

Acupuncture for the Prevention and Treatment of Pediatric Perioperative Conditions

Christine Stanley Martin, MD

ABSTRACT

Background: Many pediatric anesthesiologists are interested in multimodal approaches, such as acupuncture, to help manage clinical conditions commonly encountered in the perioperative setting.

Methods: A review of the web-based search engine PubMed was conducted to identify research articles that covered the use of acupuncture to prevent or treat perioperative conditions in pediatric patients. Once an article was identified, the reference list of that article was also reviewed to identify additional studies.

Results: Sixteen articles were included that investigated the use of acupuncture to prevent or treat four commonly encountered perioperative conditions in children: postoperative nausea and vomiting (PONV), emergence delirium or agitation, acute postoperative pain, and laryngospasm. Articles were excluded if they were not available in English or the specific acupuncture points used were not identified in the article. Acupuncture and acupressure at the Pericardium 6 point were the techniques most often used in studies on the prevention of PONV. However, there was variability in the duration and type of acupuncture or acupressure utilized. Two studies on emergence agitation were included and both reported a decrease in the incidence of agitation, compared to control groups. There is limited data on acute postoperative pain, and includes studies on pain after tonsillectomy and spinal fusion. There are mixed results from two studies on postoperative stridor and laryngospasm. Although many of the studies reviewed demonstrate the benefit of acupuncture in the perioperative setting, they were often conducted using techniques that could not easily be used in a busy anesthetic practice because of limited time and availability of specialized skills. Thus, the challenge for most clinicians is how to incorporate acupuncture into the daily practice of pediatric anesthesia.

Conclusions: There is some evidence to support the use of acupuncture to prevent common perioperative conditions in children. More research is needed to determine the best acupuncture techniques to use for these conditions.

Key Words: Nausea and Vomiting, Pain Management, Acupressure, Electroacupuncture

INTRODUCTION

MANY CHILDREN EXPERIENCE nausea and vomiting after anesthesia.¹ The use of acupuncture to prevent and treat postoperative nausea and vomiting (PONV) has been

the most thoroughly investigated perioperative condition in children.^{2–10} More recently, there have been a handful of studies investigating the use of acupuncture to prevent emergence delirium or agitation, a condition commonly seen in children in the postanesthesia care unit (PACU) as they are

Department of Anesthesiology & Perioperative Medicine, Oregon Health & Science University, Portland, OR.

CME available online at www.medicalacupuncture.org/cme Questions on page 418.

emerging from general anesthesia.^{11,12} There are a few research publications on the use of acupuncture for managing chronic pain conditions in the pediatric population,^{13,14} such as migraines,¹⁵ but there are a limited number of studies on acute postsurgical pain.^{16–18} Laryngospasm is an airway complication that can occur during induction, maintenance of and emergence from, anesthesia.¹⁹ While this complication occurs less commonly than nausea, pain, and emergence delirium, laryngospasm can lead to other serious complications. There are some data on utilizing acupuncture to prevent laryngospasm in children after general anesthesia.^{20,21} The purpose of this article is to review the scientific literature available on the use of acupuncture in the perioperative setting for pediatric patients.

METHODS

A search of the computerized database PubMed was conducted using the key words pediatrics, acupuncture, anesthesia, nausea, vomiting and pain. Studies were included only if they enrolled children ≤ 18 years old and were published in English between 1990 and 2015. It was also required that the research be conducted preoperatively, intraoperatively or in the postoperative period. Acupuncture was defined as the use of needles, bleeding, laser or electrical stimulation, or pressure applied to acupuncture points. After a study was identified as eligible for inclusion in this review, the reference list of the article was then reviewed. This was done to identify any additional articles not identified during the search of PubMed.

RESULTS

Postoperative Nausea and Vomiting

Many children experience nausea and vomiting after anesthesia. This complication can be very distressing to the patient, delay discharge from the PACU, and add additional stress for caregivers during the recovery period. Risk factors that increase the occurrence of PONV in children include surgical duration ≥ 30 minutes, age ≥ 3 years old, history of PONV in a child's relatives, and strabismus surgery. Children that have 0–1 of these risk factors have a 10% risk of experiencing PONV. Children with all 4 risk factors have a 70% risk of PONV. Because of this high incidence of occurrence, anesthesiologists must be aggressive in administering medications to prevent PONV.

Techniques for preventing PONV have a cumulative effect in decreasing the risk of PONV. While many of these medications are well-tolerated, some have a risk of unpleasant side-effects, such as increased sedation. Therefore incorporating nonpharmacologic techniques, such as acupuncture, to prevent PONV could be an important tool to further decrease the occurrence of PONV in children without increasing potential side-effects.

