiting center and the chemoreceptor trigger zone (CTZ). The vomiting center is located in the medulla oblongata where stimulation occurs via histamine, dopamine, serotonin, and acetylcholine (Nunley et al., 2008). The afferent fibers of the sympathetic and parasympathetic nervous system transmit impulses to the vomiting center in the medulla. The CTZ is located in the postrema of the fourth cerebral ventricle, adjacent to the vomiting center (Becker, 2010; Nunley et al., 2008). The CTZ lacks protection from the blood brain barrier, making it

susceptible to stimuli via neurotransmitters, emetogenic toxins, metabolites, and drugs circulating in the blood or cerebrospinal fluid (Nunley et al., 2008). The CTZ is stimulated by dopamine, serotonin, opioids, and certain anesthetic agents (Trueman, 2011). The CTZ and vomiting center are connected by the fasciculus solitarious, and is the site where many antiemetic agents work by blocking muscarinic, cholinergic, enkalphin, and histamine receptors (Becker, 2010).

Acupressure

The use of alternative means to decrease PONV is a topic of ongoing investigation. Historically the Pericardium-6 (P6) acupoint is widely considered to be the "pre-eminent point to treat nausea and vomiting of any etiology" (Trueman, 2011, p. 37). The Pericardium-6 (P6), also referred to as the Neiguan-6, acupoint is located between the tendons of the palmaris longus and flexor carpi radialis muscles, 4 cm proximal to the wrist crease. Recent clinical trials have shown promise that P6 acustimulation displays anti-emetic qualities, with the benefit of a favorable side-effect profile. If shown to be an efficacious therapy in the management of post-operative nausea and vomiting, either as a replacement method or in conjunction with traditional antiemetics, it may provide the anesthetist with a cost-effective and safe mechanism to reduce PONV and overall distress of the patient.

Acupressure is delivered via means of physical, mechanical, or electrical pressure applied over specific meridians of the body. Although the precise mechanisms that make acustimulation effective are not completely understood, a series of physiological events are thought to occur following stimulation of an acupoint. Initially afferent type I and II nerve fibers are stimulated, sending impulses to the spinal cord and periaqueductal gray matter in the midbrain (Nunley et al., 2008). Subsequently enkephalins and endorphins are released via

endorphogenic cells, with levels shown to be significantly higher in patients' cerebrospinal fluid following acupressure (Trueman, 2011). Endorphins in turn, block signals from the CTZ. Stimulation of the hypothalamopituitary axis produces a release of beta-endorphin and adrenocorticotropic hormone (ACTH) from the pituitary gland (Ertas et al., 2015). Enkephalin, beta-endorphin, and ACTH exert their antiemetic action by modifying serotonin release. The combination of the above responses act to block nausea and vomiting stimuli and calm the gastrointestinal tract, thus countering PONV.

Various methods are available to deliver stimulation to the P6 acupuncture site. Noninvasive techniques include acupressure through direct finger pressure, or simple band devices that provide continuous pressure via direct contact with the site. Commercially available electro-stimulation devices such as a TENS unit or ReliefBand also provide noninvasive stimulation through small electrical currents through the skin. More recently, interest has gained in providing noninvasive electro-stimulation with the use of a traditional nerve stimulator while monitoring neuromuscular blockade. Invasive stimulation techniques include needle acupuncture, electro-acupuncture, and dextrose injections. Invasive techniques are typically more time consuming and carry a higher incidence of side effects due to piercing of the skin.

Trueman (2011) found that "few trials have compared stimulation protocols to deliver P6 acustimulation, probably due to the large population that would be required" (p. 41). Other studies have found that non-invasive techniques were equally as effective as invasive techniques (Dundee, 1990; Dundee et al., 1989). Lee and Fan (2011) performed a Cochrane Review that included 40 randomized control trials involving 4858 surgical participants undergoing various techniques of P6 acustimulation. They concluded that the invasive and noninvasive techniques for P6 acustimulation produced similar effects. Noninvasive acustimulation via transcutaneous or

electrical methods likely provides the fastest, safest, and most readily usable treatment modality for the anesthesia provider. For this reason the focus of the literature review will remain on the application and efficaciousness of acupressure at the P6 site in general, and not as a specific modality of providing P6 stimulation, as it relates to the prevention of PONV.