There are a few studies from the 1990s that investigated the use of acupuncture and acupressure for the prevention of postoperative vomiting in children undergoing strabismus surgery. In 1991 Lewis and colleagues randomized 66 children to receive either bilateral Pericardium 6 (PC 6 or *Nei Guan*) acupressure or placebo.² PC 6 is located 2 cun* proximal from the distal palmar crease between the wrist tendons of the palmaris longus and flexor carpi radialis. There was no difference in the incidence of postoperative vomiting in the PACU, at home on the day of surgery and within the first 24 hours after surgery.²

Yentis and Bissonnette also found no benefit with PC 6 acupuncture in their study of 90 children who underwent strabismus surgery.³ Children in this study were randomized to receive the antiemetic droperidol, droperidol with PC 6 acupuncture, or acupuncture alone. Acupuncture was performed on the right PC 6 point for 5 minutes of manual stimulation.³ There was no difference in the incidence of vomiting among the three groups before discharge or 48 hours after surgery.³ Droperidol, an antagonist of dopamine and alpha-adrenergic receptors, is no longer commonly used in pediatrics because it carries a black box warning for its serious side-effect of causing cardiac arrhythmias including Q-T prolongation and torsades de pointes.

A later study published in 1998 by Schlager et al. found a statistically significant benefit of PC 6 acupuncture for prevention of postoperative vomiting.⁴ This study randomized 40 children undergoing strabismus surgery to either laser acupuncture at the PC 6 point or placebo. Laser stimulation was performed at bilateral PC 6 points over 30 seconds at two timepoints: 15 minutes before induction of anesthesia and 15 minutes after arrival in the PACU. In the placebo group, the laser was placed at bilateral PC 6 points but was not activated. In the first 24 hours, there was significantly less vomiting in the laser acupuncture group compared to the placebo group (25% versus 85%; $P = 0.0001$).⁴

Tonsillectomy with or without adenoidectomy is a very common surgical procedure performed in the pediatric population. Like strabismus surgery, it is also associated with a high incidence of PONV in children. Acupuncture has also been utilized in a number of studies of PONV after this procedure. Yentis and Bissonnette published one of the first studies in 1991. Forty-five children were randomized to have acupuncture after induction of anesthesia at the PC 6 point for 5 minutes or no acupuncture placement.⁵ There was no significant difference in the rates of vomiting between the two groups of patients.⁵

Shenkman et al. also did a study using the PC 6 point in children undergoing tonsillectomies with and without adenoidectomies.⁶ The researchers utilized two stages of treatment: the first stage involved placement of Acubands with pressure beads at bilateral PC 6 points prior to induction of

*1 cun is the width of the thumb at the interphalangeal joint.

anesthesia. In the second stage, the Acubands were removed after induction of anesthesia and replaced with acupuncture needles at bilateral PC 6 points. One hundred children were randomized to either the study group, in which the beads and needles were placed at the PC 6 point, or the placebo group, in which the beads and needles were placed at a sham point located more proximally on the forearm. Vomiting and retching were documented in each subject for an average of 19 hours postoperatively. The number of children in each group who experienced vomiting (26% versus 28%) or retching (51% versus 55%) did not differ between the acupuncture group and the placebo group.⁶

More recently, in 2002, Rusy et al. published a study in which they found a significant decrease in PONV in children treated with electroacupuncture (EA) at PC 6.⁷ The researchers randomized 120 children undergoing tonsillectomy with or without adenoidectomy to three study groups: (1) a PC 6 acupuncture treatment group; (2) a sham acupuncture group; and (3) a no-needle control group. In the acupuncture treatment group two needles were placed after removal of the tonsils. One needle was placed at PC 6 and a second needle was inserted at a neutral point midway up the forearm on the same meridian. This second point was used as a surface electrode to allow electrical current to flow through PC 6. After each child awakened, 4 Hz of electrical stimulation was applied to the points for 20 minutes. In the sham acupuncture group, a needle was placed at the acupuncture point Pericardium 2 (PC 2) and a neutral point. Electrical stimulation was administered in the same manner as the treatment group. In the control group, no needles were placed. In all three groups, the arms were covered with soft restraints in an attempt to keep the three groups blinded.

The Rusy et al. study⁷ is one of the few in which nausea in the postoperative period was assessed. The primary outcomes were nausea, vomiting, and the need for rescue treatments in the first 24 postoperative hours. The incidence of nausea was significantly lower in the acupuncture group, compared with the control group (60% versus 93%; $P=0.007$).⁷ There was no difference in rates of nausea in the sham acupuncture group and the control group (85% versus 93%; P =not significant).⁷ When comparing the PC 6 acupuncture and control groups, no significant differences were found in the incidence of vomiting (63% versus 78%) and the use of rescue therapy for nausea and vomiting (58% versus 60%).⁷ Of note, none of the participants received prophylactic antiemetics, such as dexamethasone and ondansetron, during the intraoperative period. This likely contributed to the high incidence of nausea and vomiting seen in all three of the study groups.

One of the largest studies of acupuncture for the prevention of PONV in children was conducted by Wang and Kain at Yale University and published in 2002.⁸ They randomized 187 children having general anesthesia for outpatient surgeries. A yoking randomization technique was used to assign study participants to one of four research groups.