P6 Acustimulation vs. Placebo

To determine whether P6 acustimulation is effective, it is important to compare the intervention as a sole treatment vs. a sham or placebo treatment. During a placebo treatment, a device is applied in a non-P6 location, or the illusion of P6 acupoint stimulation is provided without giving an actual stimulus (Turgut et al., 2007). This provides an opportunity to gauge the effectiveness of P6 acustimulation, and if found effective, compare it further with other interventions. A variety of Randomized Control Trials (RCTs) have discovered that P6 acupressure is both effective and superior in reducing PONV in a variety of surgical patients compared to a placebo group alone (Chen, Chang, & Hsu, 2005; Direkvand-Moghadam & Khosravi, 2013; Ertas et al., 2015; Frey, Scharmann, Lohlein, Peters, 2009; Gan, Jiao, Zenn, & Georgiade, 2004; Hickman, Bell, & Preston, 2005; Lee & Fan, 2011; Wang et al., 2011). Studies vary in the percentage of PONV reduction that P6 acupressure provides, but all reduce it to a clinically significant degree.

Direkvand-Moghadam and Khosravi (2013) performed a randomized control trial of 102 patients undergoing elective cesarean section. They found that acupressure decreased the incidence of nausea to 20.58% compared to the control group of 50%. Vomiting was reduced from 32.34% in the control group to 17.64% acupressure group. Furthermore, the need for a rescue antiemetic was only 5.88% in the acupressure group compared to 20.58% in the control group. In another randomized control trial, Wang et al. (2010) evaluated the effectiveness of P6

acustimulation in 80 patients undergoing supratentorial craniotomy. The study concluded that the prevalence of nausea and vomiting was significantly lower in the P6 acupoint group compared to the control group, more specifically, "only 18% of P6 patients had nausea and vomiting in the first 24 hours compared to 37% in the control group" (p. 130).

In a RCT consisting of 77 patients undergoing major breast surgery, Gan et al. (2004) also found similar results. They discovered that satisfaction rate (no nausea, emesis, or use of rescue antiemetic) was significantly higher in the acupressure group, compared to the placebo at 2 hours, and even up to 24 hours postoperatively, suggesting that the efficacy is prolonged past the immediate post operative period. Interestingly, they also found that the group receiving acustimulation "experienced lower pain scores in the PACU and fewer patients in this group had severe pain" when compared to the control group (p. 1072). Although slightly varying degrees of efficacy were noted among studies, all studies concluded that prophylactic stimulation of the P6 acupoint significantly reduces the prevalence of PONV in a variety of patient populations, and is advantageous due the portability and easy of application.

P6 Acustimulation vs. Pharmacological Treatment

Controversy still continues surrounding the optimal strategy to manage and reduce PONV, especially in regards to pharmacological management. Antiemetic drugs may carry serious side effects such as hypotension, extrapyramidal effects, and QT prolongation (Ertaz et al., 2015). Many factors surrounding pharmacological management are still unknown, and universal treatment is neither cost effective nor necessary. Wakefield et al. (2002), described droperidol as being the most cost effective antiemetic, while ondansetron remains superior as a rescue antiemetic. The question remains that can an intervention such as P6 acupressure produce comparable or even superior results of its pharmacologic counterpart?

One of the most popular and widely administered antiemetics includes ondansetron. Ondansetron is a competitive serotonin type 3-receptor antagonist (5-HT3), which blocks vagal afferent stimuli through 5-HT3 receptors, thus preventing the vomiting reflex. In a randomized, prospective, double-blind and placebo-controlled study conducted by Agarwal et al. (2002), 150 patients undergoing elective laparoscopic cholecystectomy were evaluated. The control group was compared to a 4 mg prophylactic dose of ondansetron or P6 acustimulation, and the results found that PONV in the first 6 hours following surgery was 44% in the control group, 10% in the acupressure group, and 8% in the ondansetron group. The same study concluded that P6 acustimulation provides a significant reduction in the incidence of PONV and is as effective as a 4 mg prophylactic dose of ondansetron. Gan et al. (2004) completed a similar study that also found P6 acustimulation to be equally effective as 4 mg of ondansetron. Although the incidence of immediate PONV was slightly less in the ondansetron group, the 24-hour incidence of vomiting was much lower in the P6 acustimulation group (19%), compared to the ondansetron group (32%).

Although it is outside the focus of the research question, Coloma et al. (2002) performed a RCT of 268 outpatients receiving ondansetron, P6 acustimulation, or a placebo, and they discovered an interesting result. In addition to concluding that P6 acustimulation is comparable in efficacy ondansetron, it was discovered that a higher percentage of patients in the acustimulation vs. ondansetron group (70% vs. 33%) also reported a regular sleep pattern 24 hours following surgery (p. 1390). Results such as this may pave the way in discovering added benefits in addition to PONV control while simultaneously reducing the need for pharmacological antiemetics. Most importantly, numerous other randomized control trials have

also established that P6 acustimulation is comparable in efficacy to ondansetron (Sharma & Goswami, 2007; Misra, Pullani, & Mohamed, 2005; Sharma & Goswami, 2007).

When compared to other common antiemetic drugs such as metoclopramide, the results are somewhat similar, while with others, such as dexamethasone are variable. Metoclopramide is an antagonist of the dopamine D2 receptor subtype, providing an antiemetic action while promoting gut motility. A randomized control trial of 120 children undergoing hernia repair, circumcision, or orchidopexy compared the effectiveness of metoclopramide, P6 acustimulation, and a placebo. The trial concluded that the control group had a higher incidence of PONV, and that acupressure to the P6 site is equally as effective as metoclopramide in preventing PONV in children (Butkovic, Toljan, Martolic, Kralik, & Radesic, 2005). Hickman et al. (2005) also noted "stimulation of the P6 acupoint was as effective as 2 standard antiemetics; cyclizine, 50 mg and metoclopramide, 10 mg" (p. 382). D2 receptor antagonists, such as metoclopramide are known for their undesirable side effect of extrapyramidal effects, which may contraindicate their use in a certain subset of patients. Although P6 stimulation may not abbreviate the same degree of bowel transit time, it has demonstrated to be a viable alternative while providing the same effect on PONV as metoclopramide (Direkvand-Moghadam, & Khosravi 2013).

The efficacy of dexamethasone, a well-known corticosteroid and anti-inflammatory, is commonly used as an adjunct to the pharmacological management of PONV and not as a sole antiemetic. Evidence lacks in direct comparison of P6 acupressure to dexamethasone. Therefor, a recommendation cannot be made until further research is conducted, and dexamethasone could be continued as an adjunct therapy to preventing PONV. Although there is literature to support P6 acupressure being as effective as metoclopramide and other antiemetics such as ondansetron, a strong argument to universally replace their therapy cannot be indisputably made at this time.

P6 Acupressure Combined with Pharmacological Treatment

Evidence has been emerging in the effectiveness of P6 acustimulation compared to traditional antiemetics but the question remains, is it the most efficacious way to use the therapy? Combining P6 acustimulation with pharmacologic antiemetics, especially ondansetron, may provide added PONV management that neither intervention could provide alone. For example, the Coloma et al. (2002) study found that there were no significant differences between the efficacies of ondansetron vs. acustimulation when either was used alone. However, when these treatments were compared to combination therapy, "significantly more patients receiving the combination therapy had no complaints of nausea or episodes of vomiting-retching" (p. 1390). Lee & Fan (2011) also described in their Cochrane Review that participants who receive of combination therapy of P6 acustimulation and ondansetron have a higher quality of recovery than those receiving either intervention alone. Because there are no major added side effects, P6 acupoint stimulation may be best suited as an alternative to antiemetic drugs in low risk patients, or in addition to antiemetic drugs for preventing postoperative nausea and vomiting in high-risk patients.

Cost Analysis

Pharmacological antiemetic costs vary from hospital to hospital, and are largely dependent on associated pharmaceutical companies (Nunley et al., 2008). Therefor, a risk benefit and cost benefit analysis should be conducted by a facility to decipher a protocol to both minimize PONV and associated hospital costs. The associated cost of using pharmacological antiemetics includes acquisition cost, time, impact on discharge, and additional materials if standard antiemetics fail. Nunley et al. (2008) found that each episode of vomiting adds an additional "20-minute delay in post-anesthesia discharge, resulting in a cost of several hundred

million dollars per year" (p. 254). It is clear that PONV is a valid and serious concern for the financial well being of a facility.

Although the purpose of this review is not intended to provide a detailed cost analysis among interventions, it is interesting to note that in the Gan et al. (2004) study,

> The acupoint stimulation unit utilized costs $200 (including 2 battery changes) and is reusable with disposable electrodes, which cost $1.84 for 4 electrodes (for each patient). The cost for ondansetron 4 mg is $16.44 (including a 2-mL syringe and needle). Assuming an acupoint stimulation unit is reusable in 200 patients, the direct cost comparison is substantial (about $3000 for ondansetron versus $600 for acupoint stimulation) (p. 1072).

The same study found that their patients would be willing to pay an average of "$56 - $100 for an antiemetic that would eliminated PONV" (p. 1072). Other studies have used TENS units that are reusable, and average a cost of $64, while some studies used less cost effective modes, such as disposable devices for each patient. It is important to note that acustimulation via a nerve stimulator can be performed routinely with virtually no added cost to the patient or hospital, which would then only require a cost analysis of the hospitals current pharmacologic modalities. The literature remains sparse in regards to cost analysis of P6 acustimulation, making further research needed to provide an up-to- date and accurate cost analysis.