This was done to assure similar ages, gender distribution, and type of surgery in each research group. Each patient in Group I (acupoint) received an intravenous (I.V.) saline injection plus acupoint injections at bilateral PC 6 points. Acupoint injections consisted of injecting 0.2 mL of a 50% dextrose solution at bilateral PC 6 points. Each patient in Group II (droperidol) received 10 mcg/kg of I.V. droperidol as well as bilateral PC 6 sham acupuncture. Sham acupuncture was defined as making a superficial skin prick at PC 6. Patients in Group III (sham) received I.V. saline injections with bilateral sham-point injections. Sham-point injections were performed using the same technique as the acupoint injections, but the dextrose fluid was placed at a nonacupuncture point located in the upper arm. Each patient in Group IV (PC 6 sham point) received an I.V. saline injection with bilateral PC 6 sham acupuncture. I.V. injections of saline or droperidol were administered after the induction of anesthesia. Acupoint PC 6 injections, sham-point injections, and sham PC 6 acupuncture were performed at the end of the surgical procedure, but prior to emergence from anesthesia.

Study subjects were then evaluated for nausea, vomiting, and retching in the PACU. A phone call was also made to obtain information on these outcomes within 24 hours postoperatively. In the PACU, the incidence of nausea was significantly less in the acupoint group, compared with the sham-point group ($P=0.029$) and the PC 6 sham group ($P=0.002$).⁸ There was no difference in nausea in the acupoint group, compared with the droperidol group ($P=0.18$). Similarly, the incidence of vomiting in the PACU was also lower in the acupoint group, compared to the sham-point group ($P=0.026$) and the PC 6 sham group ($P=0.029$).⁸ The incidence of vomiting in the PACU was similar in the acupoint group, compared to the droperidol group ($P=0.57$). After 24 hours postoperatively, there were no differences among any of the groups in the incidence of either nausea or vomiting. Based on the results of this study, both acupoint injection of bilateral PC 6 points and droperidol produced a similar decrease in the incidence of PONV in the PACU, but neither continued to have a significant effect into postoperative day (POD) 1.

Another study comparing acupuncture with an I.V. antiemetic medication (ondansetron) was conducted in 90 children who underwent general anesthesia for dental surgery.⁹ Subjects were randomized to receive acupuncture at bilateral PC 6 points and the Conception Vessel 13 point (CV 13, *Shang Wen*), ondansetron (0.15 mg/kg up to 8 mg I.V.) or placebo (saline). Acupuncture needles were placed after induction of anesthesia and remained in place for 15 minutes. Ondansetron and the saline (placebo) were administered as an I.V. infusion over 20 minutes. Surgery did not commence until the acupuncture needles were removed or the I.V. infusion was completed. Nurses in the PACU documented vomiting episodes. Caregivers were also contacted the day of surgery and on POD 1 to determine the

number of vomiting episodes at home. The caregivers were also asked to quantify their satisfaction with the antiemetic treatments received by the study subjects.

There was no significant difference among the three groups in the number of vomiting episodes occurring in the PACU.⁹ However, both the acupuncture group and the ondansetron group had significantly fewer episodes of vomiting on the day of surgery after discharge from the PACU ($P < 0.0001$).⁹ This difference did not continue into POD 1, during which subjects in all three groups had similar rates of vomiting. Parental report of overall satisfaction with antiemetic treatment was significantly higher in the acupuncture and ondansetron groups, compared with the placebo group ($P = 0.019$).⁹ Comparing the acupuncture and ondansetron groups revealed no differences in the incidence of vomiting at any of the study timepoints. Similarly, satisfaction scores were also not different between these two groups. In this study, acupuncture was at least as effective in reducing vomiting as commonly used ondansetron.

For prevention of PONV, PC 6 is the acupuncture point that has been best studied in both children and adults. A group from Austria published a study in 2000 that utilized acupressure at Korean hand points for the prevention of postoperative vomiting in children undergoing strabismus surgery.¹⁰ Fifty children were randomized to either an acupressure group or a control group. In the acupressure group, a special Korean acupressure disc (*AB-Bong*) was applied 30 minutes prior to induction of anesthesia, bilaterally to the Korean hand acupuncture point K-K 9, located on the fourth finger.¹⁰ The point was described as corresponding to, but not being identical to, the Chinese acupuncture point PC 6. The acupressure discs were left in place, and the research subjects remained in the hospital for at least 24 hours after surgery. The percent of patients who experienced vomiting in the first 24 hours after surgery was significantly less in the acupressure group compared to the control group (20% versus 68%; $P = 0.001$).¹⁰

EMERGENCE DELIRIUM

Emergence delirium, or emergence agitation, is a common complication after general anesthesia in the pediatric population. In the literature, the reported incidence of emergence delirium after anesthesia is highly variable, ranging from 20% to 80%. The condition occurs more frequently in children who have received anesthesia using volatile inhaled anesthetics. Certain medications, such as propofol, fentanyl, or dexmedetomidine may be beneficial for reducing the incidence of emergence delirium. Pediatric patients who experience agitation after anesthesia can become a danger to themselves or others, especially hospital staff and caregivers. Furthermore, delirium can often delay a child's discharge from the PACU.