Timing of Application

The optimal timing of P6 acustimulation lacks clear consensus at this point. It has been established that the mode of stimulation to the P6 site is insignificant, as long as the quality and accuracy of stimulation is present. What is still not understood is if the timing of the stimulus is of clinical importance. Studies vary in whether the stimulus is applied in a preoperative,

intraoperative, or postoperative setting, with the majority of the studies focusing on the application during the intraoperative period. A limited amount of research has been performed on the optimal timing of P6 stimulation. In the study by Hickman et al., 2005 the complete response rate was 68% when P6 stimulation was applied 30 minutes prior to surgery and 72 hours post surgery, compared to only 43% when it was applied only 30 minutes prior to surgery. This method may not be feasible in many circumstances, as the patient would have to be discharged with the acustimulation device and ensure proper positioning for the following 72 hours. Frey et al., 2009 performed a randomized control trial of 200 hundred women undergoing vaginal hysterectomy. Participants were administered P6 acustimulation either pre-induction, post-induction, or given a placebo treatment. They found that there is no significant difference in PONV reducing effects when P6 stimulation is applied pre-induction as apposed to post-induction and moreover, suggested that either method is equally as effective. Other trials have found similar results (Cheong et al., 2013; Lee & Fan, 2011), and concluded that if an optimal time to apply P6 acupressure exists, it remains unknown.

Side Effects

One of the most promising aspects associated with P6 acustimulation includes the efficacy of the treatment while carrying a positive safety profile. Ertas et al. (2015) described the use of various pharmaceutical agents occasionally carrying serious side effects as extrapyramidal effects, hypotension, cardiac dysrhythmias, and prolongation of the QT interval. Side effects such as these may limit or prevent the ability to use pharmacologic means of preventing PONV in certain patients. The side effects of non-invasive P6 acustimulation are rare, occurring in only 3.3% of patients and included only minor erythema and swelling (Nunley et al., 2008). P6

acustimulation can be used as an additional PONV adjunct therapy with no major added side effects (Arnberger et al., 2007; Frey et al., 2009; Lee & Fan, 2011)

Literature Search

A comprehensive search was conducted to answer the following question: Does the addition of Pericardium-6 acupoint stimulation decrease the incidence of post-operative nausea and vomiting (PONV) when used alone, or in combination with other traditional pharmacologic antiemetics? PubMed, CINAHL, and the Cochrane Library were the primary search engines used to gather pertinent data. These were accessed through The University of North Dakota Harley E. French Library of Health Sciences.

CINAHL was the first database utilized. Initial CINAHL headings used included “P6 stimulation”, which yielded 22 results. The search was modified using “P6 stimulation” AND “PONV”, yielding 3 results. The English language and peer-reviewed limits were then set, resulting in the same 3 articles. After review of the 3 articles, all were found to be pertinent to the clinical question.

PubMed was the following database utilized. Medical subject heading terms “P6 stimulation” were used to focus the search initially. This resulted in 248 articles. The search was refined using “P6 acustimulation” AND “PONV”, which yielded 14 results. Limits were then added which included English language, human species, and publication dates within the past 10 years. This resulted in a more refined and recently published group of articles. After a detailed review, 8 articles were found to be applicable.

The Cochrane Library was the last database used. The initial search criteria included the key words “P6 stimulation” and “P6 acustimulation” both of which yielded the same 3 results. The limits were then set to “Reviews”, yielding 2 high quality articles. The remaining 2 articles

were analyzed and one article was determined to be a high quality Cochrane Review pertinent to the research question.

After the initial literature search was complete through common databases, a total of 12 articles were obtained relevant to the research topic. Additional research means included examination of the relevant articles reference sections, which yielded access to an additional 7 articles. Research was also conducted though The Cochrane Library's Find Related Articles Function, in which 5 additional articles were accessed. At the completion of a comprehensive and thorough literature search, a total of 24 articles were collected to help answer the research question.

Discussion

When comparing the literature review with the case study, some similarities exist. According to Trueman (2011), the patient had the following PONV risk factors: young age, female gender, non-smoker, anxiety, history of PONV, laparoscopic surgery, and use of intraoperative opioids. In total, the patient had 7 risk factors, which placed her relative risk of suffering PONV at "very high" (> 80%). According to the literature review, recommended prophylaxis for this patient should include a multi-combination of anti-emetics, total intravenous anesthesia with propofol, and some form of P6 acustimulation. The anesthetic plan therefor would include a multimodal approach to ideally alleviate any PONV from occurring with the patient. The literature does not detail the ideal combination of antiemetics, nor the ideal dosage and timing of those drugs. A combination of 3 different antiemetics was chosen to occupy multiple receptors in the vomiting center. The patient received a transdermal scopolamine patch in the preoperative holding area, ondansetron 4 mg prior to induction, and dexamethasone 5 mg immediately following induction. Anesthetic inhalational agents were to be avoided due to their

known incidence of increasing PONV (Frey et al., 2009; Trueman, 2011, Wang et al., 2010). Anesthetic vaporizers were secured with tape prior to the case to avoid accidental initiation of any inhalational agent.