Acupressure might be a useful nonpharmacologic technique to prevent emergence delirium. Acar and colleagues investigated the use of acupressure to prevent emergence agitation in 50 pediatric patients undergoing adenoidectomy and/or tonsillectomy.¹¹ Participants were randomized to either an acupressure group, in which capsicum plasters were applied to bilateral Heart 7 points (HT 7, *Shen Men*) preoperatively, or to a sham group, in which inactive plasters were placed at the same location as the treatment group. The HT 7 point is located at the distal transverse crease of the wrist, between the flexor digitorum superficialis and the flexor carpi ulnaris. Plasters were placed 30 minutes prior to the induction of anesthesia.

The research subjects were monitored for emergence agitation every 5 minutes for a total of 15 minutes in the PACU using the Post-Anesthetic Emergence Delirium (PAED) scale. A PAED score of ≥ 10 of a possible total of 40 is often used in the literature as the cutoff point for emergence delirium. Using this score, the number of children with emergence agitation was statistically significantly lower in the acupuncture group than in the sham group (28% versus 60%; $P = 0.023$).¹¹ However, the median PAED scores at any of the 4 timepoints (0, 5, 10, and 15 minutes) did not differ between the two groups. The researchers also measured pain scores in the PACU using the Children's Hospital of Eastern Ontario Pain Scale (CHEOPS) scale. There was no significant difference between the median pain scores of the two groups at any of the measured timepoints.¹¹

The use of acupuncture to prevent emergence agitation has also been studied in children undergoing another very common pediatric procedure—placement of myringotomy and tympanostomy tubes. Lin et al. enrolled 60 children undergoing this procedure and randomized them to receive acupuncture at bilateral HT 7 and bilateral Large Intestine 4 (LI 4, *He Gu*) points or no treatment (control group).¹² In the acupuncture group, needles were placed immediately after induction of anesthesia, manually manipulated for 10 seconds, and left in place for at least 10 minutes. An observer monitored the patients in the PACU for pain and agitation every 5 minutes until discharge. Pain was assessed using CHEOPS and emergence agitation was rated on a 4-point scale.

The acupuncture group, compared to the control group, had a statistically significant decrease in CHEOPS pain scores at all timepoints from arrival in the PACU until 30 minutes after arrival. The acupuncture group also had a statistically significant reduction in their agitation scores, compared to the control group, at all measured timepoints.¹² Rescue treatment for postoperative agitation was administration of oral acetaminophen. There were statistically fewer patients in the acupuncture group requiring rescue treatment, compared with patients in the control group (57% versus 87%; $P = 0.02$).¹² Based on these results, acupuncture at the HT 7 and LI 4 points appears to be beneficial for

decreasing both pain and agitation in children after placement of myringotomy and tympanostomy tubes.

ACUTE POSTSURGICAL PAIN

The two studies on acupuncture and emergence agitation described earlier both included evaluations of postoperative pain in the PACU. Results were mixed as the study of patients post-tonsillectomy showed no decrease in pain scores, but acupuncture did reduce pain in the PACU in the post-myringotomy tube placement study.^{11,12}

More recently, Tsao et al. published a study examining the use of intraoperative acupuncture for post-tonsillectomy pain.¹⁶ Fifty-nine children were enrolled and block randomized to receive acupuncture or sham acupuncture. Acupuncture needles or sham needles were placed after induction of anesthesia and removed prior to the conclusion of surgery. Four ear points were needled, using SEIRIN[®] Jr. acupuncture press tacks in the study group, or control stickers in the sham group. Ear points included *Shen Men*, Cingulate, Master Cerebral, and Tonsil points. EA with alternating frequencies of 4 and 100 Hz was conducted from point LI 4 to Stomach 36 (ST 36, *Zu San Li*), PC 6 to Triple Energizer 5 (TE 5, *Wai Guan*), and at Kidney 6 (KI 6, *Zhao Hai*).¹⁶ The PC 6 point was chosen for its antiemetic effect, and all the other points were incorporated into the EA for their analgesic properties. In addition, acupuncture needles were placed at HT 7 to decrease postoperative agitation. Primary endpoints of the study were time spent in the PACU, and opioid administration in the operating room and PACU.

A home survey completed by the caregivers was used to capture pain measurements and rates of nausea/vomiting. There was no difference between the two groups for primary outcomes of opioid administration in the operating room and PACU ($P=0.38$ and 0.76 respectively).¹⁶ There was also no effect of acupuncture treatment on the duration of time spent in the PACU ($P=0.51$).¹⁶ Parents completed home surveys using the Wong Baker Pain FACES scale to rate pain perceived by both parents and the children. Scores were recorded two times per day through POD 3. The pain scores reported by the participants were statically significantly lower in the acupuncture group, compared with those reported in the sham acupuncture group ($P=0.0065$).¹⁶ The parent-reported pain scores were also lower in the acupuncture group, compared with the parent-reported scores for the controls, but this did not reach statistical significance ($P=0.051$).¹⁶ There was no difference in the rates of nausea and vomiting between the two groups as reported by parents in the home survey ($P=0.12$).