Determining the optimal stimulation method, timing, and duration of the P6 acupoint presented the biggest challenge. The literature review has established that the method (invasive vs. noninvasive) in which P6 acupoint stimulation is elicited is not of much importance compared to the accuracy of the stimulus (Dundee, 1990; Dundee et al. 1989; Lee & Fan, 2011; Trueman, 2011). For this reason, a peripheral nerve stimulator was chosen as the method to deliver P6 acustimulation due to multiple factors. Monitoring of neuromuscular blockade is standard in modern anesthesia, and necessary in this case due to the administration of the non-depolarizing neuromuscular blocker, rocuronium. The wrist was an easy accessible point on the patient, due to the arms being suspended bilaterally on arm boards and adducted slightly less than 90 degrees. This allowed the opportunity to provide supramaximal electrical stimulation of the P6 acupoint, while measuring neuromuscular blockade via the median nerve at the same time. It is also a safe, and cost effective manner to provide P6 acustimulation. In a prospective, double-blind, randomized control trial, Kim et al. (2011) established that

> Electrical stimulation of a peripheral nerve at the P6 acupoint improved PONV while simultaneously measuring neuromuscular blockade. Tetanic stimulation at 50 Hz for 5 seconds every 10 minutes decreased the incidence of PONV from 70% to 15.4% for the first 6 hours after surgery. (p. 821)

The P6 acupoint was located on the patient's dominant hand, and the proximal positive electrode was placed between the tendons of the palmaris longus and the flexor carpi radialis 1 cm proximal to the P6 acupoint. The distal negative electrode was placed 2 cm distal to the P6

acupoint. Each electrode was connected to the nerve stimulator and tetanic stimulation at 50 Hz for 5 seconds was delivered every 10 minutes for the duration of the procedure following induction of anesthesia. This followed the same strategy Kim et al. (2011) described in their randomized control trial of 264 women undergoing laparoscopic hysterectomy, which concluded P6 acustimulation with a nerve stimulator is effective in decreasing PONV. In a similar prospective, double-blinded RCT, Arnberger et al. (2007) investigated 220 women undergoing elective laparoscopic surgery. They utilized the same mode of P6 acustimulation, with the same electrode placement, but applied single-twitch stimulation with "1 Hz (over 0.2 ms, at a constant current of 50 mA) throughout the maintenance of anesthesia" (p. 904). Both studies described a significant decrease in PONV when using their described strategy for the first 6 hours post operatively, but found it less effective in the late postoperative period of 6-24 hours. Much like the two prior studies, the patient in the case study denied any episodes of PONV in the first 6 hours. The patient also described no episodes of PONV for the late postoperative period of 6-24 either, demonstrating a more favorable outcome.

In a study completed by Arnberger et al. (2007), subjects were given sodium thiopental, fentanyl, and rocuronium on induction, with Sevoflurane for maintenance anesthesia. Kim et al. (2011) provided anesthesia for subjects in which they received remifentanil, sodium thiopental, and rocuronium on induction, and anesthesia was maintained with Sevoflurane. An oral-gastric tube was also inserted during the case in which the stomach was emptied of contents. Both studies used glycopyrrolate and neostigmine in equivalent doses to reverse neuromuscular blockade until twitches returned to 100%. Rescue antiemetics were only administered post operatively if the subject displayed symptoms of PONV. Induction medications, maintenance anesthesia, and the use of antiemetics in the literature review differed from the strategy presented

in the case study. It is unknown to what degree these factors contributed to the reduction of PONV in my patient.

The results of the presented case study showed promise in that unilateral stimulation of the P6 acupoint while measuring neuromuscular blockade can be effective in reducing PONV in the early postoperative period, as well as late postoperative period. It also provides strong evidence that a multimodal approach to reducing PONV with the use of P6 acustimulation can be extremely effective.

Evidence Based Recommendations

Based on the current literature search, four practice recommendations can be put forth for anesthesia professionals to consider:

1. P6 acustimulation may be used as an alternative or adjuvant therapy for prevention of postoperative nausea and vomiting in low to moderate risk patients. Aggressive universal pharmacological prophylaxis is not effective in a risk to benefit ratio (Stoelting & Hillier, 2004). Due to its low cost, favorable side-effect profile, and relative efficacy, P6 acustimulation could be recommended for universal prophylaxis, or possibly replacing the use of a single prophylactic pharmacological dose of antiemetic.
2. In high-risk patients (with four or more risk present risk factors), P6 acustimulation should be used in conjunction to pharmacological prophylaxis as a multi-modal approach. This combination has shown to be significantly effective in high-risk patients to reduce vomiting and retching (Frey et al., 2009).
3. P6 acustimulation should be used in conjunction to pharmacological methods as a multi-modal approach in patients who may suffer from potential catastrophic consequences of PONV. Wang et al. (2010) suggested that in patients who have the potential for

catastrophic consequences, “if such a risk cannot be excluded, a multimodal antiemetic approach should be considered, regardless of individual risk factors” (p. 130).

4. Additional randomized control trials with large sample sizes should be conducted to determine the optimal timing and duration of P6 acustimulation. Establishing clear guidelines on application and duration will provide anesthesia providers with an optimal strategy to maximize the benefits of P6 acustimulation and further reduce PONV.

Conclusion

Post-operative nausea and vomiting is one of the most common side effects following anesthesia, capable of causing the patient severe mental and physical distress, prolong PACU stays, and increase healthcare costs. Pharmacological means of prophylaxis have been the mainstay treatment in the past. Although proven effective, they are also costly, have potential life threatening side effects, and do not eliminate PONV. Side effects and cost profiles of pharmacological antiemetics reinforce the broadly held belief that there remains opportunity for improvement.

The addition of P6 acustimulation has been suggested as an alternative to, or in conjunction with current pharmacological treatment, while carrying a cost effective and safe method for PONV prophylaxis. P6 acustimulation can also be suggested for use in combination therapy for those patients at high risk. The findings of this paper support the implementation of P6 acustimulation within the modern clinical practice; however further research is desired on the optimal timing and duration of application.

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MANAGEMENT OF POST-OPERATIVE NAUSEA AND VOMITING THROUGH STIMULATION OF THE PERICARDIUM-6 ACUPOINT

Nathan Roehrich, SRNA

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Introduction

- Post operative nausea and vomiting can occur at a rate of 25 % despite the use of traditional antiemetics
- Complications can include:
  - Dehiscence of sutures
  - Venous hypertension
  - Bleeding
  - Aspiration
  - Pneumothorax
  - Dehydration and electrolyte imbalances
  - Prolonged PACU stays
  - Increased hospital cost

(Ertaz et al., 2015)

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Risk Factors for PONV

- Patient Specific
  - Female gender
  - Age less than 50
  - Nonsmoker
  - Hx of PONV/motion sickness
- Anesthetic Related
  - Use of volatile anesthetics & Nitrous Oxide
  - High dose of opioids
- Surgery Related
  - Duration greater than 1 hour
  - Laparoscopic, strabismus, craniotomy, breast, etc.
  - Inexperienced surgeon
    - Increases length of surgery and unnecessary handling of tissues

(Nagelhout & Plaus, 2014)

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Etiology of PONV

- N/V are coordinated by emetic or vomiting center found in the lateral reticular formation
- Vomiting is caused by direct or indirect noxious stimuli via 1 or more of 4 additional sites
  - *Vagus Nerve* (eye, oropharynx, GI tract, mediastinum, peritoneum)
  - *Cerebral Cortex* (emotions, sights, smells)
  - *Vestibular Apparatus* (ear, movement)
  - *Chemoreceptor trigger zone CTZ* (blood, CSF)
- Conventional ligands involved: Histamine (H1), Acetylcholine (M1), Serotonin (5-HT3), Dopamine (D2), Neurokinin (NK1), Substance P

(Becker, 2010; Truman, 2011)

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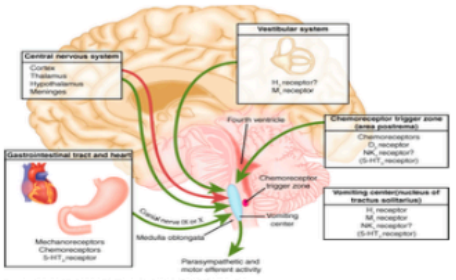
Etiology of PONV Cont.



SOURCE: (http://ddxof.com/nausea-and-vomiting/)

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Case Information

- Robotic assisted laparoscopic cholecystectomy
- 25 years old
- 72 kg
- Female
- ASA 2

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Pre-operative Evaluation

- Past Medical History:
  - Back pain
  - Myofascial pain
  - Sinusitis
  - Anxiety
  - Heart burn (occasional)
- Surgical History:
  - Cesarean section (hx of N&V)
  - Laparoscopic hernia repair (hx of N&V despite TIVA)
- Medications:
  - Acetaminophen
  - Hydrocodone-acetaminophen
  - Tizanidine
  - Cetirizine