While acupuncture treatment did not affect PACU time or use of opioids, it appeared to decrease pain scores after discharge from the hospital.¹⁶ PACU discharge times can depend on many factors unrelated to patient pain, such as nurse availability and a parent's comfort level with caring for a patient at home. One limitation on implementing this acupuncture

regimen into clinical practice is that nine acupuncture points were utilized and the time required to complete all the needling may be unacceptable in a busy operative environment.

Acupuncture has also been studied to treat acute pain in the pediatric intensive care unit (PICU). Wu et al. recruited two groups of pediatric patients from the PICU to participate in two consecutive acupuncture treatment sessions. Group 1 included children ages 7–18 who had undergone spinal-fusion surgery and were able to utilize patient-controlled analgesia.¹⁷ Group 2 included surgical and nonsurgical patients ages 6 months to 18 years who required I.V. analgesics. For all study subjects, needles were manually manipulated both after insertion and 10 minutes later. Needles were removed after 15 minutes. A second session of acupuncture was conducted 24–48 hours after the first session.

A total of 3–6 needles were placed for each patient, and needle locations were tailored to the specific locations of pain. Needle locations were more standardized for patients in Group 1 and included Large Intestine 4 (LI 4, *He Gu*), Liver 3 (LR 3, *Tai Chong*), Bladder 60 (BL 60, *Kun Lun*) and Kidney 3 (KI 3, *Tai Xi*).¹⁷ In addition to vital signs, pain scores and opioid usage were recorded at intervals of 2, 4, 8, and 24 hours after acupuncture treatment. Groups 1 and 2 had significant decreases in pain scores 4 hours after treatment with acupuncture, compared to their pretreatment pain scores ($P<0.05$).¹⁷ Within 4–8 hours after acupuncture, narcotic usage decreased for Group 1, but the change was not statistically significant. There were no statistically significant changes in pain scores at any timepoints after the second acupuncture session for either group. This study demonstrated a potential benefit of using acupuncture for managing acute postoperative pain beyond just the operative and PACU periods. Acupuncture may be beneficial for many children requiring hospital admission after surgical procedures, as it is common for these patients to continue experiencing postoperative pain after transition from the PACU to the PICU or hospital ward.

Acupuncture may also have a beneficial role in patients who have complex pain conditions in the postoperative period, such as phantom-limb pain. In 2015, a case report was published that described the use of acupuncture for treating phantom-limb pain in a 16-year-old female with osteosarcoma.¹⁸ The patient had undergone a hemipelvectomy and subsequently developed severe phantom-limb and postoperative pain. The acupuncture technique used was the National Acupuncture Detoxification Association (NADA) acupuncture protocol, which includes five ear points (*Shen Men*, point 55; Liver, point 97; Kidney, point 95; Lung, point 101; and Sympathetic, point 51).¹⁸ The NADA protocol is most often used in conjunction with group therapy to treat drug withdrawal.

This patient underwent a total of 12 sessions throughout a 6-week period, and completed the Measure Yourself Concerns and Wellbeing (MYCaW) questionnaire.¹⁸ Using this questionnaire, the patient reported both a reduction in her phantom-limb pain as well as an improvement in her general well-being.¹⁸ This case report is an example of how using

acupuncture for pediatric patients with complex postoperative pain could provide a reduction in pain and improvements in mood and overall well-being. For some pediatric patients, acupuncture could be a beneficial addition to a multimodal approach to management of acute postoperative pain.

LARYNGOSPASM

Laryngospasm is an airway complication that can be stimulated by the presence of blood or secretions in the airway, especially during light planes of anesthesia. Laryngospasm is closure of the glottis caused by reflexive constriction of the laryngeal muscles that continues even after removal of the inducing stimulus. In complete laryngospasm, no ventilation is possible. This can lead to more serious complications, including hypoxia, arrhythmias, cardiac arrest, and even death. It is a complication more commonly seen in pediatric patients undergoing general anesthesia than adults.

Lee and colleagues investigated if acupuncture can be used to prevent laryngospasm in the pediatric population after general anesthesia.²⁰ Seventy-six children were enrolled; all had general anesthesia with tracheal intubation using cuffed endotracheal tubes. Subjects underwent a variety of surgical procedures, but none involved surgery of the oral pharynx. Patients randomized to an acupuncture group were treated with acupuncture and bloodletting at bilateral *Shao Shang* points in each thumb immediately before extubation. This treatment consisted of using a sharp, wide and hollow needle to puncture the acupuncture location.²⁰ The needle was then removed after insertion and the location was allowed to bleed. Control group subjects received no extra interventions.

If laryngospasm occurred in the treatment group after extubation and any patient's oxygen saturation decreased below 90% despite jaw thrust and controlled ventilation with 100% oxygen, additional acupuncture and bloodletting was performed at the *Shang Yang* (LI 1) point bilaterally in the index fingers. If a similar scenario occurred in the control group, they received acupuncture at the *Shao Shang* points bilaterally. There was a lower incidence of laryngospasm in the acupuncture group, compared to the control group (5.3% versus 23.7%; $P < 0.05$).²⁰ The incidence of laryngospasm in the control group was relatively high, compared to rates of laryngospasm published in the literature. In this study extubation was conducted when the patients began swallowing, which may not have been an appropriate indication of readiness for safe extubation.²⁰

Another study conducted in Iran also used bloodletting acupuncture for the prevention of stridor after extubation.²¹ The researchers randomized 60 patients to receive either acupuncture at the *Shao Shang* point immediately before extubation or no intervention. There was a higher rate of postextubation stridor in the acupuncture group, compared to the control group (33% versus 3%; $P = 0.006$).²¹ None of the patients in this study experienced complete laryngospasm.

Given the mixed results of these two studies,^{20,21} it is still unclear if acupuncture is beneficial for preventing postextubation stridor and laryngospasm. Furthermore, the acupuncture technique used in both studies would be difficult to integrate into clinical practice, as many anesthesia providers and parents would not be comfortable using bloodletting acupuncture.

DISCUSSION

There is growing interest in integrating multimodal techniques to help prevent and treat commonly encountered conditions in the perioperative period, such as PONV, emergence delirium, and acute postoperative pain. Acupuncture is a modality that could benefit patients with these conditions with minimal risk of serious side-effects. While there are an increasing number of studies of acupuncture in the pediatric population, the best approach to integrating acupuncture into a clinical anesthesia practice remains unknown for the conditions reviewed in this article.

One of the challenges researchers face is determining the frequency and duration of acupuncture treatment to achieve a clinical effect. Many anesthetics used in pediatric patients are administered for a limited duration. For example, Lin et al studied acupuncture for preventing emergence agitation in patients receiving myringotomy tubes, a procedure that is often performed in <30 minutes.¹² Placing acupuncture needles in children prior to anesthesia may not be acceptable to either patients or their caregivers. However, placing acupuncture needles after induction of anesthesia may not allow for a sufficient duration of needle placement to achieve a benefit. Two of the early studies on using acupuncture to address PONV included needle placement at PC 6 for only 5 minutes.^{3,5} These studies showed no significant effect of acupuncture for preventing PONV, potentially because the duration was inadequate to produce a clinical effect. Furthermore, repeated treatments with acupuncture, such as those used by Wu et al. to relieve acute pain,¹⁷ may not always be feasible, given that the majority of children are discharged to go home on the same day of their surgeries.

Researchers must also consider what would be the best type of acupuncture or acupressure to use to achieve the desired effect. One advantage of acupressure, which was used in studies by Shenkman et al.⁶ and Schlager et al.,¹⁰ is that awake children are more likely to tolerate this than acupuncture. This difference would allow for a longer duration of placement because acupressure could be initiated preoperatively. Other techniques, such as laser acupuncture, have been studied for preventing PONV in children,⁴ but the equipment and skills needed to utilize laser acupuncture may be more difficult to acquire and implement safely. Bloodletting was used in both studies for the prevention of laryngospasm.^{20,21} The results from these two studies were mixed, and it may be difficult to obtain permission from patients and caregivers to use the bloodletting technique. Furthermore, providers may

not feel comfortable implementing bloodletting, compared with more-standard needle acupuncture.

The particular characteristics of each perioperative condition also influence how each one can best be prevented with acupuncture. Stridor, laryngospasm, and emergence agitation tend to present during or immediately after emergence from anesthesia. PONV often develops within the first few hours after anesthesia, but can persist for days after the anesthetic. Therefore, monitoring for these outcomes and the effect of acupuncture must be conducted for varying lengths of time depending on the perioperative condition.

Postoperative pain is often most severe immediately after surgery but can continue for days to weeks after a procedure. Patients may therefore need to be followed for a prolonged period of time to determine the efficacy of acupuncture for preventing postoperative pain. The complexity of studying acupuncture for the prevention of postoperative pain is exacerbated by the fact that it greatly depends on the type of surgery performed. Acupuncture regimens have to be tailored to specific locations of pain and may not be transferable to other surgical procedures.

One main advantage of acupuncture is that it is associated with mostly mild adverse events, estimated to occur at a rate of 11.8%.²² These mild adverse events include crying, pain, bruising, transient bleeding, worsening of symptoms, and vasovagal events. Some of these mild adverse events could be avoided by either placing the needles after inducing general anesthesia or using acupressure instead of acupuncture. The risk of severe adverse events caused by acupuncture is very low. Unfortunately, while some of the reviewed studies demonstrated benefit from acupuncture or acupressure, many were conducted using techniques that could not easily be used in a busy anesthetic practice because of limited time and availability of specialized skills. Thus, the challenge for many clinicians continues to be determining how to integrate acupuncture into their daily practices of pediatric anesthesia.

CONCLUSIONS

There is an increasing body of literature on the use of acupressure and acupuncture for children in the perioperative period. Acupuncture in conjunction with standard care appears to have a beneficial effect on emergence delirium and PONV. More research is needed to assess the cost and ease of acupuncture and acupressure integration with anesthesia in the operating room, and their role in relieving other postoperative complaints.

AUTHOR DISCLOSURE STATEMENT

Dr. Martin has no commercial associations that might create a conflict of interest in connection with submission of the manuscript for this article.