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Pre-operative Evaluation

- Pre-op VS
  - BP: 116/71
  - Spo2: 98%
  - HR: 82
  - Temp: 98.6 F
- Pertinent labs
  - Hemoglobin: 13.3
  - Potassium: 4.1
  - Glucose: 98
- Airway evaluation
  - Mallampati: II
  - Thyromental distance: 3 fingerbreadths
  - Full neck ROM

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Anesthetic Course

- Medications:
  - Preoperative:
    - Transdermal scopolamine patch
    - 2 mg versed
    - 4 mg ondansetron
  - Induction:
    - 200 mcg fentanyl
    - 50 mg lidocaine
    - 30 mg rocuronium
    - 5 mg dexamethasone
- Technique
  - Total Intravenous Anesthetic
    - Vaporizers taped to prevent accidental usage
    - Propofol infusion started @ 175 mcg/kg/min and titrated to effect
- Rationale
  - Decease as many emetic stimuli as possible

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Intraoperative Issues

- High peak airway pressures with Trendelenburg position and CO_2 insufflation
  - Switched from VCV to PCV
    - Rate 12, Pinsp 25, PEEP 4
    - PAP decreased with adequate Tv
- Otherwise uneventful intraoperative course
  - Propofol titrated down towards end of case
  - Additional 50 mcg fentanyl given on emergence
  - 30 mg ketorolac
  - Patient extubated uneventfully after displaying adequate respiratory dynamics

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PACU

- Patient transferred to PACU with 4L NC
- Alert, orientated, responding appropriately
- Denied pain, or symptoms of nausea/vomiting
- Given 0.5 mg hydromorphone by PACU nurse
- No rescue antiemetics required

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Discussion

- Acustimulation is a noninvasive treatment modality applied by delivering transcutaneous signals on specific acupoints on the body's surface for therapeutic purposes.
- Delivered via means of physical, mechanical, or electrical pressure.
- Historically the Pericardium-6 (P6) acupoint is widely considered to be the "pre-eminent point to treat nausea and vomiting of any etiology."

(Trueman, 2011, p. 37)

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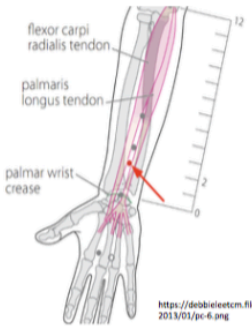
Discussion Cont'd



https://debbieleetcm.files.wordpress.com/2013/01/pc-6.png

- The P6 acupoint is located between the tendons of the palmaris longus and flexor carpi radialis muscles, approximately 4 cm or 2 fingerbreadths proximal to the wrist crease

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Discussion Cont'd

- Mechanism of action is not completely understood
- Impulses are sent through type I & II afferent nerve fibers and median nerve
- The generated signals travel to the body's central nervous system and the higher emetic center of the brain
  - Resulting in endorphins, enkalphin, adrenocorticotropic hormone release
  - The combination modulate the neural pathways between the brain and the stomach restoring normal gastric rhythm, blocking CTZ signals, and relieving nausea

(Nunley, Wakim, & Guinn, 2008)

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Discussion Cont'd

- P6 acupressure can be delivered by either invasive or non-invasive techniques
  - Invasive: Direct needling, dextrose injections
  - Noninvasive: Pressure bands, electrostimulation, ReliefBand®

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Discussion Cont'd

- A multitude of studies have concluded that P6 acustimulation reduces PONV compared to placebo treatments.
- Direkvand-Moghadam and Khosravi (2013) performed a RCT of 102 patients undergoing elective cesarean section.
  - 24 hour incidence of PONV was 50% in the control group and 20.58% in the P6 group.
- Gan et al. (2004) performed a RCT of 77 patients undergoing major breast surgery.
  - P6 acustimulation decreased the 2 hour incidence of PONV from 79% in the control group to 19% in the P6 group.
  - Also found pain scores and need for additional opioids was decreased.

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Discussion Cont'd

- P6 acustimulation is also comparable in efficacy to common antiemetics
- In a randomized, prospective, double-blind and placebo-controlled study conducted by Agarwal et al. (2002), 150 patients undergoing elective laparoscopic cholecystectomy were evaluated:
  - The control group was compared to a 4 mg prophylactic dose of ondansetron or P6 acustimulation
  - PONV in the first 6 hours following surgery was 44% in the control group, 10% in the acupressure group, and 8% in the ondansetron group.

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Discussion Cont'd

- A Cochrane Review completed by Lee and Fan (2011) of 40 RCT's involving 4,858 participants found:
  - There was no difference between P6 acupoint stimulation and pooled antiemetic drugs in the risk of nausea, vomiting, or need for rescue antiemetics.
    - Antiemetics evaluated included ondansetron, metoclopramide, prochlorperazine, cyclizine, and droperidol.
  - There was no difference between effectiveness of invasive vs. noninvasive forms of P6 acupoint stimulation.
  - Side effects were minor to nonexistent
  - *participants who receive of combination therapy of P6 acustimulation and ondansetron have more favorable PONV rates, and a higher quality of recovery than those receiving either intervention alone.