REFERENCES

- Eberhart LH, Geldner G, Kranke P, Morin AM, Schäuffelen A, Treiber H, Wulf H. The development and validation of a risk score to predict the probability of postoperative vomiting in pediatric patients. *Anesth Analg*. 2004;99(6):1630–1637.
- Lewis IH, Pryn SJ, Reynolds PI, Pandit UA, Wilton NC. Effect of P6 acupressure on postoperative vomiting in children undergoing outpatient strabismus correction. *Br J Anaesth*. 1991;67(1):73–78.
- Yentis SM, Bissonnette B. Ineffectiveness of acupuncture and droperidol in preventing vomiting following strabismus repair in children. *Can J Anaesth*. 1992;39(2):151–154.
- Schlager A, Offer T, Baldissera I. Laser stimulation of acupuncture point P6 reduces postoperative vomiting in children undergoing strabismus surgery. *Br J Anaesth*. 1998;81(4):529–532.
- Yentis SM, Bissonnette B. PC6 acupuncture and postoperative vomiting after tonsillectomy in children. *Br J Anaesth*. 1991;67(6):779–780.
- Shenkman Z, Holzman RS, Kim C, et al. Acupressure–acupuncture antiemetic prophylaxis in children undergoing tonsillectomy. *Anesthesiology*. 1999;90(5):1311–1316.
- Rusy LM, Hoffman GM, Weisman SJ. Electroacupuncture prophylaxis of postoperative nausea and vomiting following pediatric tonsillectomy with or without adenoidectomy. *Anesthesiology*. 2002;96(2):300–305.
- Wang SM, Kain ZN. P6 acupoint injections are as effective as droperidol in controlling early postoperative nausea and vomiting in children. *Anesthesiology*. 2002;97(2):359–366.
- Somri M, Vaida SJ, Sabo E, Yassain G, Gankin I, Gaitini LA. Acupuncture versus ondansetron in the prevention of postoperative vomiting: A study of children undergoing dental surgery. *Anaesthesia*. 2001;56(10):927–932.
- Schlager A, Boehler M, Pühringer F. Korean hand acupressure reduces postoperative vomiting in children after strabismus surgery. *Br J Anaesth*. 2000;85(2):267–270.
- Acar HV, Yilmaz A, Demir G, Günel Eruray S, Dikmen B. Capsicum plasters on acupoints decrease the incidence of emergence agitation in pediatric patients. *Paediatr Anaesth*. 2012;22(11):1105–1109.
- Lin YC, Tassone RF, Jahng S, Rahbar R, Holzman RS, Zurakowski D, Sethna A. Acupuncture management of pain and emergence agitation in children after bilateral myringotomy and tympanostomy tube insertion. *Paediatr Anaesth*. 2009;19(11):1096–1101.
- Zeltzer LK, Tsao JC, Stelling C, Powers M, Levy S, Waterhouse M. A phase I study on the feasibility and acceptability of an acupuncture/hypnosis intervention for chronic pediatric pain. *J Pain Symptom Manage*. 2002;24(4):437–446.
- Kemper KJ, Sarah R, Silver-Highfield E, Xiarhos E, Barnes L, Berde C. On pins and needles? Pediatric pain patients' experience with acupuncture. *Pediatrics*. 2000;105(4[pt2]):941–947.
- Pintov S, Lahat E, Alstein M, Vogel Z, Barg J. Acupuncture and the opioid system: Implications in management of migraine. *Pediatr Neurol*. 1997;17(2):129–133.
- Tsao GJ, Messner AH, Seybold J, Sayyid ZN, Cheng AG, Golianu B. Intraoperative acupuncture for posttonsillectomy

- pain: A randomized, double-blind, placebo-controlled trial. *Laryngoscope*. 2015;125(8):1972–1978.
17. Wu S, Sapru A, Stewart MA, Milet MJ, Hudes M, Livermore LF, Flori HR. Using acupuncture for acute pain in hospitalized children. *Pediatr Crit Care Med*. 2009;10(3):291–296.
 18. Kurath-Koller S, Bauchinger S, Sperl D, Leithner A, Urlesberger B, Raith W. Use of NADA ear acupuncture in an adolescent patient with phantom limb pain after surgery for osteosarcoma. *Acupunct Med*. 2015;33(1):82–84.
 19. Miller R, Eriksson L, Fleisher L, Wiener-Kronish J, Young W, eds. *Miller's Anesthesia, 7th ed*. Philadelphia: Churchill Livingstone Elsevier; 2010.
 20. Lee CK, Chien TJ, Hsu JC, Yang CY, Hsiao JM, Huang YR, Chang CL. The effect of acupuncture on the incidence of postextubation laryngospasm in children. *Anaesthesia*. 1998;53(9):917–920.
 21. Saghaei M, Razavi S. Bloodletting acupuncture for the prevention of stridor in children after tracheal extubation: A randomised, controlled study. *Anaesthesia*. 2001;56(10):961–964.
 22. Adams D, Cheng F, Jou H, Aung S, Yasui Y, Vohra S. The safety of pediatric acupuncture: A systematic review. *Pediatrics*. 2011;128(6):e1575–e1587.