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Discussion Cont'd

- P6 with in combination with traditional antiemetics may be the best use for the therapy.
- Coloma et al. (2002) performed a RCT of 268 outpatients receiving ondansetron, P6 acustimulation, a placebo, or a combination of both.
  - Concluded that there were no significant differences between the efficacies of ondansetron vs. acustimulation when either was used alone.
  - However, when these treatments were compared to combination therapy, "significantly more patients receiving the combination therapy had no complaints of nausea or episodes of vomiting-retching" (p. 1390).
  - Discovered that a higher percentage of patients in the acustimulation vs. ondansetron group (70% vs. 33%) also reported a regular sleep pattern 24 hours following surgery.

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Discussion Cont'd

- P6 acustimulation in the presented case study was equivalent in technique to a prospective, double-blind, RCT in which 264 women underwent laparoscopic hysterectomy.
  - P6 acustimulation was delivered via several different modes during monitoring neuromuscular blockade of the median nerve with a traditional nerve stimulator.
  - Proximal positive electrode was placed between the tendons of the palmaris longus and the flexor carpi radialis 1 cm proximal to the P6 acupressure point.
  - The distal negative electrode was placed 2 cm distal to the P6 acupoint.
    - ST at 1-Hz, TOF every 15 seconds, DBS every 20 seconds, and **Tetanic stimulation at 50-Hz for 5 seconds every 10 minutes.**

(Kim, Kim, Lee, Shim, & Yoon, 2011)

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Discussion Cont'd

- Results found that the incidence of PONV was significantly lower in the tetanus group than any other for 0-6 hours:
  - *Control: 53.7%*
  - ST at 1-Hz: 40.4%
  - TOF: 37.7%
  - DBS: 26.4%
  - *Tetanus: 15.4%*
- Patient in this case study did not experience episodes of nausea or vomiting in her 24 hour stay.

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Evidence Based Recommendations

- P6 acustimulation may be used as an alternative or adjuvant therapy for prevention of postoperative nausea and vomiting in low to moderate risk patients.
- In high-risk patients (with four or more risk present risk factors), P6 acustimulation should be used in conjunction to pharmacological prophylaxis as a multi-modal approach.
  - This combination has shown to be significantly effective in high-risk patients to reduce PONV.
- P6 acustimulation should be used in conjunction to pharmacological methods as a multi-modal approach in patients who may suffer from potential catastrophic consequences of PONV.

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Conclusion

- P6 acustimulation can be used as a cost effective and safe adjunct for PONV prophylaxis.
- A multimodal approach in treating PONV remains the most effective technique.
- Further research should be conducted on the optimal application time, duration of therapy, and cost analysis of P6 acustimulation.

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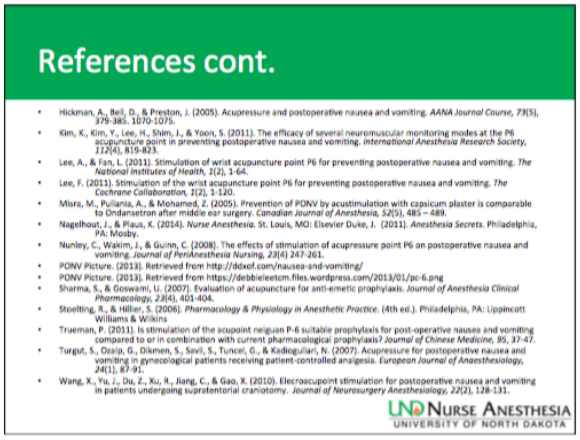

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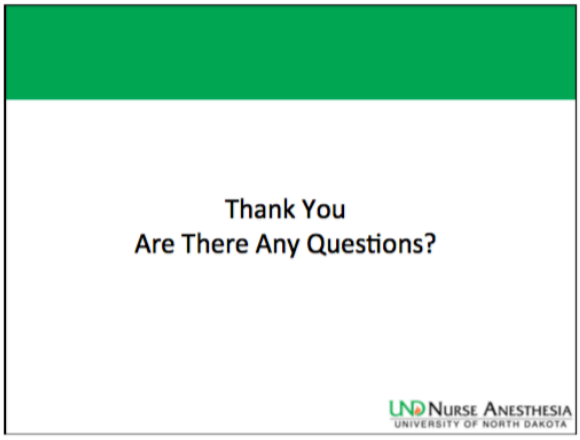

Thank You
Are There Any Questions?

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