Address correspondence to:
Christine Stanley Martin, MD

Department of Anesthesiology & Perioperative Medicine
Oregon Health & Science University
3181 SW Sam Jackson Park Road, BTE-2
Portland, OR 97239

E-mail: martich@ohsu.edu

**To receive CME credit, you must complete the quiz
online at: www.medicalacupuncture.org/cme**

CME Quiz Questions

Article Learning Objectives:

After studying this article, participants should be able to assess the current English language evidence for acupuncture in the prevention and treatment of pediatric perioperative conditions. Participants should also be able to apply the best current evidence on acupuncture in the management of pediatric perioperative conditions.

Publication date: December 2, 2015

Expiration date: December 31, 2016

Disclosure Information:

Authors have nothing to disclose.

Richard C. Niemtzwow, MD, PhD, MPH, Editor-in-Chief, has nothing to disclose.

Online CME Questions:

1. According to the authors, the most thoroughly investigated perioperative use of acupuncture is:
 - a) to prevent emergence delirium.
 - b) to prevent laryngospasm.
 - c) to prevent and treat postoperative nausea and vomiting.
 - d) for the management of chronic pain in the pediatric population.
2. The studies on acupuncture in the prevention of postoperative nausea and vomiting (PONV):
 - a) Stimulation of the acupuncture point PC 6 (Nei Guan) is the technique most often used in the studies on the prevention of PONV.
 - b) The published studies on PONV have utilized identical methods of point stimulation.
 - c) In the studies cited on PC6 stimulation for PONV, all types of stimulation demonstrated equal effectiveness.
 - d) In separate studies on children undergoing strabismus surgery, the techniques of laser stimulation of PC 6 and the use of Korean acupressure disc (AB-Bong) on point K-K9 both demonstrated significantly reduced pain in the first 24 hours post-op compared to placebo.
3. Emergence agitation:
 - a) No acupuncture studies have demonstrated effectiveness for emergence agitation in the pediatric population.

- b) Pediatric patients who experience emergence agitation are fortunately not a danger to themselves or caregivers and this delirium is not a cause of delay of discharge from the PACU.
 - c) In children undergoing myringotomy and placement of tympanostomy tubes, needle acupuncture of HT 7 (Shen Men) and LI4 (He Gu) demonstrated significantly reduced agitation scores, need for rescue treatment, and pain scores compared to no treatment controls.
 - d) Emergence agitation refers to a hyperactivity syndrome in grade school children which occurs in the afternoon immediately after the end of school hours.
4. According to the authors, perioperative acupuncture in the pediatric population presents unique difficulties because:
- a) The ideal needle gauge for use in the pediatric population has not been identified.
 - b) Many surgeries performed on children are of a limited duration and placing acupuncture needles after induction of anesthesia may not allow for a sufficient duration of needle placement to achieve a benefit.
 - c) Children have demonstrated no preference for type of acupuncture point stimulation, e.g., acupressure, needle stimulation, laser stimulation, bloodletting.
 - d) Parental consent is sometimes difficult to obtain.
5. According to studies cited by the authors:
- a) Preoperative application of capsicum plasters to bilateral HT 7 (Shen Men) significantly reduced emergence agitation and pain scores in pediatric patients undergoing adenoidectomy/tonsillectomy.
 - b) Needle acupuncture of LI 4 (He Gu) and HT 7 (Shen Men), performed immediately after induction of anesthesia, significantly reduced emergence agitation and CHEOPS pain scores at all time points for pediatric patients undergoing myringotomy and tympanostomy tube placement.
 - c) Research trials on laser stimulation and auricular acupuncture have yielded the most promising results to date for post-extubation laryngospasm.
 - d) Studies employing bloodletting acupuncture at Lung 11 (Shao Shang) immediately before extubation have shown consistently beneficial results on the incidence of post-extubation laryngospasm.

Continuing Medical Education – Journal Based CME Objectives:

Articles in *Medical Acupuncture* will focus on acupuncture research through controlled studies (comparative effectiveness or randomized trials); provide systematic reviews and meta-analysis of existing systematic reviews of acupuncture research and provide basic education on how to perform various types and styles of acupuncture. Participants in this journal-based CME activity should be able to demonstrate increased understanding of the material specific to the article featured and be able to apply relevant information to clinical practice.

CME Credit

You may earn CME credit by reading the CME-designated article in this issue of *Medical Acupuncture* and taking the quiz online. A score of 75% is required to receive CME credit. To complete the CME quiz online, go to <http://www.medicalacupuncture.org/cme> – AAMA members will need to login to their member account. Non-members have opportunity to participate for small fee.

Accreditation: The American Academy of Medical Acupuncture is accredited by the Accreditation Council for Continuing Medical Education (ACCME). **Designation:** The AAMA designates this journal-based CME activity for a maximum of 1 *AMA PRA Category 1 Credit*[™]. Physicians should claim only the credit commensurate with the extent of their participation in the activity.